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On Cloud-Pendants.

By F. J. W. Whipple, M.A.

PROBABLY any observer watching such cloud-pendants as are shown in the sketches in the January number of the *Meteorological Magazine* would gather the impression that they originated in the cloud. It is therefore worth while emphasizing the point that the pendant consists of waterdrops formed from the surrounding air, not of drops which have descended from the cloud.

It is known that the pendant marks the centre of a vortex. With the rapid rotation of the air centrifugal force is developed and pressure at the centre is reduced. The motion being violent, this reduction of pressure takes place quickly and the expanding air is therefore cooled. If the cooling brings the temperature below the dew-point, drops of water will be formed, and these constitute the cloud-pendant. It will be seen that according to this theory the whirlwind is the essential, the presence of the low cloud is just an indication that the air is so humid that the dew-point may be reached by a slight reduction of pressure. Close to the cloud the necessary reduction of pressure is comparatively small and a large proportion of the cross-section of the vortex is occupied by the drops of condensed moisture. Near the ground or sea the interval between the temperature of the atmosphere and its dew-point is greater, and at most only the centre of the vortex is cold enough for the drops to form. It is therefore to be expected that the pendant will be funnel-shaped. As the energy of the whirlwind is exhausted the centrifugal force fails, and the air in the vortex, being re-compressed to atmospheric pressure, is warmed up and the drops evaporate. The cloud-pendant seems to withdraw into the cloud, but actually it is being dissipated.

A cloud-pendant at sea gives rise to a waterspout, the sea-water sputtering up as the vortex passes. That the pendant itself is not formed by the sea-water is well brought out by the sketch issued with the Monthly Meteorological Chart of the East Indian Seas, January 1921.

An outstanding difficulty in the discussion of the origin of whirlwinds is that in laboratory experiments, as in the theory of fluid motion, a vortex must either be re-entrant or else end on the boundary of the fluid. It is therefore of special interest to notice that in both our illustrations the cloud-pendants occur in pairs. It may be that in such cases a single vortex of horse-shoe or hair-pin shape has its ends on the ground and arches up into, or even beyond, the cloud. Evidence as to the direction of rotation in such twin pendants would be valuable.

As justification for the suggestion that the temperature at the centre of a whirlwind may be reduced below the dew-point we can consider a particular numerical case. On a day with low and heavy clouds and much turbulent motion the lapse-rate of temperature would be nearly adiabatic, *i.e.*, $5\frac{1}{2}°$ F. per 1,000 feet. Let us assume clouds at a height of 1,000 feet, so that pressure at cloud-level is less than that on the ground by about 30 mb. The presence of the cloud is direct evidence that the gradual reduction of pressure by 30 mb. will lower the temperature of a sample of air from ground-level sufficiently to produce condensation. For a whirlwind with its axis cutting through the cloud to produce a pendant reaching to the ground the reduction of pressure at the centre of the vortex must be 30 mb. Such a deficiency of pressure represents suction which would support 1 foot of water, and is by no means exceptional in whirlwinds. The corresponding difference between air-temperature and dew-point is $5\frac{1}{2}°$ F.

As to the rate of rotation of the air in the vortex, we may take as a good enough approximation the simplest assumption that the air of the whirl rotates like a solid, whilst the air beyond is stationary. Then we have

$$P_0 - P_1 = \tfrac{1}{2}\rho a^2\omega^2 = \tfrac{1}{2}\rho v^2,$$

where P_0 and P_1 are pressures outside and at the centre of the vortex, ρ is the mean density of the air, a the radius of the vortex, ω its angular speed, and v the speed at the outer surface where slipping takes place.

In such problems it is convenient to remember that the millibar is the unit of pressure on the D.T.S. (decametre, tonne, second) system. Writing $P_0 - P_1 = 30$, $\rho = 1 \cdot 2$, we find $v = 7$, so that the maximum wind speed is 70 metres per second or 160 miles per hour. Such speeds have been estimated for the wind in tornadoes. To find the angular speed of our rotating column, we must know its size. If the width of the top of the funnel where it joins the cloud be regarded as the diameter of the rotating column, and we may suppose it to be 20 metres (66 feet), then the angular speed is 7 radians per second and the column turns once a second.

How and why such rotation is produced is at present an unsolved problem.

The Scottish Meteorological Society.

AT meetings held in Edinburgh on December 17th, 1920, and in London on January 19th, 1921, appropriate action was taken to bring about the incorporation of the Scottish Meteorological Society with the Royal Meteorological Society. The Scottish Meteorological Society after a career of 65 years thus ceases to exist as a separate entity.

As may be learned from a paper by Mr. A. Watt in the Journal (Vol. XV., No. 28), the foundation of the Society in 1855 was due mainly to the exertions of Sir John Stuart Forbes, of Pitsligo and Fettercairn, Bart., and Mr. David Milne Home, of Wedderburn and Milne Graden. The period was one of special significance. The British (now the Royal) Meteorological Society had been founded five years before as a successor to the Meteorological Society of London (1823–40). The Meteorological Department of the Board of Trade—the forerunner of the present Meteorological Office—was in process of organisation. The work of Dove on the distribution of temperature over the globe had stimulated interest in the science, while Leverrier had just organised a daily weather report in France. As regards Scotland itself, the considerable amount of observational work which had been done by enthusiastic amateurs required co-ordination.

The Society had its birth at a meeting held on July 11th, 1855, in the rooms of the Highland and Agricultural Society of Scotland, presided over by the eighth Marquis of Tweeddale. The Duke of Argyll, F.R.S., was elected President, and an influential Provisional Council was formed, among whom we may note Thomas Stevenson, the lighthouse engineer, father of Robert Louis Stevenson* and designer of the well-known Stevenson screen. Until 1908, when the constitution was revised, appointments were practically permanent, and there had been only four Presidents, the Duke of Argyll being succeeded by the Marquis of Tweeddale, the Duke of Richmond and Gordon, and the Hon. Lord M'Laren. Such well-known names as Lord Kelvin, P. G. Tait, John Aitken, Sir Arthur Mitchell, Sir John Murray, and Professor Chrystal appear in the roll of officers and members of the Council.

The activities of the Society have been numerous. For some years after its foundation Dr. Stark was Secretary, and he virtually created a network of about 50 observing stations. An Ozone Committee was extremely active for a long period. In 1883 the Society erected an observatory on the summit of Ben Nevis for the study of mountain conditions, and in 1890 opened a sea-level station at Fort William to work in conjunction with it. The observatories remained in operation till 1904, and their supervision absorbed much of the energies of the Society, but in that year financial difficulties led to their closing. A most valuable series of observations extending over 20 years had, however, been obtained, and their discussion by Buchan, Omond, and other authors, in the Transactions of the Royal Society of Edinburgh is of permanent value.

Throughout its existence the Society has regularly published its Journal, in which the observations of Scottish observatories and lighthouses have been co-ordinated and many important papers on Scottish and general meteorological subjects have appeared.

No review, however brief, of the work of the Society could be written without mention of the work of Dr. Alexander Buchan, who was appointed Secretary in December 1860. He had previously been a schoolmaster at Dunblane and had made his mark as a botanist. Dr. Buchan became one of the most eminent of meteorologists; his work on "The Mean Pressure of the Atmosphere and the Prevailing Winds of the Globe" has been described by Professor Hann as epoch-making and as constituting a starting point for the newer meteorology. On the return of the "Challenger" expedition the meteorological data were placed in Dr. Buchan's hands

* It is interesting to note that in 1873 Robert Louis Stevenson, who was a member of the Society, contributed a paper on "Local Conditions influencing Climate," which was read but not published in full. He also communicated to the Royal Society of Edinburgh a paper on "The Thermal Influence of Forests," which was published in the Proceedings of that Society.

for discussion. In 1889 he published an elaborate report on "Atmospheric Circulation," based on these observations and on meteorological statistics from all parts of the world. In addition to other works, a large number of papers were published by him in the Journal, and with the co-operation of Dr. A. J. Herbertson he prepared the Atlas of Meteorology, which was published by the enterprise of Dr. J. G. Bartholomew. Dr. Buchan retained the secretaryship until his death in 1907, when he was succeeded by Mr. Andrew Watt, who had been his personal assistant for seven years and who has ably carried on the traditions of the Society.

Dr. Wedderburn, Hon. Secretary of the Society, who graduated as a meteorologist by assisting the late Sir John Murray in researches on lake temperatures, was Meteorological Officer in the Gallipoli and Salonika campaigns, and subsequently when stationed at Shoeburyness systematised the use of balloon observations in artillery practice.

In recent years the association between the Society and the Meteorological Office has been very close, and the Edinburgh Branch Office was located in the Society's rooms until a few months ago, when the Office took over the responsibility for all the statistical work which had been organised by the Society. Fortunately, Mr. Watt, with his twenty years' experience of Scottish meteorology, has been able to accept an appointment on the staff of the Edinburgh Office.

The concentration of effort which will result from the incorporation of the Scottish in the Royal Meteorological Society should be of benefit to the study of meteorology throughout the Empire.

OFFICIAL NOTICES.

Collective Weather Reports for London and S.E. England. As from March 1st, 1921, the code used for these reports will be modified in accordance with the recommendations of the International Commission for Weather Telegraphy, London, 1920. Copies of the revised code (M.O. Form 2622) are obtainable on application, *Meteorological Office, Air Ministry, Kingsway, W.C.2.*

British Rainfall Organization Postal Arrangements.

ARRANGEMENTS have now been made by which official correspondence addressed to The Superintendent, British Rainfall Organization, *62, Camden Square, London, N.W.1*, and marked "On His Majesty's Service," can be transmitted free of postage. It is important to note that the form of address prescribed must be used. Otherwise letters must be stamped in the ordinary way.

Climatological Stations.

WITH the retirement at the close of 1920 of Mr. Edwin C. Hathaway in charge of Lloyd's Signal Station at Cape Spartel in Morocco, the useful series of meteorological observations which he has maintained there since May 1893 comes to an end. The record was continuous with one exception—on August 9th, 1914, the Signal Station was attacked by Moors and subsequently was temporarily closed. The instruments were transferred to the neighbouring lighthouse, and on August 17th the observations were recommenced under Mr. Hathaway's direction. In January 1916 the instruments were taken back to the Signal Station.

Official Publications.

Report of Proceedings of the Fourth International Meteorological Conference. Paris, 1919.

THE French edition of the Minutes of the International Meteorological Conference at Paris, 1919, was noticed in the *Meteorological Magazine* for March 1920. The English edition, which is now issued, contains two additional appendices which should be useful for reference. One is a geographical list of institutions and persons who have, during the last ten years, sent publications to the Meteorological Office; the other a list of institutions on the presentation lists of the Office.

British Meteorological and Magnetic Year Book, 1917. Part IV.—Hourly Values from Autographic Records.

THIS volume contains summaries on the same lines as its predecessors, as well as general articles discussing some of the results.

It is of interest to notice that the installation of apparatus to detect the rate of leakage from the electrograph at Eskdalemuir is placed on record. The bugbear of the observer who wishes to investigate the fluctuations of the electric potential gradient is defective insulation of his apparatus, caused, for instance, by the industry of spiders, and the value of a safeguard by which this fault may be readily detected will be appreciated.

The development of a sound system of classification of days according to the amount of disturbance of the magnetic field has been the subject of a good deal of discussion amongst magneticians of late years, and attention may be called to the tables prepared at Eskdalemuir to facilitate comparison between the old system, which depends so largely on the personality of the tabulator, and the new, which is to be a matter of routine.

Discussions at the Meteorological Office.

THE discussion on January 10th, 1921, was on "The position in space of the Aurora Polaris from observations made at the Haldde Observatory, 1913–1914," by L. Vegard and O. Krogness (Kristiania, 1920).

The paper was brought before the meeting by Dr. Chree. It forms No. 1, Vol. 1, of a series published by the new Norwegian Geophysical Committee, and contains reproductions of many auroral photographs, besides much statistical data and descriptions of apparatus and methods used.

To determine auroral heights, simultaneous photographs showing the aurora and neighbouring stars were taken from the two ends of a base-line. Some photographs were taken with a base-line of 26·3 km. (Haldde-Gargia), others with one of 12·5 km. (Haldde-Bossekop). A measurable degree of parallax relative to the stars was obtained, and both sets of observations give the average height of the aurora as about 100 km. Measurements of the upper visible limit ranged from 103 km. to 335 km. The azimuths of the westward end of bands and arcs were also investigated and showed much variation, the mean azimuth measured from the magnetic meridian being about 80°. Coronal measurements gave the radiant point of the rays an altitude about one degree less than the magnetic dip.

Dr. Chree stated that the Norwegians have been pioneers in the measurement of auroral heights. As regards theory, the two chief authorities recognised in Norway are Professor Störmer and the late Professor Birkeland. It is supposed that electrical charges emanating from the sun penetrate our atmosphere, describing spirals round the earth's lines of magnetic force and so tending to approach the magnetic pole. According to Birkeland, the emanations are cathode or β rays, but Störmer has put forward reasons for considering them to be α rays. After discussing these theories in the light of their observations, Vegard and Krogness discard the α ray hypothesis in favour of that of β rays.

At the meeting on January 24th Mr. L. F. Richardson discussed papers by W. Schmidt on (1) exchange of mass in irregular currents in the free air and its consequences, and (2) the effects of the exchange of air on climate and the diurnal variation of temperature in the upper air.

The central idea of Schmidt's papers is that the same laws will govern the exchange of various properties between layers of the atmosphere. Heat, water vapour, dust, and carbonic acid can all be transported, and in each case the result of mixing two samples of air from different regions is that the concentration of the property in question is averaged. The rate at which this averaging takes place is measured by a certain coefficient A, the "Austausch," which is defined by the author in a somewhat complicated way. In the kinetic theory of a gas regarded as an aggregate of molecules the "Austausch" would be proportional to the frequency with which molecules cross unit area on a horizontal plane and to their mean free path. In the theory of eddies there is nothing which corresponds exactly with the mean free path, and the specification of the "Austausch" leads to difficulties. The "Austausch" is closely related to the coefficient ξ of Mr. Richardson's own papers on this subject, and it is equal to $k\rho$, where k is the coefficient denoted by that symbol in G. I. Taylor's work and ρ is the density.

As an example of Schmidt's results we may quote his estimates of the rate at which water passes upwards in the form of vapour past the levels of 1,000 m. and 3,000 m. For Lindenberg he finds that in the course of the average day ·063 grammes of water are carried upwards across each square centimetre at 1,000 m. and similarly ·039 at 3,000 m. These values are arrived at by estimating the "Austausch" from considerations of wind strength, and applying the result to find the movement of the water vapour.

The great range in the possible values of the "Austausch," which is practically a measure of turbulence, is remarkable. Using wind observations, Schmidt finds that the average "Austausch" at 200 metres is nearly 30 times that at 1 metre.

The following subjects are announced for discussion :—

February 21st.—Dr. G. C. Simpson: British Antarctic Expedition, 1910–13 (Meteorology).

March 7th.—W. J. Humphreys : Optics of the Air : Journal of the Franklin Institute, October and November 1919.

March 21st.—R. Emden: Radiative Equilibrium and Atmospheric Radiation. Munich. SitzBer. Ak. Wiss., 1913, p. 55.

The Royal Meteorological Society.

THE Annual General Meeting of the Royal Meteorological Society was held on January 19th in the rooms of the Royal Astronomical Society, Mr. R. H. Hooker, President, in the Chair. The business of the Meeting included the adoption of the Report of the Council for 1920, the election of the Council for 1921, and the passing of resolutions bringing about the incorporation of the Scottish Meteorological Society, a matter which is referred to on another page of this Magazine. The Royal Meteorological Society has reverted this session to evening meetings during the winter in place of the afternoon ones of the war years, and the merits of this change were debated.

The subject of the Presidential address delivered by Mr. Hooker was "Forecasting the crops from the weather." The following is a brief summary :—

Forecasts of harvests fall into two main groups, those which predict the succession of good and bad crops in cycles and those in which knowledge of the weather actually experienced is made the basis of an estimate of the subsequent crop. A good deal has been written concerning periodicity in the weather and the resultant cycles in agricultural production, but it seems that insufficient progress has yet been made to allow of reliable prophecies for any particular season being made by this method; and indeed few authors who have discovered such cycles have based actual predictions upon them.

As to the possibility of measuring the gain or loss directly caused by given variations of rainfall or temperature, various methods of ascertaining relationships between the weather at different seasons of the year and the subsequent harvest have been evolved. Originally writers such as Gilbert and Lawes could only examine the meteorological conditions in years of exceptional abundance or scarcity. A great advance was made when Sir Rawson Rawson, and later Sir Napier Shaw, studied an entire sequence of crops and the previous weather conditions, and suggested formulæ from which the crop might be calculated. Still wider possibilities were opened by the method of correlation. Successive advances have been made by Jacob, Kincer, Okada, Walter, Wallén, and others. These authors have established relationships which can be utilised in the preparation of precise forecasts of the yield of various crops. It is of great importance to notice that direct observation of the growing plants is not of itself a safe guide in predicting the coming harvest. It is abundantly clear, from comparison with actual forecasts in India and elsewhere, that the weather is responsible for developments in the plant which are not visible to an observer surveying the young crops in the fields, and the time is ripe for using meteorological statistics in conjunction with the survey of the crops for preparing such forecasts.

The President urged the extreme importance to the welfare of the country and of the whole world of a knowledge of the out-turn of the crops, enabling us to provide in good time against scarcity or to arrange for the distribution of a surplus. Whereas 25 years ago England held the place of honour in such research, this was no longer the case and we now occupied a very inferior position to the United States and several of our colonies. The subject of agricultural meteorology was now being taken up by the International Agricultural Institute, and he appealed to scientific men in this country to devote themselves to the investigation of this vital problem.

The Revised Rainfall Averages.

SINCE the year 1910 the average values used in the rainfall tables in this Magazine have been those for the period of 35 years 1875 to 1909, and the same averages have been used in the tables in *British Rainfall.* The principal value of averages is to supply a medium for comparison, and it is undesirable therefore to make any unnecessary change, but as time goes on the records for which averages are available drop out one by one and, occasionally, revision is necessary.

For the climatological normals referred to in the *Monthly Weather Report* of the Meteorological Office the period of 35 years 1881 to 1915 is now in use, the normals in question being printed in Section I. of the *Book of Normals of Meteorological Elements,* which is in course of publication. It was a matter of convenience and expediency to come into line. Opportunity has now therefore been taken to compute a new series of average values for 1881–1915, and these are brought into use for the first time in the present issue of the *Meteorological Magazine.* The number of complete records for the period in question is considerably greater than that for the 35 years ended in 1909. The choice of stations for the tables is thus widened and a more satisfactory representation of the country as a whole is thereby secured.

For all purposes 550 monthly averages were computed, and it is hoped shortly to publish them as a section of the *Book of Normals,* and to adopt them for use in *British Rainfall.*

In discarding the old averages and introducing the new it is important to ascertain the relation between the two. The comparison is limited to the records which appear in both series, that is, to records which had been continued without a break from 1875 to 1915, and to secure a representative distribution 118 stations were selected. The method adopted was to express the new average for each month as a percentage of the old. The percentage values were plotted on maps and their distribution indicated by means of isopleths. The maps are of considerable interest, but want of space makes it impossible to reproduce them. By far the majority of the individual monthly averages differ by less than 5 per cent. from the old series, but in every month except May, August, October and November some areas showed deviations of as much as 10 per cent., the adjacent stations exhibiting a good agreement. The month of least regional change was May, and that of most pronounced regional change April. In the last-named month there was a well-marked graduation from a deficiency of 16 per cent. in the new average as compared with the old in the neighbourhood of London to an excess of 20 per cent. in the West Highlands. This was the only month with a very definitely marked regional distribution. Apart from geographical variations the month of greatest change was September, which was everywhere drier in the new period, the value of the general rainfall for the whole country falling by 10 per cent. In December the average increased everywhere except on part of the east coast, the general value for the British Isles being 8 per cent. above the old average. The map for the whole year indicates that in the west the average for 1881 to 1915 is from 1 to 3 per cent. higher than that for 1875 to 1909, in the east from 1 to 3 per cent. lower. In a narrow strip along the east coast, one or two stations showed a falling off of as much as 4 per cent. This would appear to indicate that the rainfall of the years 1910 to 1915 now included was more definitely orographical than that of the excluded years 1875 to 1880, and the inference is made stronger by the fact that the general values for the countries are increased in winter, when orographical rain is most frequent, and decreased in summer, when it is a minimum. The general values for the whole year are practically identical for the two periods.

AVERAGE RAINFALL 1881–1915 AS PERCENTAGE OF AVERAGE 1875–1909. GENERAL VALUES.

Month.	England.	Wales.	Scotland.	Ireland.	British Isles.
January	103	102	100	100	101
February	100	103	104	106	103
March	107	108	103	103	105
April	93	103	105	99	98
May	98	99	101	99	99
June	97	99	94	97	96
July	95	95	98	101	97
August	97	98	99	100	98
September	89	90	93	91	90
October	98	97	95	97	97
November	98	101	101	101	100
December	110	110	105	108	108
Year	99	100	100	100	99

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

Meteorological Terminology.

PROFESSOR V. BJERKNES, of Bergen, has written about the use of the word "tropopause" as a short name for the surface separating troposphere and stratosphere, and asks whether the component word "pause," which means stopping or falling off, could be applied in other cases to indicate a surface of discontinuity. He gives as examples polar-pause for the surface separating polar and equatorial air, and trade-wind-pause or trade-pause for the surface separating the trades from the anti-trades.

I have suggested thermo-pause for the former of these two discontinuities, as indicating the surface where warmth ends and cold begins, and I propose anemo-pause as a general name for a surface of separation between winds in opposite directions, so that the trade-anemo-pause would indicate the surface of separation between the trades and superjacent anti-trades.

At the same time I may remark that I find it very difficult to grasp the meaning that is intended by "anti-trades." The original convection theory suggested that the anti-trade was the trade returning up aloft above its old path, but, so so far as I can understand the situation, the track of wind from the Equator must begin from the east and become south-west by following what I will describe as a hurricane track. On the other hand, a south-west wind may be part of the westerly circulation diverted; the difference of origin of the observed south-westerly wind is of some dynamical importance.

NAPIER SHAW.

January, 1921.

Hill-Mist and Rainfall.

HAVING had experience of the weather on the hills of the north of England and on the Grampians of Scotland, I may make a few remarks on Mr. Bonacina's article in the November number of the *Meteorological Magazine.* As the ground rises nearly 1,100 feet within half a mile from my house to an altitude of 1,551 feet above sea-level, and to 1,989 feet in less than one and a half miles, I have good opportunities of studying the formation of mist during rainfall. Without going out of doors I have views of the summits of four fells varying in elevation from 1,825 to 2,250 feet at a distance of from 4½ to 6 miles.

In reply to Mr. Bonacina's question at the conclusion of his article, my experience coincides with that given by Mr. Wardale (*Met. Mag.*, pp. 252–253), viz., that it *is* usual on the high hills to get dense cloud-fog and steady rain at the same time. The exceptions generally occur after the passing of the trough of a depression, especially when this is of the V-shaped type. On such occasions I have seen the dense hill-mist, which accompanied the rain on the advancing side of the Low, suddenly clear off completely, leaving all the mountains perfectly clear from base to summit, the rain meanwhile still continuing from high nimbus which gradually thinned out to clear blue sky as the rain ceased. In the great majority of cases, however, the advent of rain on our mountains, whether steady rain or showers (I am not now speaking of convectional or thunderstorm rain, but of the combination of cyclonic and orographical rain which makes up the bulk of our total fall), is quickly followed by a lowering of the mist level, more especially if the wind be blowing directly from the sea and low country. The phenomenon may be observed here almost any time during cyclonic weather, and I have also experienced it on many of the highest mountains in Scotland and of the Lake District. I could give dates and full details, but space forbids. The effect of falling rain, as is well known, is almost always to chill the air over the low ground—except sometimes just at the break up of anticyclonic frosty weather in winter—and as the wind is forced up the hill slopes, the further chilling by expansion causes condensation at a lower level than would otherwise be the case if the air from below had not been already chilled. I therefore cannot follow Mr. Bonacina when he says that "whatever the reason may be, there is no doubt about the general observation that when heavy rain approaches the hills the cloud-fog over them rises." This may be true in some parts of the south of England, but certainly not, so far as my observations go, in the north of England and Scotland. I have never known a case "when a decided, sometimes even heavy, rain in the valleys degenerated into a hill-mist, often relatively dry at a height which may vary from about 600 feet upwards." The very opposite is usually the case. On our high hills one generally gets the rain of the valleys combined with a heavy drizzle. Typical mountain rain, as I know it, consists of large or medium sized drops with the addition of drizzle. I think the rain on our hills is much oftener composite in character than rain in the lowlands. This is what would be expected, as such rain contains drops which have fallen from high up in the atmosphere—the precipitation probably consisting first of snow from the region of cirro-stratus—*plus* the smaller rain drops formed lower down and of the drizzle locally produced on the hill slopes within a few hundred feet of the surface by the ascending currents of air. Of course, pure orographical drizzle also often occurs, as on November 7th to 9th last, when the fall here amounted to ·73 in. whilst that at the neighbouring coast stations was insignificant.

With regard to the "washing out" process mentioned by Mr. Bonacina, there is no doubt falling rain drops must tend to reduce the density of mist, but I doubt if the effect is ever appreciably noticeable to the eye, at any rate during windy weather, as the ascending air on the hill slope from which condensation is taking place is continuously being pushed upwards and replaced by a fresh supply from below, the process continuing so long as the temperature, humidity, and direction of the wind remain favourable.

As mentioned by Mr. Bonacina, the annual rainfall in Britain usually increases with elevation up to the summits of our highest hills. It is probable, however, that rain gauges on mountains, especially when the rain is only measured monthly, seldom give an adequate value of the total fall owing (1) to the sweep of the wind causing eddies about the gauge, and (2) to the fact that at high altitudes so much of the precipitation in winter consists of snow. A large portion of this is blown from the summits and ridges on to the leeward slopes, and also into rock crevices and sheltered hollows. A visit to the gauge after a heavy fall may show the funnel almost empty of snow and the ground about it swept bare. Almost the only occasions when my rain gauge on Fairsnape Fell, Lancashire, at 1,630 feet, has, during about 20 years, shown a smaller fall than the gauge in the adjacent valley, have been during those winter months when the snow fall was considerable and the winds strong in force. ALBERT WILSON, F.L.S., F.R.Met.Soc.

Havera Bank, Sedbergh, Yorks, 24th December, 1920.

MR. WARDALE and others who have written in connection with my recent article appear to have missed the real point at issue, namely, whether heavy rain and thick fog commonly prevail together at the same level over the same ground—whether, that is to say, a pedestrian climbing up from the lowlands in heavy rain would expect to find the real rain cease as he approached the cloud level or to continue inside the fog. I would like to focus attention on the real point of the discussion by a concrete observation which is typical of what I mean. One morning last July, at Westbury-sub-

Mendip, Somerset, the Mendip plateau was thickly shrouded in mist. About 9.0 a.m. a heavy shower came up from the low-lying marshes of Sedgmoor, and the moment the shower struck the escarpment the fog on the hills vanished, to reappear as soon as the rain had passed, before finally disappearing for a sunny afternoon. This was an unmistakable instance of heavy rain "killing" a thick fog.

Mr. Wilson's remarks upon the composite character of precipitation on the high Pennine fells constitute just the kind of information which is sought, and afford a most interesting glimpse of the complex nature of severe weather conditions on these wild uplands. His experiences, however, of mist and drizzle run directly counter to what has been found on Dartmoor, as the following excerpt from a letter written to me in 1916 by Mr. A. W. Clayden brings out very emphatically:—

> "Dartmoor mist seems impossible with real rain, just as drizzle cannot come at the same time as heavy rain, and I take it the reason is that the fast-moving large drops lick up the small ones which would otherwise drift about."

The glaring discrepancy between the Pennines and Dartmoor is due either to a true geographical difference or else to faulty or premature generalisation on the part of one or both writers. It was on Dartmoor that I first noticed the apparent incompatibility of heavy rain and thick fog, and since that time I have had no personal experience of the Pennines. I do not wholly pledge myself to the "washing out" explanation suggested in the above quotation, but, as stated in my article, I think that absence of mist during rain on hill-side locations where mist is otherwise common may sometimes be due to direct passage of the atmospheric moisture into transparent drops.

I might note that on January 1st, 1921, I found a light rain at Willingdon, near Eastbourne, to persist as I climbed up into the swirling mists which were enveloping the South Downs, though, unluckily, the rain did not come on heavily to provide a test case.

In conclusion, the object of my article was to try and get this interesting subject deliberately studied all over the country by favourably placed observers, as such a co-operative study would furnish a valuable contribution to the climatology of England. With reference to the clause in my article which Mr. Wilson cannot follow, I ought to have made it clear that the statement had reference only to my personal experience, which, in consequence of my living in London away from the hills, is limited.

L. C. W. Bonacina.

27, Tanza Road, London, N.W.3, 3rd January, 1921.

The Record January.

I SUPPOSE the above month will prove to be a record since reliable observations were started. It is curious that perhaps the two warmest Januaries ever known, viz., 1916 and 1921, should be so close together. The mean maximum of last month, 49·2° F., failed to reach the mean maximum of January 1916 by ·3° F.; but the mean minimum, 40·3° F., easily eclipses that of its rival, 39·1° F., and the mean for the month comes out as 44·8° F.

——	Mean Minimum.	Mean Maximum.	Mean.
	°F.	°F	°F.
January 1916 - -	39·1	49·5	44·3
January 1921 - -	40·3	49·2	44·8

The night temperature of January 1921 was quite extraordinary, as it was higher than the corresponding temperature for any January, February, March, or even April in my 21 years' detailed observations, while 10 Mays in the same period had colder nights than last month. Two Septembers, nine Octobers, every November, and every December in the same period had a lower night temperature than January 1921. All these readings are by the shaded but unscreened thermometers, and they would tend to make the night readings lower than in the screen, but the maxima would be practically the same, at any rate in the winter half.

R. P. DANSEY.

Kentchurch Rectory, Hereford, 1st February, 1921.

A Lunar Rainbow in Colours.

OUR meteorological assistant, W. Game, has informed me of a curious lunar phenomenon which occurred on the night of Tuesday, January 25th, about 9.45 p.m. He did not see it himself, but the two people who observed it are to be regarded as trustworthy. The phenomenon appears to me to have been a lunar rainbow; approximately a semi-circle was observed, red-yellow on the outside, faint green inside, in a N.N.E. direction, the moon being approximately south. It was showery at the time.

B. A. KEEN.

Rothamsted Experimental Station, 27th January, 1921.

[At the time mentioned, the elevation of the moon was 30°, its bearing S. 58° W., so that the orientations given in Mr. Keen's letter do not tally. The estimates are, however, confessedly rough and there seems little reason to doubt that it was a rainbow that was observed.—ED. M.M.]

Weather Lore.

THE note on "Weather Lore" in the January number of the *Meteorological Magazine* may be supplemented by this couplet :—

"If the sun shines in Janiveer,
March and April pay full dear."

It has been a sunless month, and it will be interesting to see what March and April are like. If warm, fruit-growers will have no reason to rejoice.

H. NOWELL FFARINGTON.

Worden, Leyland, Lancs, 2nd February, 1921.

[This saying is quoted by Mr. Inwards in "Weather Lore" in a slightly different form—

"In Janiveer if the sun appear,
March and April pay full dear."

He follows it up with—

"January warm, the Lord have mercy!"

—ED. M.M.]

A Mechanical Forecaster.

As the inventor of the Mechanical Forecaster referred to on page 279 of the January *Meteorological Magazine*, I beg leave to offer the following remarks, as I feel that the writer of the article does not quite do justice to the instrument.

I make no extravagant claim that the Forecaster is a wonderful meteorological invention; it is intended to teach the untrained observer to regard not only changes in pressure, but other conditions also. Without my device he has only the stereotyped and most misleading words engraved on nearly every barometer to go by.

The Forecaster is already doing excellent work by popularising the study of weather changes, and every one in use is causing its owner to observe weather conditions for himself, instead of relying blindly upon the forecast given in his daily paper.

In cases, and of course there are a few, where it is not possible to decide with certainty whether the barometer is rising or falling, the amateur uses the "steady" section of the Forecaster with good results.

With the concluding paragraph of the article referred to I am quite unable to agree. It states—on what grounds I am unaware—that "any such instrument can only be of service in a restricted area." I would point out that the instrument has been carefully tested upon records, covering periods of 12 months, from all over the British Isles, and has consistently given a percentage of correct forecasts varying between 75 per cent. and 80 per cent. of the total number of days tested.

There may be a few places, exceptionally situated, where local weather overrides the general weather, but I believe that the makers of my Forecaster, Messrs. Negretti and Zambra, have received letters from customers testifying to the accuracy of the instrument; and as these letters have come from places as distant as the north and south of England, Ireland, and even Norway, I think you will agree that the writer of the article in question has been somewhat harsh in his criticism of my instrument. E. W. KITCHIN, F.R.Met.Soc.

"*Markonia,*" *Egmont Road, Sutton, Surrey,* 31*st January,* 1921.

[It is evident that there must be some restriction of the area in which Mr. Kitchin's ingenious instrument is to be used, but as his forecasts are in general terms, the restriction is not so stringent as with Dr. Chapman's aneroid, which gives the numerical measure of the probability of rain. We are glad to learn that the Forecaster has proved so great a success.—ED. M.M.]

NOTES AND QUERIES.

The Unification of the French Meteorological Services.

IN the September issue of the *Meteorological Magazine* we were able to announce that the consolidation of the Meteorological Service of this country had been completed by the incorporation of the Admiralty Meteorological Service in the Meteorological Office. It is now officially announced that the three meteorological organizations in France are being amalgamated in like fashion. By a decree dated November 25th, 1920, a National Meteorological Service, attached to the Ministry of Public Works (Under-Secretariat for Aeronautics and Aerial Transport), is created by the unification of—

(*a*) the Central Meteorological Office (hitherto under the Ministry of Public Instruction);

(*b*) the Central Metereological Service of the Ministry of War; and

(*c*) the Meteorological Service of the Service de la Navigation Aerienne.

The National Meteorological Office will deal with all meteorological questions, and will comprise a scientific section and a technical section as well as other sections in touch with the special requirements of the Ministries concerned. An Advisory Committee, including representatives from the Academy of Science and from various Ministries, is being constituted. Colonel Delcambre is appointed Director of the National Meteorological Service as from January 1st, 1921.

Meteorology in Australia.

An interesting account of the Australian Meteorological Service is given in an article on "Floods and Gales in Australia" which appeared in the "Australian Sunday Times" of 24th October 1920. The writer of the articles draws attention to the practical value of the warnings issued by the Bureau in preventing damage to shipping and destruction of stock. An industry for which warnings are of prime importance is fruit-drying, for unheralded rain would cause enormous losses.

In times of heavy rainfall the Bureau is able to give special advices of rises and rates of flow of flood-crests. A recent warning, seven days in advance, of an impending arrival of a big flood crest at Brewarrina, New South Wales, was fulfilled to within a few hours. Before the oncoming inundation had reached this area, countless sheep, horses, and movable effects were taken to higher land, and thousands of pounds worth of stock and property saved. On this occasion the old hands who predicted that there would be no flood were entirely mistaken in their sanguine view.

The article is illustrated by some interesting flood photographs, including one of a piano resting, 30 feet above the normal level of the neighbouring creek, in the branches of a tree. A picture of a sheet of galvanised iron which had been hurled by wind at a post and folded into the semblance of a lady's fan, may also be mentioned.

The range of climate in Australia being so wide, expert advice is of great value in the selection of districts for the establishment of manufactures which depend on suitable atmospheric conditions, and the importance of this side of the work of the Bureau is duly emphasized.

Ascension Island.

Arrangements are now being completed for the establishment of a fully equipped Second Order Station at Ascension Island, in the Atlantic Ocean, lat. 7° 55′ S., long. 14° 25′ W. Incomplete observations have been taken since April 1917 at two stations in the Island, "Garrison" and "Mountain," but unfortunately, with the exception of the barometer, the instruments hitherto in use have not been tested, and may require large corrections.

Thanks to the interest of Major C. H. Malden, R.M.L.I., who is in charge of the Wireless Station, a full set of instruments has been sent out, and full reports based on observations taken three times daily should soon be available.

Meteorological records from Ascension have hitherto been of the scantiest, covering only those taken at the "Garrison" station by the Captain of the H.M.S. "Tortoise," 1853 to 1861, full observations for two years 1863 to 1865 by Lieut. Rokeby, and less complete observations from October 1906 to the end of 1907.

A permanent observatory there is greatly to be desired.

St. Louis Observatory, Jersey.

THE retirement of the Reverend M. Dechevrens, S.J., of St. Louis Observatory, Jersey, and the cessation of meteorological work there, is announced. M. Dechevrens, who had been in charge of the observatory maintained by the Society of Jesus at Zi-ka-wei for many years, organized the St. Louis Observatory for the Society in 1894. The equipment included many instruments of his own devising.

Up to 1913 the observations were published locally. The meteorological and magnetic data for 1914–16 were printed as a special supplement to the Geophysical Journal for 1916, and frôm 1917 to 1920 they have been published monthly in that journal. Results have also appeared in the Monthly Weather Report for 1919 and 1920.

M. Dechevrens has carried out suggestive researches in terrestrial magnetism and atmospheric electricity, and has written much on these subjects, on typhoons in the China Seas, on the hydrodynamic theory of cyclones, and on the zodiacal light.

The Significance of Correlation Coefficients.

IT is well known to all who have had occasion to make use of correlation coefficients that a coefficient as high as ·5 does not indicate relationship between two variables sufficiently close to be of much value for forecasting one when the other is known. The utility of a correlation is measured in fact by the square of the coefficient rather than by the coefficient itself.

New light is thrown on this fact by a proposition which Mr. W. H. Dines has put forward in recent correspondence with the Meteorological Office.

"*If there is a cause* A *and a result* M *with a correlation* r *between them, then in the long run* A *is responsible for* r^2 *of the variation of* M."

Mr. Dines's original demonstration may be illustrated by supposing that the value of M is completely determined by four independent causes all equally efficacious. Denoting departures from the mean by small letters and measuring the "causes" A, B, C, D by their contributions to M, we have

$$m = a + b + c + d \quad \ldots\ldots\ldots\ldots \quad (1)$$

The standard deviations of a,b,c,d are by hypothesis equal and these variables are independent, and hence

$$\sigma_m^2 = 4\sigma_a^2 \quad \ldots\ldots\ldots\ldots \quad (2)$$

as may be seen by squaring (1) and averaging.

On the other hand, by multiplying both side of (1) by a and averaging, we find—

$$r\ \sigma_m\sigma_a = \sigma_a^2 \quad \ldots\ldots\ldots\ldots \quad (3)$$

and hence that—

$$r = \frac{1}{2} \quad \ldots\ldots\ldots\ldots \quad (4)$$

It will be seen that the relation (1) may be written as a regression equation in the form—

$$\frac{m}{\sigma_m} = \frac{1}{2}\left[\frac{a}{\sigma_a} + \frac{b}{\sigma_b} + \frac{c}{\sigma_c} + \frac{d}{\sigma_d}\right] \quad \ldots\ldots \quad (5)$$

Thus correlation between cause and effect measured by the coefficient ·5 is consistent with the existence of three other equally efficacious causes.

The following demonstration of Mr. Dines's proposition is more general:—

The theory of regression equations implies that—

$$\frac{m}{\sigma_m} = r.\frac{a}{\sigma_a} + x \quad \ldots\ldots\ldots\ldots \quad (6)$$

where x is independent of a, and—

$$\frac{a}{\sigma_a} = r.\frac{m}{\sigma_m} + y \quad \ldots\ldots\ldots\ldots \quad (7)$$

where y is independent of m.

Hence we may write—

$$\frac{m}{\sigma_m} = r\left[r.\frac{m}{\sigma_m} + y\right] + x \quad \ldots\ldots\ldots \quad (8)$$

For a given value of m the average value of y is zero, and therefore the average contribution of a to m, *i.e.*, the average value of $r\sigma_m\left[r\frac{m}{\sigma_m} + y\right]$ is measured by r^2m, and the proposition is proved.

F. J. W. W.

Floods at Kilkenny, 1338.

MR. RICHARD COOKE sends the following quotation with reference to *Materials for the History of the Franciscan Province of Ireland, A.D.* 1230–1450, *by the Rev. E. B. Fitzmaurice* (*Brit. Soc. Franciscan Studies*, p. 137), and to *Annals of Ireland*, by J. Clyn, ed. R. Butler (Tr. Arch. Soc., 1849):—

"Item die Martis scilicet XV Kal. Decembris fuit maxima inundancia aque, qualis a XL annis ante non est visa: que pontes, molendina et edificia funditus evertit et asportavit: solum altare magnum et gradus altaris de tota abbacia Fratrum Minorum Kilkennie aqua non attigit nec cooperuit." (*Clyn*, p. 28.)

In Low's "Chronology of the Seasons" there is no reference to heavy rain in the year 1338, but famines in England occasioned by very wet seasons are attributed to several years in the period 1314 to 1335. William Andrews in his book entitled "Famous Frosts and Frost Fairs" mentions that there was a "twelve weeks frost after rain" in England in 1338.

News in Brief.

PRIZES offered for essays on meteorological and phenological observation during 1920, open to boys and girls under 18 either resident in or attending school in the parish of Enfield, Middlesex, are offered by an announcement in the *Enfield Gazette* of January 14th, 1921. These competitions, which have now been carried on for several years, should give a valuable stimulus to the study of nature by the Enfield youngsters.

ON SATURDAY, January 29th, the staff of the Meteorological Office held their Second Annual Soiree at the Merrick Rooms, Kensington, W. Over 200, members of the staff and friends, were present. An attractive programme had been arranged, a concert and dance being followed by progressive games and an interesting address on Phrenology by Mr. B. Francis. Dr. G. C. Simpson and Mrs. Simpson, with many senior officials of the office, were present.

British Rainfall, 1919, recently formed part of the booty abstracted by burglars from a house in Scotland, as we learn from a subscriber who has found it necessary to apply for a second copy on this account.

THAMES VALLEY RAINFALL —— JANUARY. 1921.

H. M. Stationery Office Press, Kingsway, W.C.2.

Weather in the British Isles: January 1921.

In all parts of the British Isles the abnormally mild weather which set in just before Christmas was continued nearly throughout the whole of January. At South Kensington (roof station) the minimum temperature was above the freezing point continuously from December 17th, throughout January, and up to February 3rd. During the month the type of weather was persistently cyclonic, so that very generally the unusually high temperatures which were so widely recorded were accompanied nearly everywhere by much precipitation. Only rarely, however, did the latter take the form of snow, and it is noteworthy that at such a high-level as Sheepstor (Devon), 749 feet above mean sea-level, no snow fell throughout the month, an experience quite unique for January in the history of this station. Many other localities had a similar experience. Sleet or snow was, however, not infrequent in some parts of Scotland, and on the 24th a heavy snowstorm was reported at St. Andrews.

The only really cold weather experienced generally during the month occurred between the 11th and 16th, and it was during this brief wintry spell that the falls of snow of any significance occurred. On the 10th a decided fall of temperature occurred in England and Ireland, the 7 h. readings showing a decrease of as much as 15° F. at some stations. This change appears in some cases to have been initiated by a line squall which swept across south-east England late in the afternoon of the 9th. During the night of the 15th–16th, under the influence of an area of relatively high pressure over England and France, there were several degrees of frost inland, and a dense fog in some parts of London. At Eskdalemuir on the 15th a minimum of 15° F. was recorded and 17° F. on the 13th, on which day the temperature remained below 40° F. at several northern stations. Apart from this interlude there was no cold weather at all, and day after day the temperature rose to abnormal levels, the maximum temperatures recorded at numerous stations, although equalled (mainly in 1916), having never before been exceeded in records in some instances extending over 50 years. The frequency with which maxima between 51° F. and 59° F. were recorded was very remarkable; at Falmouth there were 24 such days, 22 at Dublin (Phœnix Park), 21 at Baldonnell (Dublin), 20 at Isle of Grain (Kent) and Birr Castle, and 19 at Kew Observatory and Nottingham. At Llandudno on the 4th a maximum of 60° F. was recorded.

During the month deep depressions frequently passed between Iceland and Scotland as they travelled eastwards. They were accompanied by numerous minor disturbances which affected the British Isles in general, while on two occasions the main system was centred over these regions, notably about the 12th–13th and again at the close of the month. Stormy conditions were experienced occasionally, especially on the 18th, when a severe westerly gale swept across the British Isles. Gusts of over 60 miles per hour were reported from many parts, while in north-west England and on Salisbury Plain the maximum speed (at 60 feet above ground) was nearly 80 m.p.h.

A feature of the month was the persistence of mild damp winds from the south-west or west, with much low cloud. There was occasional fog on the south-west coasts and on the high ground near the English Channel, but little inland on the low ground. There were a few fine, clear days, especially in the middle of the month.

In accordance with previous experience in abnormally mild winter months, the total rainfall was high. It failed to reach the average over small areas in the east and south, while more than twice the average fell in the neighbourhood of the Cheviot Hills. Less than 50 mm. fell in the south-east of England and in the east of Aberdeenshire, the range in Scotland being from 33 mm. in the east to 810 mm. at Loan. A considerable area in the west of Scotland recorded over 250 mm. In Ireland 50 mm. was recorded in the neighbourhood

(*Continued on* p. 28.)

Rainfall Table for January 1921.

STATION.	COUNTY.	Aver. 1881–1915. in.	1921. in.	1921. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days.
Camden Square	*London*	1·86	2·48	63	133	·46	2	20
Tenterden (View Tower)	*Kent*	2·15	2·02	51	94	·25	13	20
Arundel (Patching Farm)	*Sussex*	2·60	3·34	85	128	·55	1	16
Fordingbridge (Oaklands)	*Hampshire*	2·76	3·80	96	138	·53	30	23
Oxford (Magdalen College)	*Oxfordshire*	1·72	2·30	58	134	·39	30	17
Wellingborough (Swanspool)	*Northampton*	1·85	2·40	61	130	·59	7	20
Hawkedon Rectory	*Suffolk*	1·74	1·97	50	113	·40	1	19
Norwich (Eaton)	*Norfolk*	1·96	2·03	52	104	·29	7	23
Launceston (Polapit Tamar)	*Devon*	3·72	4·38	111	118	·59	1	28
Lyme Regis (Rousdon)	„	2·91	2·85	72	98	·55	30	20
Ross (Chasedale Observatory)	*Herefordshire*	2·42	2·91	74	120	·41	12	16
Church Stretton (Wolstaston)	*Shropshire*	2·53	3·30	84	130	·41	12	20
Boston (Black Sluice)	*Lincoln*	1·62	1·96	50	121	·39	7	19
Worksop (Hodsock Priory)	*Nottingham*	1·77	1·83	47	104	·39	1	18
Mickleover Manor	*Derbyshire*	2·02	2·63	67	130	·61	17	20
Southport (Hesketh Park)	*Lancashire*	2·55	4·30	109	169	·53	17	25
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·44	3·96	100	162	·32	17	16
Hull (Pearson Park)	„ *E. R.*	1·80	2·08	53	156	·42	1	18
Newcastle (Town Moor)	*North'land*	2·04	4·40	112	216	1·71	12	17
Borrowdale (Seathwaite)	*Cumberland*	13·28	25·95	659	195	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	3·78	5·11	130	135	·67	1	31
Haverfordwest (Gram. Sch.)	*Pembroke*	4·61	6·04	153	131	·81	11	28
Aberystwyth (Gogerddan)	*Cardigan*	4·09	6·36	162	156	·79	16	20
Llandudno	*Carnarvon*	2·58	4·63	117	179	·87	31	25
Dumfries (Cargen)	*Kirkcudbrt.*	3·99	8·31	211	208	1·34	9	28
Marchmont House	*Berwick*	2·25	5·97	152	265	·95	31	19
Girvan (Pinmore)	*Ayr*	4·72	8·15	207	173	1·20	9	30
Glasgow (Queen's Park)	*Renfrew*	3·34	6·17	157	185	·60	9, 24	29
Islay (Eallabus)	*Argyll*	4·68	8·85	225	189	1·93	24	30
Mull (Quinish)	„	5·60	..	..	..	..	..	..
Loch Dhu	*Perth*	9·10	14·40	366	158	1·20	3	27
Dundee (Eastern Necropolis)	*Forfar*	1·95	..	..	..	..	..	..
Braemar (Bank)	*Aberdeen*	3·08	3·59	91	117	·49	23	25
Aberdeen (Cranford)	„	2·38	1·39	35	58	·37	24	16
Gordon Castle	*Moray*	2·02	2·73	69	135	·41	21	20
Fort William (Atholl Bank)	*Inverness*	9·58	16·85	428	176	2·34	21	29
Alness (Ardross Castle)	*Ross*	3·80	6·13	156	161	·97	21	24
Loch Torridon (Bendamph)	„	9·40	17·03	433	181	2·10	21	27
Stornoway	„	5·17	8·15	207	158	·88	21	28
Wick	*Caithness*	2·46	2·82	72	115	·63	20	25
Glanmire (Lota Lodge)	*Cork*	4·30	2·92	74	68	·77	11	25
Killarney (District Asylum)	*Kerry*	5·92	5·28	134	89	·92	11	27
Waterford (Brook Lodge)	*Waterford*	3·69	3·36	85	91	·73	11	23
Nenagh (Castle Lough)	*Tipperary*	3·96	5·22	133	132	·67	3	29
Ennistymon House	*Clare*	4·20	5·56	141	132	·69	25	31
Gorey (Courtown House)	*Wexford*	3·12	2·68	68	86	·62	11	21
Abbey Leix (Blandsfort)	*Queen's Co.*	3·28	3·93	100	120	·70	11	26
Dublin (FitzWilliam Square)	*Dublin*	2·29	2·42	62	106	·54	12	24
Mullingar (Belvedere)	*Westmeath*	3·21	3·83	97	119	·58	2	22
Woodlawn	*Galway*	3·82	4·27	108	112	·73	3	30
Crossmolina (Enniscoe)	*Mayo*	5·24	7·53	191	144	1·74	9	30
Collooney (Markree Obsy.)	*Sligo*	3·90	4·96	126	127	1·10	9	28
Seaforde	*Down*	3·15	5·05	128	160	·72	17	26
Ballymena (Harryville)	*Antrim*	3·71	5·45	138	147	·72	9	29
Omagh (Edenfel)	*Tyrone*	3·54	5·81	148	164	1·10	9	29

Supplementary Rainfall, January 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	1·64	42	XII.	Langholm, Drove Rd.	11·37	289
,,	Sevenoaks, Speldhurst	2·59	66	XIII.	Selkirk, Hangingshaw	5·22	133
,,	Hailsham Vicarage	2·84	72	,,	North Berwick Res.	3·71	94
,,	Totland Bay, Aston	4·50	114	,,	Edinburgh, Royal Ob.	3·98	101
,,	Ashley, Old Manor Ho.	3·16	80	XIV.	Biggar	5·95	151
,,	Grayshott	3·61	92	,,	Leadhills	13·17	334
,,	Ufton Nervet	2·44	62	,,	Maybole, Knockdon	7·10	180
III.	Harrow Weald, Hill Ho.	2·73	69	XV.	Dougarie Lodge	6·93	176
,,	Pitsford, Sedgebrook	2·48	63	,,	Inveraray Castle	20·57	522
,,	Chatteris, The Priory	1·83	46	,,	Holy Loch, Ardnadam	15·59	396
IV.	Elsenham, Gaunts End	2·08	53	XVI.	Loch Venachar	8·75	222
,,	Lexden, Hill House	1·97	50	,,	Glenquey Reservoir	6·50	165
,,	Aylsham, Rippon Hall	2·11	54	,,	Loch Rannoch, Dall	10·05	255
,,	Swaffham	2·35	60	,,	Trinafour	9·59	244
V.	Devizes, Highclere	3·14	80	,,	Coupar Angus	3·11	79
,,	Weymouth	3·61	92	,,	Montrose Asylum	1·70	43
,,	Ashburton, Druid Ho.	5·60	142	XVII.	LogieColdstone,Loanh'd	1·43	36
,,	Cullompton	2·71	69	,,	Fyvie Castle	1·66	42
,,	Hartland Abbey	4·60	117	,,	Grantown-on-Spey	3·13	80
,,	St. Austell, Trevarna	4·84	123	XVIII.	Cluny Castle	7·75	197
,,	North Cadbury Rec.	2·92	74	,,	Loch Quoich, Loan	31·90	810
,,	Cutcombe,Wheddon Cr.	5·31	135	,,	Drumnadrochit	3·88	99
VI.	Clifton, Stoke Bishop.	3·59	91	,,	Arisaig, Faire-na-Sguir	9·50	241
,,	Ledbury, Underdown.	2·62	66	,,	Skye, Dunvegan	11·93	303
,,	Shifnal,HattonGrange	2·14	54	,,	Glencarron Lodge	17·60	447
,,	Ashbourne, Mayfield	4·08	104	,,	Dunrobin Castle	4·29	109
,,	Barnt Green, Upwood	2·48	63	XIX.	Tongue Manse	5·29	134
,,	Blockley, Upton Wold	2·51	64	,,	Melvich Schoolhouse	4·51	115
VII.	Grantham, Saltersford	1·81	46	,,	Loch More, Achfary	14·63	372
,,	Louth, Westgate	2·16	55	XX.	Dunmanway Rectory	6·38	162
,,	Mansfield, West Bank	2·17	55	,,	Mitchelstown Castle	3·51	89
VIII.	Nantwich, Dorfold Hall	3·71	94	,,	Gearahameen	12·50	318
,,	Bolton, Queen's Park.	7·16	182	,,	Darrynane Abbey	5·12	130
,,	Lancaster, Strathspey.	6·79	172	,,	Clonmel, Bruce Villa	2·79	71
IX.	Wath-upon-Dearne	1·66	42	,,	Cashel, Ballinamona	3·73	95
,,	Bradford, Lister Park.	5·84	148	,,	Roscrea, Timoney Pk.	..	..
,,	West Witton	6·44	164	,,	Foynes	4·78	122
,,	Scarborough, Scalby	3·34	85	,,	Broadford, Hurdlesto'n	5·39	137
,,	Ingleby Greenhow	..	..	XXI.	Kilkenny Castle	3·48	88
,,	Mickleton	7·10	180	,,	Rathnew, Clonmannon	2·40	61
X.	Bellingham	6·68	170	,,	Hacketstown Rectory	3·66	93
,,	Ilderton, Lilburn	4·79	122	,,	Ballycumber, Moorock.	..	..
,,	Orton	13·15	334	,,	Balbriggan, Ardgillan	3·33	85
XI.	Llanfrechfa Grange	4·44	113	,,	Drogheda	2·99	76
,,	Treherbert,Tyn-y-waun	15·63	397	,,	Athlone, Twyford	3·85	98
,,	Carmarthen,The Friary	6·08	154	,,	Castle Forbes Gdns.	4·05	103
,,	Fishg'rd,Goodwick Stn.	5·45	138	XXII.	Ballynahinch Castle	6·87	174
,,	Lampeter, Falcondale	5·74	146	,,	Galway Grammar Sch.	4·49	114
,,	Crickhowell, Talymaes	3·50	89	,,	Westport House	7·40	188
,,	B'ham W.W.,Tyrmyndd	8·16	207	XXIII.	Enniskillen, Portora	4·89	124
,,	Lake Vyrnwy	10·16	258	,,	Armagh Observatory	4·32	110
,,	Llangynhafal, P. Drâw	3·93	100	,,	Warrenpoint	3·67	93
,,	Oakley Quarries	18·87	479	,,	Belfast, Cave Hill Rd.	6·51	165
,,	Dolgelly, Bryntirion	8·59	218	,,	Glenarm Castle	7·93	201
,,	Lligwy	5·59	142	,,	Londonderry, Creggan.	4·51	115
XII.	Stoneykirk,ArdwellHo.	5·40	137	,,	Sion Mills	4·64	118
,,	Whithorn, Cutroach	..	..	,,	Milford, The Manse	4·82	122
,,	Carsphairn, Shiel	15·42	392	,,	Killybegs, Rockmount	6·27	159

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean of Day M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	° F.		° F.		° F.	° F.	° F.	° F.
London, Kew Observatory	1019·7	+4·7	73	8	43	21	65·1	50·2	57·7	−3·9
Gibraltar	1015·6	+0·4	95	6	64	23	84·5	69·6	77·1	+1·2
Malta	1014·3	−0·1	97	24	68	28	85·4	76·4	80·9	+2·6
Sierra Leone	1014·2	+0·9	85	4, 9, 21	70	sev.	82·1	71·4	76·7	−1·4
Lagos, Nigeria	1014·2	+0·6	87	30	71	26	81·5	73·7	77·6	+0·5
Kaduna, Nigeria	1014·4	+2·6	84	26	63	15	79·0	66·4	72·7	−1·1
Zomba, Nyasaland	1017·2	+1·0	82	27,28,31	49	10	75·6	53·7	64·7	0·0
Salisbury, Rhodesia	1018·0	−1·6	84	28, 29	38	1	75·5	46·2	60·9	+0·8
Cape Town	1018·6	−1·6	81	7	39	11	63·8	49·7	56·7	+1·5
Johannesburg	1021·5	+0·7	77	27	35	6	66·3	44·9	55·6	+1·7
Mauritius	1021·6	+1·1	77	20	57	21	74·3	62·2	68·3	−0·2
Bloemfontein	..	..	79	29	25	16	67·5	39·1	53·3	+1·1
Calcutta, Alipore Obsy.	1001·5	+0·5	92	10	76	1	88·7	79·1	83·9	+0·9
Bombay	..	..	87	24	75	2	85·3	77·9	81·6	+0·9
Madras	..	..	101	28	75	2	95·3	78·5	86·9	+1·2
Colombo, Ceylon	1010·7	+1·8	86	2	73	4	84·5	77·1	80·8	−0·7
Hong Kong	1004·7	−0·5	90	6	74	26	85·4	78·5	81·9	−0·2
Sydney	1015·0	−3·2	70	4	41	16	63·6	46·1	54·9	0·0
Melbourne	1014·4	−3·6	67	22	35	15	57·2	43·4	50·3	−0·8
Adelaide	1015·7	−3·5	74	21	39	13	61·7	46·2	53·9	0·0
Perth, Western Australia	1015·4	−3·4	70	29	41	21	61·5	47·6	54·5	−1·5
Coolgardie	1015·6	−3·7	83	29	33	8, 15	62·0	41·1	51·5	−2·1
Brisbane	1017·0	−2·0	85	24	42	15	69·8	51·2	60·5	0·0
Hobart, Tasmania	1011·3	−2·3	64	30	36	16	56·1	42·9	49·5	+1·6
Wellington, N.Z.	1013·3	−1·4	60	26	30	18	52·1	41·8	46·9	−1·6
Suva, Fiji	1012·8	−1·5	82	7, 19	60	26	77·0	66·6	71·8	−1·9
Kingston, Jamaica	1014·3	+0·6	93	5	71	sev.	89·7	73·0	81·3	−0·2
Grenada, W.I.	1013·1	+0·5	89	26	69	19, 20	85·5	74·5	80·0	+0·5
Toronto	1017·3	+1·9	89	7	48	1	79·6	60·1	69·9	+3·3
Winnipeg	1014·1	+0·2	95	14	41	12	82·8	56·3	69·5	+6·5
St. John, N.B.	1018·0	+2·6	79	5	51	19, 26	68·9	53·1	61·0	+0·4
Victoria, B.C.	1017·2	0·0	84	8	46	18	69·9	52·3	61·1	+1·0

London, Kew Observatory.—Mean speed of wind 5·8 mi/hr ; 1 day with thunder heard, 2 days with fog.

Gibraltar.—2 days with fog.

Malta.—Prevailing wind direction NW ; mean speed 5·2 mi/hr.

Sierra Leone.—Prevailing wind direction SW.

Zomba.—The pressures and differences from normal from January to July should read :—

1006·6 ; 1008·4 ; 1009·9 ; 1014·6 ; 1014·9 ; 1017·9 ; 1019·8.
− 1·3 + 0·6 + 0·2 + 2·7 + 0·6 + 0·5 + 1·9

Johannesburg.—The pressures from May to July should read :—1018·7 ; 1022·8 ; 1025·1.

British Empire, August 1920.

TEMPERATURE				PRECIPITATION				BRIGHT SUNSHINE		STATIONS
Absolute		Relative Humidity	Mean Cloud Am'nt	Amount		Diff. from Normal	Days	Hours per day	Percentage of possible	
Max. in Sun	Min. on Grass									
° F.	° F.	%	0–10	in.	mm.	mm.				
134	33	71	7·1	1·49	38	− 19	8	4·5	31	London, Kew Observatory.
145	60	77	2·2	0·00	0	− 4	0	..	..	Gibraltar.
153	..	69	1·5	0·03	1	− 2	1	10·4	77	Malta.
..	..	76	7·5	11·52	293	−621	15	..	..	Sierra Leone.
161	68	78	7·1	1·36	35	− 33	8	..	..	Lagos, Nigeria.
..	..	..	..	12·39	315	+ 19	23	..	..	Kaduna, Nigeria.
..	..	73	2·8	0·51	13	+ 5	2	..	..	Zomba, Nyasaland.
133	31	48	2·7	0·10	3	+ 2	1	..	..	Salisbury, Rhodesia.
..	..	77	5·5	3·19	81	− 6	11	..	..	Cape Town.
..	33	52	3·2	0·05	1	− 8	2	8·5	76	Johannesburg.
..	52	75	5·9	2·68	68	+ 8	24	7·5	66	Mauritius.
..	..	58	..	0·65	17	+ 5	2	..	..	Bloemfontein.
..	74	76	8·7	18·66	474	+165	18	..	..	Calcutta, Alipore Obsy.
129	72	81	6·9	4·58	116	−244	24	..	..	Bombay.
167	73	65	6·2	2·09	53	− 72	9	..	..	Madras.
154	71	75	8·6	0·94	24	− 61	11	..	..	Colombo, Ceylon.
..	..	82	8·4	10·97	279	− 86	20	4·4	34	Hong Kong.
119	33	66	3·8	1·21	31	− 48	13	..	..	Sydney.
119	31	74	6·2	3·17	81	+ 35	22	..	..	Melbourne.
131	29	68	5·1	3·38	86	+ 22	19	..	..	Adelaide.
117	33	74	6·6	9·94	252	+109	22	..	..	Perth, Western Australia.
141	29	53	5·7	1·42	36	+ 10	8	..	..	Coolgardie.
138	37	59	3·7	1·16	29	− 28	5	..	..	Brisbane.
117	29	71	6·9	1·13	29	− 17	22	4·5	43	Hobart, Tasmania.
116	19	84	6·9	4·73	120	+ 4	24	4·0	38	Wellington, N.Z.
..	..	82	5·4	3·12	79	−130	16	..	..	Suva, Fiji.
..	..	75	5·7	0·99	25	− 68	10	..	..	Kingston, Jamaica.
144	..	74	5·1	7·10	180	− 59	18	..	..	Grenada, W.I.
140	43	74	4·4	1·00	25	− 45	9	..	..	Toronto.
..	..	75	2·9	1·70	43	− 17	9	..	..	Winnipeg.
132	39	92	6·4	4·85	123	+ 25	11	..	..	St. John, N.B.
139	43	74	2·3	1·60	41	+ 24	3	..	..	Victoria, B.C.

SALISBURY, RHODESIA.—Prevailing wind direction ENE. Pressures from May to July should read :—1015·5 ; 1019·1 ; 1021·3.

COLOMBO, CEYLON.—Prevailing wind direction SW ; mean speed 6·3 mi/hr.

HONG KONG.—Prevailing wind direction S ; mean speed 9·8 mi/hr ; 6 days with thunder heard ; 2 days with fog.

PERTH, W. AUSTRALIA.—5 days with gale. With exception of 1882 wettest August on record.

SUVA, FIJI.—2 days with thunder heard.

GRENADA.—Prevailing wind direction E ; 2 days with thunder heard.

of Dublin, whilst small areas in the mountain regions of the west had over 250 mm. In the English Lake District 1,080 mm. (42·50 in.) was recorded at the Stye near Borrowdale. At Dungeon Ghyll 155 mm. (6·10 in.) and 105 mm. (4·12 in.) fell on the 8th and 9th respectively. A large area in the north-west of Scotland had more than 50 mm. on the 21st, and at Ardgour 87 mm. (3·41 in.) was recorded on the 5th.

The general rainfall for the countries expressed as a percentage of the average were England and Wales, 146; Scotland, 168; Ireland, 119; British Isles, 145.

In London (Camden Square) the mean temperature was 46·0° F., or 7·3° above the average. Only two days (15th and 16th) had a mean temperature below the January average, and five days had a mean above 50° F. Since 1858 only one December, no Januaries, no Februaries, and five Marches have had a higher mean temperature. Duration of rainfall, 59·7 hours. Evaporation, ·20 inch.

Weather Abroad: January 1921.

THE month opened with an anticyclone situated over Spain and the Western Mediterranean, and a large area of low pressure over the North-East Atlantic. The high pressure area persisted with only slight modifications north-eastward and westward until nearly the end of the month, when it moved away in a south-westerly direction.

All through this period depressions from the Atlantic moved on easterly or north-easterly paths to the western and north-western parts of the Continent. Consequently over a large part of western Europe mild, stormy and unsettled weather with South-Westerly winds, alternated with brief spells of the finer, colder weather occurring in the rear of the depressions and their secondaries. Although rain was frequent and widespread, the rainfall amounts were not, as a rule, exceptionally large.

In Northern Europe the weather was, for the most part, cold, and severe frosts were experienced at some of the stations in Norway and Sweden. Thus, at Haparanda, the 7 h. temperature was – 13° F. on the 12th, – 17° F. on the 24th and 27th, and – 15° F. on the 28th. Saerna reported 7 h. readings of – 6° F. on the 27th and 30th, and – 9° F. on the 28th, and even at Stockholm there was a 7 h. temperature of 0° F. on the 15th.

Over South-Western Europe, which was usually in the anticyclonic region, the weather was mostly rainless during January.

In Italy and the central part of the Mediterranean fair weather prevailed, except in the middle of the month, when a depression in that region caused an unsettled period.

At the reporting stations in the Eastern Mediterranean fair weather predominated, although towards the end of the month a depression over the Eastern Mediterranean caused some rain.

On December 31st the International Mercantile Marine Company announced a change in the Transatlantic steamship routes on account of ice recently reported in low latitudes. The alteration, which ordinarily takes place in February, was to become effective immediately.

At the beginning of the month heavy general rain occurred in Victoria and fairly heavy falls in the Riverina district of New South Wales. Isolated rainfalls were experienced in northern New South Wales and in South Queensland. Beneficial rain fell throughout New Zealand during the month.

A message despatched from Delhi on January 6th stated that the agricultural situation in India was causing anxiety, a deficiency of rainfall of the winter monsoon type being anticipated in North-West India and the neighbouring hills. During the week ending January 22nd, however, light to heavy rain was general in the north-eastern and central parts of the country and in parts of Madras. While this fall was of considerable benefit, more rain is needed in the majority of the provinces.

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London Smoke Fogs.

By DR. J. S. OWENS.

THE Advisory Committee on Atmospheric Pollution have always realised that a measurement of impurities deposited from the air, such as has been made for some years by means of large open-topped gauge vessels similar in principle to rain gauges, gave an incomplete statement of the case. A large proportion of the total impurity is so finely divided that there is little tendency to settle; the particles are so small that the slightest turbulence in the air is sufficient to keep them practically permanently suspended. It was therefore necessary to supplement measurements of deposit with some method of ascertaining the quantity of suspended matter in order to get a more complete view of the case. It is obvious that in any discussion of smoke-fogs suspended impurity is the important thing.

A method of measuring suspended impurity in cities has been devised and has now been in continuous operation in London for some months. Briefly, the method consists in the use of an automatic instrument* which filters a fixed volume of air through a small disc of white filter paper at short intervals. The impurities are left behind on the paper and, by the aid of a carefully calibrated scale of shades, provide a measure of the quantity of impurity in known units. Instruments have been set up at the Meteorological Office, South Kensington, at Kew Observatory, and at the

* Sixth Report of the Committee for the investigation of Atmospheric Pollution, p. 15.

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author's office at 47, Victoria Street, Westminster. Continuous records are now available since October last, and it appears probable that entirely new light will be thrown on the question of source of impurity by means of these records.

Curves have been drawn showing in each case the mean amount of suspended impurity for each hour over a number of days. This has been done for ordinary week-days, excluding Saturdays and Sundays, and also for Saturdays and Sundays separately.

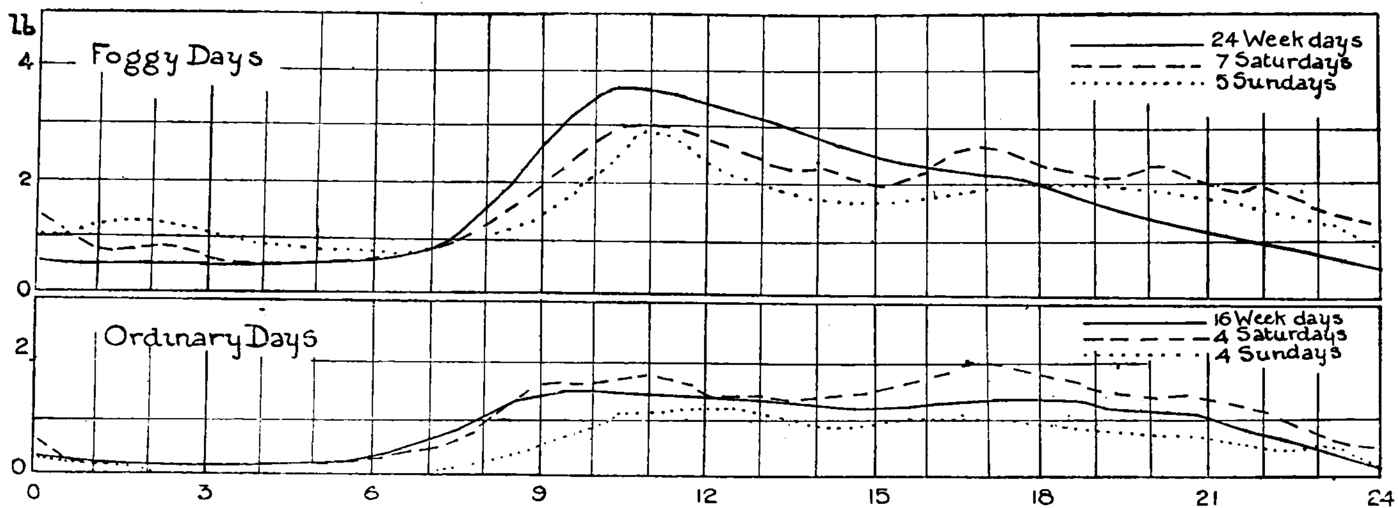
A study of these curves brings to light certain information bearing upon the source of the impurity, and should enable us ultimately to state definitely what proportion of the suspended impurity is due to domestic heating and cooking fires and what to factory furnaces.

The curves mentioned are reproduced here for reference, and each group of days has been split up into foggy and non-foggy days, the non-foggy days being taken as those in which the maximum impurity at any period did not exceed Shade 4 on the scale of shades or, say, 2·16 lb. per million cubic yards. The foggy days were taken as those in which the impurity exceeded this figure at some time during the 24 hours.

Features common to all Curves.—Referring now to the curves, it will be observed that there are certain features common to all: between midnight and early morning the air is at its purest. On week-days and Saturdays about 6 a.m. and on Sundays about 7 a.m. a rapid increase in the amount of impurity begins. This is continued to a maximum at about 11 a.m. on week-days and Saturdays, and somewhat later, about 12 noon, on Sundays. In the afternoon there is a general tendency for the impurity to diminish in quantity; this is very well marked in the curve for foggy week-days, but it is distinct in all the curves. About 5 p.m. (17 h.) most of the curves show a slight peak, and about 10 p.m. (22 h.) a rapid fall commences which continues up to midnight, when the quantity approaches the minimum.

It appears legitimate to infer from the above that the comparatively pure period between midnight and early morning is due to all fires and furnaces being out of operation. The commencement of the rise of the impurity at about 6 a.m. is clearly connected with the starting-up again of fires and furnaces. The peak about 5 o'clock in the afternoon suggests a tea-time rise, and the falling off at about 10 p.m. is evidently connected with the letting out of fires.

If the impurity is due chiefly to domestic smoke, we should expect to find little difference in the quantity recorded on Saturday afternoons and Sundays when compared with other



SUSPENDED IMPURITY IN LONDON AIR.

Variation at Westminster in the number of pounds of dirt in a 100-yard cube on selected days in the winter 1920–21.

week-days. On the other hand, if the impurity is due chiefly to industrial furnaces, then Saturday afternoon and the whole of Sunday should show a very marked difference when compared with other days. Referring to the curves for days without abnormal fog, as these give a better indication of the source of the impurity than foggy days when some abnormal meteorological condition exists, we find that so far as the data at present available indicate there is not an outstanding difference to be observed in the amount of impurity on Saturdays, Sundays, or week-days; the Saturday curve shows somewhat the largest amount of impurity, the Sunday curve shows the least, but there is not a great difference.

Referring now to the curve for non-foggy Saturdays, there is no sudden falling off in the amount of smoke after 1 o'clock, when most factories close; on the contrary, there is a distinct rise and a very well marked peak at 5 o'clock, the same peak as is to be observed in the curve for foggy Saturdays. The inference is clear that since the shutting down of factories does not bring about a marked reduction in the quantity of impurity recorded, the factory fires are not mainly responsible for the impurity. Thus, both the quantity of suspended matter and its distribution point towards the domestic heating and cooking fires as being mainly responsible.

Turning to the much disputed question as to the relative proportions of factory and domestic smoke, we find that something approaching definite information is contained in the curves.

Consider the elementary case of a uniform stream of air which receives the smoke emitted by a certain chimney, and suppose that records are taken further down the stream. As long as all other conditions remain constant any variation in quantity of smoke emitted will cause, a little later, a corresponding variation in impurity recorded. Under such conditions the records of suspended impurity are also records of rate of smoke emission. If now a sufficient number of normal winter days be taken, that is, days without conditions which cause that banking up of impurities resulting in smoke-fog, the corresponding curves may be regarded as showing relative smoke production. Further, since rate of smoke production multiplied by the time gives total smoke produced, the areas enclosed between the curves and the base are proportional to the total smoke produced in 24 hours.

On week-days we have both domestic and factory fires in operation, while on Sundays we have domestic fires only, or practically so, hence the area enclosed by the curve for non-foggy Sundays deducted from that for non-foggy week-days should give, in some unit, the smoke produced by factories on week-days. If then W is equal to the area of the week-day curve, and S is equal to that of the Sunday curve, the proportion of domestic smoke to factory smoke in the air of London is approximately equal to $\frac{S}{W - S}$. The assumption is made that the amount of domestic smoke produced on Sundays is the same as on week-days.

In the curves 16 week-days are included, but only four Sundays, and it may be that when more data are available the result will be somewhat different, but treating the curves as indicated gives the ratio of domestic to factory smoke as two to one. The domestic fires appear, therefore, to be responsible for two-thirds of the total smoke in Westminster.

Whether this ratio holds for other parts of London, and what it is in other cities, are questions which can only be answered when continuous records are available for the particular places considered. This is, however, believed to be the first time that a reliable method has been made available for fixing the relative importance of factory and domestic fires as sources of atmospheric pollution.

OFFICIAL NOTICES.

Lectures in Meteorology.

THE course of lectures by Sir Napier Shaw, F.R.S., for the University of London on "An Historical Review of Meteorological Theory" which was announced in the *Meteorological Magazine* for January, 1921, has been postponed until the summer term. The lectures will be held on Fridays at 3 p.m., beginning April 29th, 1921.

Climatological Stations.

Crathes.—It is to be regretted that Mr. J. Smith, of Pinewood, Crathes, has been compelled to give up his meteorological observations. The majority of the instruments have been taken over, however, by Mr. W. S. Kemp, who has set up a station at the schoolhouse, some two miles from Pinewood. The sunshine recorder, however, remains at Pinewood. Observations from Pinewood have been published since 1904; the situation is described in Mr. Smith's papers on the Relation of Rainfall to the Depth of Water in a Well (Journal of the Scottish Meteorological Society, Vols. XIV. and XVI.).

Summer Time Act.

It is officially announced that "Summer Time" will come into force this year at 2 a.m. G.M.T. on the morning of Sunday, April 3rd, and will continue until 2 a.m. G.M.T. on the morning of Monday, October 3rd.

After the public clocks have been altered, each hour of observation for the climatological record should remain the same by G.M.T., and should, therefore, be one hour later by Public Time.

Observers are reminded that it is important to state explicitly the standard of time on all communications with regard to natural phenomena observed during the summer months, and also that the times of observations printed in the *Monthly Weather Report* should be checked at the beginning and end of the summer-time period.

Discussions at the Meteorological Office.

The discussion on February 7th, 1921, was opened by Mr. W. W. Bryant, who brought before the meeting a paper by H. H. Clayton on "Variation in Solar Radiation and the Weather" (Smithsonian Misc. Coll., Vol. 71, No. 3).

The paper deals mainly with the statistical results obtained from the comparison of the variations of the observed values of solar radiation and the variations of temperature in Argentina, a comparison which leads the author to the conclusion that weather, as distinguished from climate, has its origin in the variations in solar radiation, and could therefore be forecasted if these variations were accurately known.

The results gain an additional interest from the use which the Director of the Argentine Weather Service has already made of them for forecasting temperature and rainfall. A decrease in solar radiation is followed by a fall of temperature in Central Argentina three or four days later, and consequently by rain at about the same interval; and as the radiation-values are available the day after observation, forecasts can be made for one or two days ahead.

An interesting question referred to in the discussion of the paper was that of finding a single index figure which would measure the degree of storminess in the atmosphere at any time, and the suggestion was made that such an index might be obtained by taking the "root mean square" of the departure of pressure from the normal for a *réseau* of stations over the Globe.

The meeting on Monday, February 21st, was devoted to Dr. G. C. Simpson's *Antarctic Meteorology.** Mr. Lempfert

* A review of this work was published in the *Meteorological Magazine*, July 1920, p. 105.

gave an account of the work, laying special stress on the results obtained by the use of the Dines anemometer, on the scientific imagination with which the daily maps had been constructed, usually with observations for only three stations as far apart as Lerwick, Oxford and Hamburg, and on the theory of pressure waves put forward to explain the sequence of weather at these observing stations.

The view that the pressure "waves" were really highs and lows akin to those of our own latitude, but with a general drift from the South Pole over the Ross Sea, was put forward in the discussion, but Dr. Simpson was not able to accept it. With reference to the katabatic winds rolling off the great Antarctic Plateau to which the blizzards of McMurdo Sound had previously been attributed, Dr. Simpson pointed out that the orographical conditions would not favour such winds since the highest ground was generally along the edge of the plateau.

With reference to the account of the discussion of auroral observations at the Haldde Observatory (*Met. Mag.*, Feb. 1921, p. 7), Dr. Chree points out that the average height of the lower limit of the aurora was found to be at 108 km., not at 100 km. The azimuths of the ends of the bands were not reckoned from the magnetic meridian, but from the great circle through the poles of the first zonal harmonic in the Gaussian expression for the magnetic field of the whole earth.

The Royal Aeronautical Society.

A MEETING of this Society was held on February 3rd (Dr. G. C. Simpson, Director of the Meteorological Office, being in the chair), when Major Gordon Dobson gave a paper on *The Use of Meteorology to Aviation, and Vice Versâ.* The lecturer said that meteorology could aid aviation in two main ways, by providing a daily weather service and by issuing statistical information. He dealt chiefly with the first aspect of the subject, and discussed the essentials of an ideal weather service fully developed without restriction in finance. Such a service should give (1) the force and direction of the wind at various heights; (2) the levels of the cloud sheets; (3) an indication of the localities where low cloud reached to the ground or where fog existed; (4) a general forecast of the weather, especially with regard to squalls and thunderstorms, and could be provided either by the circulation of forecasts from a central office or by direct communication from places along the route to the starting point. Both systems depend ultimately on local observations. Various methods were available for obtaining upper air observations at a given place, but Major Dobson advocated the use of small kite balloons carrying instruments but not observers. The balloons should be stationed 30 to 50 miles off the line of the route to avoid the danger of collision, and one balloon to each 150 to 200 miles should suffice. Probably 10,000 feet would be a sufficient height to set as a limit to the observations, as commercial flying would presumably not be carried on at higher altitudes.

Colonel E. Gold emphasised the fact that observations, however numerous, made at stations along the line of a route could not in themselves be sufficient. Conditions have time to change, especially during a long flight, and more than half the accidents due to bad weather arise from conditions becoming bad during a flight, not through being so at the start. Colonel Gold gave an interesting illustration of this fact from his own experience in France during the war. A squadron of aeroplanes was about to start on an expedition in weather which would have been reported as satisfactory from anywhere in the neighbourhood or on the route. A forecast based on more extensive observations was, however, issued, and the squadron did not set out. Had they done so they would probably all have been lost, as severe weather came up in a short time. The forecast is therefore essential, and this must be based on a wider range of stations than those near a given route. Adequate upper air forecasts could be made from a comparatively small number of stations of the type suggested by Major Dobson, say 12 over Western Europe and four or five in the British Isles.

General Brancker said that meteorology was the life-blood of aviation. He did not, however, regard the prevention of accidents as the principal object of the meteorological service. Weather conditions would have to be studied and forecasted solely from the point of view of regularity of travel. He considered that intervals of 150 or 200 miles between reporting stations were too big, four being required on the London–Paris route (220 miles).

In summing up the discussion Dr. Simpson criticised the use of kite balloons as expensive and dangerous to aviators, and also as requiring considerable time to get results. He considered that the method of direct readings made on aeroplane flights was the best. He looked forward to the time when every pilot would be a meteorologist.

The Royal Meteorological Society.

A SPECIAL meeting of the Society was held on February 16th at 70, Victoria Street, S.W.2 (Mr. R. H. Hooker, President, in the chair), for the purpose of discussing a resolution by Capt. D. Brunt, who moved that it was desirable that the ordinary meetings should in future be held at 5 p.m. instead of 8 p.m. An amendment, moved by Mr. W. W. Bryant, that the matter should be referred to the fellows by means of a card-vote, was carried.

An ordinary meeting followed, at which Mr. M. de C. S. Salter read a paper on "A new method of constructing Average Monthly Rainfall Maps." The method of weighting short rainfall records in order to compute the equivalent value for a long period, although applicable to the construction of an average annual map, fails when applied to monthly maps on account of the greater variability of the fall over such short periods as a month. The factor of monthly rainfall which shows the simplest regional arrangement is the "isomeric" distribution of the average monthly rainfall. An isomeric rainfall map is constructed by plotting the percentage which the average rainfall in any month forms of the average in the whole year. On account of the simplicity of distribution isomeric maps can be constructed with fewer data than isohyetal maps which show the actual fall.

The method used was to construct a highly detailed isohyetal map of the average annual rainfall and to combine it successively with each of twelve monthly isomeric maps compiled from a smaller number of data. For the purpose of the annual map Dr. Mill's incomplete survey maps on the scale of 2 miles to one inch were copied on the scale of 20 miles to one inch, and supplemented by 1,160 additional points. The isomeric maps used were compiled from 550 monthly averages for the period 1881–1915.

The resultant average maps appear to have the advantage of a high general level of accuracy, whilst showing more detail than is feasible by any other method.

The discussion turned principally on the validity of the method Dr. G. C. Simpson expressed the belief that it should be capable of mathematical demonstration, and Mr. Whipple, Mr. Corless and the President discussed this aspect. Mr. Brooks drew attention to the fact that the method did not throw any light on the details of the orographical control of rainfall at different seasons. Mr. Glasspoole, who had taken a large part in the work, mentioned the severe test of the accuracy of the data which the method provided. He estimated that the annual map was built up from about 12,000,000 daily observations of rainfall, the equivalent of a year's work for 500 men.

An account of Mr. G. A. Clarke's paper on "An unusual Pilot Balloon Trajectory," was given by Mr. J. S. Dines.

The balloon in question was sent up at Aberdeen on June 30th, 1920, in the afternoon, and followed with a single theodolite. It ascended very slowly at first, so that after six minutes the elevation was only 4°. Subsequently the apparent rate of ascent increased and the elevation at the end of the eleventh minute was 12° 40′. Working up the observations on the usual assumptions of the one-theodolite method led to very improbable results, and the correct interpretation appears to be that there were actually vigorous downward and upward currents of about six miles an hour combined with the horizontal current of 24 miles an hour. The general direction of the wind was from WSW., a quarter which is notoriously squally at Aberdeen, and the author cites corroborative evidence for the irregularity of the wind on the particular day.

In the discussion Mr. J. S. Dines mentioned that he had not met with such strong vertical currents in his long series of observations with two theodolites. Mr. S. P. Holloway gave an account of observations made at Malin Head, when on one occasion a balloon was carried by the wind first out to sea and then back to land.

Correspondence.

To the *Editors*, "*Meteorological Magazine*."

Weather Lore.

YOUR correspondent in the January number of the *Meteorological Magazine*, page 281, says "The first half of the couplet (on the weather) is plausible enough; but does experience bear out the second line?"

In my long experience it does very fully, and even this spring I have seen my old version come quite true, "Evening grey and morning red, put on your hat or you'll wet your head," and the converse equally so, "Evening red and morning grey is a sure sign of a fine day."

"January warm, the Lord have mercy," is new, and quaint.

THEREZA STORY MASKELYNE.

Basset Down, Swindon, Wilts, February 18th, 1921.

REFERRING to the remarks on this subject in the *Meteorological Magazine* for January 1921, and with reference to the old proverb, " Red at night is the shepherd's delight, red in the morning the shepherd's warning," I may say my experience has proved the second half of this couplet to be more often correct than the first half, and that a red sunrise, especially in the winter time, invariably denotes wind and rain.

A good example took place here on January 5th last, when between 8 h. and 8 h. 20 m. the eastern sky was illumined by a brilliant red colour. During the forenoon the sky became cloudy to overcast, and by the afternoon rain had set in, and continued squally and wet throughout the night. On examination of the *Daily Weather Report* (British Section) for 7 h. of January 5th, a deep cyclone lay over Iceland, while the observer was situated on the extreme edge of the system of relatively high pressure lying to the south-east.

On January 21st a similar display occurred, but on this occasion a south-westerly gale (force 8) was in progress at the time of observation, and continued more or less throughout the day, with rain at times, culminating in the evening in heavy squalls of whole gale force (10 estimated). The phenomena should be recorded by observers. Three colours could be noted: (1) bright yellow, (2) light crimson, (3) dark red. The question is one that might be raised at the next international conference and suitable symbols provided.

C. F. PRIESTLEY.

" Rockcliffe," 20, Murdieston Street, Greenock, February 7th, 1921.

IN connection with the notes on Weather Lore in the January and February numbers the following adage, quoted in *Symons's Meteorological Magazine*, Vol. 4, p. 14, may not be without interest :—

" When January calends are summery, say
'Twill be winterly weather till calends of May."

JOHN GLASSPOOLE.

62, Camden Square, N.W.1, March 9th, 1921.

March Easters and Wet Summers.

FOR some reason or another, there seems to be a very marked relationship between March Easters and wet or " weak " summers. Out of the eleven Easters which have fallen in March during the last 50 years, *i.e.*, 1871–1920, only two have had dry summers, five have been wet and four have been conspicuous for rain, chill and gloom.

This induction certainly does not augur well for the coming season, and I hope it may be upset.

A. C. F. LUTTRELL.

Lea Combe House, Axminster, Devon, February 28th, 1921.

NOTES AND QUERIES.

Mirage on the Gulf of Finland, May 1st, 1919.

VARIOUS reports from meteorological logs are reproduced on the back of the *Meteorological Chart of the East Indian Seas* for March 1921. The following interesting note is taken from the Remark Book of H.M.S. "Cleopatra," dated May 1st, 1919, in Lat. 59° 47′ N., Long. 26° 5′ E :—

"The weather was fine, hot sun, bc., wind ESE., about 1–2, sea 1. Barometer 29·90 (55°), air 43° F., sea 39° F. The ice presented a curious mirage effect, being reflected upwards. When first sighted with the sun on it, it looked very like a continuous line of chalk cliffs in a slight haze; with the sun behind it, small detached pieces appeared as dark blurred objects which might be anything, and might be mistaken for land. On closing it, it was found to be floating not more than a foot or so above water. No appreciable change of temperature was experienced, although the wind was off the ice.

"A very curious effect—probably due to the hot sun on the water—was observed with regard to other ships. At 8.29, sun bearing S. 48° E. (true), the rear ship in the line bearing N. 21° E. 6,000 yards was distorted to about double its height; while the leading ship, bearing N. 35° E. 6,000 yards, was reduced in height, her quarter deck appearing almost awash. The remaining ships were very blurred and distorted, their heights being increased. Their shapes changed rapidly on approach, but did not become normal until within 2 miles."

The thermometer readings here stated do not suffice to provide the full explanation of the phenomena. It seems likely that there was, so to speak, a sandwich of very cold air, the temperature being 39° F. immediately over the water, about 32° F. in a shallow current blowing from the ice-field, and 43° F. at deck level. In such cases additional observations giving the temperature close to the water and at the highest accessible point would be of great value.

A point of considerable interest is the fact that the mirage was observed with the sun behind the ice floes, and that the floes appeared as black objects. In contrast with this observation, Dr. John Ball's remark* concerning the mirage of the desert may be quoted: "It may be mere accident, but the author has never observed a mirage under the sun's position, but always in that part of the horizon which lies away from it. The ordinary explanation of mirage does not appear to require any condition as to the sun's position in relation to the illusion."

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* On the topographical and geological results of a reconnaissance survey of Jebel Garra, &c., Survey Department, Egypt, Cairo, 1902, p. 40. An instructive sketch of a mirage, worked up from a photograph, is reproduced in this Memoir.

Mirage across the Bay of Plenty.

Lt.-Col. D. C. Bates sends from New Zealand a cutting from the *Bay of Plenty Times* of December 6th, 1920:—

"Anyone who happened to be looking out to the eastward from the higher portions of the town yesterday afternoon between four and five o'clock might have observed a very unusual meteorological occurrence in these parts, due to an unusually refractive condition of the atmosphere. Colonel G. A. Ward, who had the good luck to see it, gives us the following notes:—'There appears to have been a layer or bank of air lying over the land and sea to the east of the town of most unusual refractive power. Looking across the harbour and narrow strip of mainland (Matapihi-Whareroa) between the harbour and the sea, from my residence, the island of Motiti is always plainly visible, and in a few places, through dips in the intervening low-lying land, small glimpses of the sea between. Of the curious and almost detached high lump at the south-east end of the island, only just the very top is normally visible, the distance being twelve miles. Plate Island, 21 miles away, is almost entirely hidden by the intervening land. Yesterday (Sunday) afternoon, between 4 and 5 o'clock, the whole of the three objects named and the intervening sea were, by an extraordinary effect of refraction, lifted into plain view, and in addition distorted by vertical extension to between two and three times their natural height; to such an extent was this done that, even viewed through powerful field glasses, details were scarcely recognisable owing to the blurred out-of-focus effect produced. A broad strip of blue sea intervened between the mainland and Motiti for its whole length, and even between the mainland and Plate Island a narrow strip of sea was visible at the base of the island, which loomed up like a great grey bulk, flanked on the left by two towering pinnacles and on the right by one, vertical optical extensions of normally small prominences. All this time there was a dark grey-blue band on the horizon, about as high as the islands appeared to rise. Soon after 4.30 this bank appeared to condense from the surface of the sea towards its upper margin, its colour along the top edge becoming much darker, till it resembled a thick dark-coloured cable stretched from island to island. This phase only lasted a few minutes, and then, beginning at the south-east end of the main portion of Motiti, it slowly faded out, as a chalk line would disappear on a blackboard if a sponge, invisible to the eye, were slowly passed along it. As this occurred the islands began to shrink down to their normal size and usual position, Motiti appearing to thin itself down to its usual height and settle back till most of its base was hidden by the intervening land, while Plate Island, like an island of one's dreams, sank slowly out of sight and disappeared. I may add that I have seen occasional freaks of refraction, but never before one to equal this, though I have read of such in other lands.

This morning, Monday, I notice refractive distortion becoming unusually prominent with the increasing heat of the day. At 7 a.m. Plate Island was not distinguishable; now, 10 a.m., about one-third of its height is thus made visible.'"

[The explanation of the black band which is such a remarkable feature of this interesting description may be as follows:—The light which reached the observer from the "band" must have come from a narrow strip of sky beyond the islands. The total amount of light being the same as would have been received from this strip in normal circumstances, whilst the apparent width was much greater, the intensity was reduced and the band appeared dark in contrast with the rest of the sky.—Ed. M.M.]

The Characteristics of Gales on the Coast of Venezuela.

A NOTE received from Senor L. Ugueto, Director of the Observatorio Cajigal, states that the season of gales on the coast of Venezuela extends normally from December to the middle of March, but occasionally begins even in October. The wind blows from west or north-west on several successive days, reaching a maximum in the afternoon or early evening, and falling off in the night and early morning. The winds are cold, bringing temperatures of 45° F. or even less, and humid, but they are accompanied by a clear sky with only a few cirrus or cirro-cumulus clouds. They are generally associated with a slight fall of the barometer. At other seasons of the year less violent winds from the same direction bring overcast skies and heavy rain.

The gales from east or south-east are less violent; they occur always between noon and 16 h., are warm and dry, with a clear sky, and have no appreciable relation to the barometer. They are evidently Föhn-like winds from the mountains of Macarao and Los Teques, which rise to 2,500 m. a few kilometres to the east-south-east.

Squalls at Night on the Lee Side of a Mountainous Island.

THE following extract from the meteorological log of the S.S. "Krasnoiarsk" (Captain W. Tingey; observer, Mr. E. J. Berry) is reproduced from the same chart as the note on p. 40:—

> "Whilst passing to the northward of Sokotra between 7 p.m. and 2.30 a.m. on August 5th and 6th, 1920, distance about 7 miles off, violent squalls were experienced, clearly defining the causes of wind. Between the squalls, which were of ½ to 1 hour duration, force of wind was about 2 to 3. The temperature was then about 80° F., which during the squalls fell to 74° F. The warm atmosphere seemed to be rising and forming cloud in the zenith, the cooler air rushing in to take its place sweeping obliquely from the mountains, causing squalls of about force 8. Before and after clearing the lee of the island the force of monsoon was 5."

Sokotra is an island in the Indian Ocean, about 200 miles from the Arabian coast. Its length from east to west is 71 miles, its greatest breadth 22. The peaks of the central mass rise to about 4,000 feet. The log of the "Krasnoiarsk" shows that the sea-temperature was about 70° F.

Solar Radiation and Sunspots.

NEW light on the cause of the variations in the intensity of the solar heat stream is thrown by recent comparisons*

* H. H. Clayton, "*Nature*," January 13th, 1921, p. 631.

between the positions of spots on the solar disc as recorded at the Observatory of the University of La Plata and the observation of solar radiation at the Smithsonian Solar Observatory at Calama, Chile. It is found that when spots are on the margin of the sun the total radiation is as much as ½ per cent. above the average, whilst spots in the centre of the disc bring the radiation slightly below the average. Mr. Clayton's theory to account for the former result is that when the solar eruptions which are known to surround regions where spots are numerous stretch out beyond the edge of the visible sun they increase the total radiation. On the other hand, with the spot in the middle of the sun's disc, absorption in the cold centre of the spot may, he thinks, reduce the total emergent radiation.

Soaring Flight: An Unsolved Riddle.

AN interesting paper, "The Problem of Soaring Flight," by Dr. E. H. Hankin, is published in the *Proceedings of the Cambridge Philosophical Society* for January 1921. Dr. Hankin has made careful observations not only of the soaring birds, but of flying-fishes and of dragon-flies, and in this paper he summarises his conclusions. He holds that neither occasional unobserved flapping of the wings nor the utilisation of atmospheric turbulence can provide an explanation of soaring. Against the latter hypothesis he cites, for instance, observations of the flight of vultures gliding in air so full of aerial seeds as to suggest a snowstorm, the floating seeds being in a slow equable movement that showed no turbulence. Dr. Hankin's conclusion is that soaring flight is inexplicable in the light of existing knowledge. "In the case of soaring flight at slow speed a proof exists that the energy involved is derived from the sun's rays. But the mode by which it becomes available to the soaring animal is, as yet, a complete mystery. Direct observation having failed to point the way to a solution, it is to be hoped that the subject will be attacked with the aid of an experimental investigation. It is only in this way that an explanation of the problem is likely to be attained."

The discovery that the flight of dragon-flies is of the same type as that of the great birds should facilitate experimental investigation. Another opening for research is afforded by his account of the *puttung*, a toy kite used by boys in India, which flies vertically over its string and even flies up wind when struck by a sudden gust. Such a kite should be brought into the service of the meteorologist.

The Parkin Prize.

The following notice has been received from Dr. J. S. Fowler, Secretary of the Royal College of Physicians of Edinburgh :—

> In terms of the Bequest made to the Royal College of Physicians of Edinburgh by the late Dr. John Parkin, Fellow of the College, a Prize is offered for the best Essay on certain subjects connected with Medicine.
>
> The subject of the Essay for the present period is, in the terms of the deed :—
>
> "On the effects of volcanic action in the production of epidemic diseases in the animal and in the vegetable creation, and in the production of hurricanes and abnormal atmospherical vicissitudes."
>
> The prize is of the value of One Hundred Pounds, and is open to Competitors of all Nations.
>
> Essays, which must be written in English, must be received by the Secretary not later than December 31st, 1921. Each Essay must bear a motto, and be accompanied by a sealed envelope bearing the same motto outside and the author's name inside.
>
> The successful Candidate must publish his Essay at his own expense, and present a printed copy to the College within three months after the adjudication of the Prize.

It may be recalled that Dr. Parkin (1801–86) was a London physician and twice visited the West Indies, on the second occasion as an agent of the Government, to study and combat disastrous outbreaks of cholera. He became convinced that cholera was in some measure due to the atmospheric conditions which attend or follow volcanic disturbances. Hence his bequest of 1,500*l.* to the Royal College of Physicians of Edinburgh for founding the Prize, the competition for which is now announced. It is understood that a similar bequest was made to the Académie des Sciences, Paris.

A Safe Place for the Grass Minimum Thermometer.

It is customary to caution observers not to leave grass minimum thermometers exposed during the day. The Meteorological Office is now supplying a suitable fitting, a little piece of wood with a hole through the middle, to be screwed inside the Stevenson screen so that the thermometer can be kept safely in the correct position, *i.e.*, bulb downwards, when not in use. The thermometer leans against the corner of the screen with the bulb resting in a little cup.

Reviews.

Clouds; a descriptive illustrated guide-book to the observation and classification of Clouds. Geo. Aubourne Clarke. 8vo, pp. xvi + 136. Constable and Co., 1920. Price 21s. net.

THE development of aviation in recent years, coupled with the many observations made with pilot balloons and in other ways, has added so much to our knowledge of the atmosphere that all textbooks on that subject have become more or less out of date. Hence the publication of a new book on clouds, written by a professional observer and introduced by Sir Napier Shaw as "a substantial addition to the growing edifice of the study of weather," raises great hopes in the mind of a student of meteorology. The author himself describes it as an explanatory guide-book to cloud observation prepared chiefly for those who are engaged in the teaching of meteorology. As such, we naturally look for some description of the methods employed and turn to the first chapter, entitled "The observation of the clouds," to find nothing but a short introduction to the International Classification which follows in detail in Chapter II. This is succeeded by four other chapters which are brief essays on the subjects they deal with, embodying some of the discoveries made in the last few years, and therefore giving on those points information which is otherwise only to be culled from original papers. We note for special commendation the passages in Chapter IV. dealing with the vertical temperature gradient, or lapse-rate, and its relation to cloud formation. On page 71 the author points out that whereas ascending air may be cooled as little as 3° F. per 1,000 feet of ascent, descending air must be warmed at the adiabatic rate of 5½° F. per 1,000 feet. This is true of dry air, but not if cloud particles are evaporated in the process.

The two chapters which follow are comparatively slight, dealing mainly and shortly with the distribution of clouds over the British Islands during different types of weather. Frequent references to other works are given, but the teacher is not spared from the necessity of looking them up.

These chapters are clearly written and illustrated by sufficient diagrams, but we doubt if the coloured plates add much to the attractiveness of the interesting letterpress.

The best part of the whole book is reserved for Section II., which consists of about 70 excellent photographs of clouds, many of which are most beautifully reproduced. Here we have a real guide to the names of clouds, which an observer will find useful enough. Each photograph has a short description appended, in many cases with notes of the attendant weather. In the introduction the author says " they represent a selection from several hundred pictures taken at Aberdeen by methods which were varied so as to give the best possible representation of each particular type." But there is no description of even one of those methods! If the author would substitute for the chapter which he calls " The observation of the clouds " a clear description of the apparatus used (such as the nephoscope), and how to use it, together with directions for making records and taking satisfactory photographs, his book might become a guide of real value to those for whose use it is intended.

The high cost of everything just now suggests that good photographic illustration must be expensive, but few teachers will be ready to pay a guinea for a book which only deals with a part of meteorology. In my opinion it would have been wiser, therefore, to have omitted the plates in Section I., and even to have sacrificed some of the duplicates in Section II. if by those means the price could have been substantially reduced.

Anyone would be glad to possess the book as it is, but the best part is Section II., and we should be glad to see that more generally available. A. W. CLAYDEN.

[By the courtesy of Messrs. Constable we are able to give reproductions of two illustrations from " Clouds." The notes printed with these illustrations are as follows :—

" A. *Cirro-cumulus.*—Intensely white high cloud in radiating bands, At the upper left-hand corner it will be seen that the cloud is opening up into the familiar globular masses of cirro-cumulus. The height of these bands was probably about 20,000 feet, while the broken cumulus below was not more than 5,000 feet high.

B. *Cirro-cumulus.*—The same bands mentioned above as they appeared some time later and in a different part of the sky, which accounts for their different apparent orientation. The character of cirro-cumulus is now well developed and wave motion can be seen in the bands both longitudinally and transversely. These bands were not less than 250 miles in length."]

O problema das seccas do Nordeste resolvido por Luiz Mariano de Barros Fournier. (The Problem of Drought in North-east Brazil.) Rio de Janeiro, 1920. Size 8vo, pp. 166.

THIS pamphlet has been published by the author, who is a cavalry officer with a training in engineering, with a view to interesting the world at large in his project for solving the problem of the deficient rainfall in the north-east of

CIRRO-CUMULUS CLOUDS.

ILLUSTRATIONS FROM "CLOUDS" BY G. A. CLARKE, F.R.P.S., F.R.Met.Soc.

(Published by Constable and Co., Ltd. 21s. net. Postage extra.)

Brazil. The area affected—400,000 square miles in the States of Bahia, Piauhy, Maranhão and Ceará—has an annual rainfall of less than 1,000 mm. (40 inches), which is barely sufficient in a tropical country, and in addition fluctuates widely, so that at average intervals of about five years the rains fail and widespread distress ensues. The author's solution is to build a dam nearly 44 miles long near Quixeramobim, so reversing the flow of a number of streams and forming a reservoir with an area of about 1,500 square miles. The evaporation from this reservoir is expected to provide a sufficient increase of rainfall to carry the region above the fear of drought, and in addition the seepage will benefit the surrounding soil.

The meteorological parts of the book are written in a general way, which make detailed criticism difficult, but it may be remarked that meteorological experience is decidedly against expecting any appreciable amelioration from the presence of such a comparatively small water surface. The pamphlet is a remarkable parallel to a book with a similar object recently published by E. H. L. Schwartz,* of South Africa, and reviewed in the January number of the *Quarterly Journal of the Royal Meteorological Society.*

Climatic Cycles and Tree-Growth, by Professor A. E. Douglass. Publication No. 289 of the Carnegie Institution of Washington. Size 10 × 7, pp. 127, 12 plates. Washington, 1919.

Professor Douglass's study of the annual rings of trees in relation to climate and solar activity has overcome to a considerable extent the difficulties Sir Robert Christison foresaw when he first brought the question before the Scottish Meteorological Society in 1880. The first tree-section considered was the yellow pine of the arid regions of Flagstaff, Arizona, where the critical problem of the tree is to survive periods of drought. The annual increments are recognised by the rings or red tissues which denote the close of the annual period of growth, the tree's year ending in the autumn. The degree of accuracy with which these tree-growths represent the annual rainfall was found to be as much as 70 per cent. in recent years, and this accuracy presumably extends over centuries. The agreement was substantially increased by the use of a formula involving a correction for moisture conservation. Trees from other areas, including Europe, were also examined (*see* this Magazine, Vol. 50 (1915), page 21).

* *The Kalahari, or Thirstland Redemption.* Cape Town and London, 1920.

Difficulty was experienced in the identification of the series of yearly rings. With scanty winter and summer precipitation the rings were meagre, there being no additional growth for the summer rains. Double rings occurred with spring drought and were indicative of the distribution of the rainfall throughout the year. Trees which grew on hills, relying on the snow and rain as it came, showed great variation; those of the valleys showed slight variation from year to year. In some of the older trees a change from one type to the other was noticed. The major characteristics of the trees in mountain regions were alike over distances of 56–60 miles.

While the trees of drier climates showed conspicuously a relation to the rainfall, the wet climate trees prominently indicated the solar rhythm in their growth, and this became more certain as the tree record extended further back. This and "the suggestive correlation existing in the dates of maxima and minima found in the tree growth, rainfall, temperature and solar phenomena point towards a physical connection between solar activity and terrestrial weather."

Details are given of the elaborate methods employed, including the "automatic optical periodograph" used in the analysis of the periods, together with tables of mean tree growths for various districts for each year as far back in one case as B.C. 1220, and a most comprehensive bibliography of the subject. J. G.

Obituary.

NEWS is received of the death, on January 25th, 1921, of *Señor Tomás de Azcárate* in his 72nd year. He was for eighteen years director of the San Fernando *Instituto y Observatorio de Marina*, an important centre for meteorological, magnetic and seismic observations.

THE death, on February 16th, 1921, of *Mr. Charles Grover* is announced. Mr. Grover, who was in his 79th year, was astronomical assistant and meteorological observer to the late Sir C. E. Peek, Bart., of Rousdon, Devon, and had been in charge of the instruments there for many years. The observations from Rousdon, which have been utilised at the Meteorological Office since 1886, cease with Mr. Grover's death.

THE death of *Mrs. H. Edith Purchas*, of Chasedale, Ross-on-Wye, on February 17th, 1921, is reported. In 1914

Mrs. Purchas organised a meteorological station in conjunction with Mr. F. J. Parsons, and whilst he was on service with the Meteorological Section, R.E., she accepted full responsibility for the observations, and in spite of her years took a majority of the readings, three times a day, herself. The combination of a high sense of duty with much kindliness was characteristic of a charming personality.

News in Brief.

The Observatorio Meteorologico la escuela Normal de Varones, Honduras, Central America, commenced in August 1920 the publication of a Monthly "Boletin," of which two numbers have now been received. The greater part of the publication is devoted to the daily observations, taken at 7, 14 and 21 h., and completed by self-recording instruments, but in addition there are articles on the barometric formula and on local geography. Observations from a well-equipped station in this meteorologically little known region were greatly to be desired, and it is to be hoped that the "Boletin" will continue to appear regularly.

ON March 9th, at the Cambridge University Aeronautical Society, Sir Napier Shaw, F.R.S., delivered a lecture on "The Artificial Control of the Weather." A report of the paper will be given in the next issue of this magazine.

ON February 27th the barometer at Valencia Observatory rose to 1048·3 mb. The highest recorded reading at Valencia is 1053·2 mb. on January 28th, 1905, and the highest for the British Isles is 1055 mb. at Aberdeen on January 31st, 1902.

FROM 2 h. on February 1st until 10 h. on February 3rd (56 hours) "dead calm" was registered continuously by the anemometer at Alnwick Castle, Northumberland; and at the Groyne Lighthouse, South Shields, no wind above five miles per hour was registered during the same period.

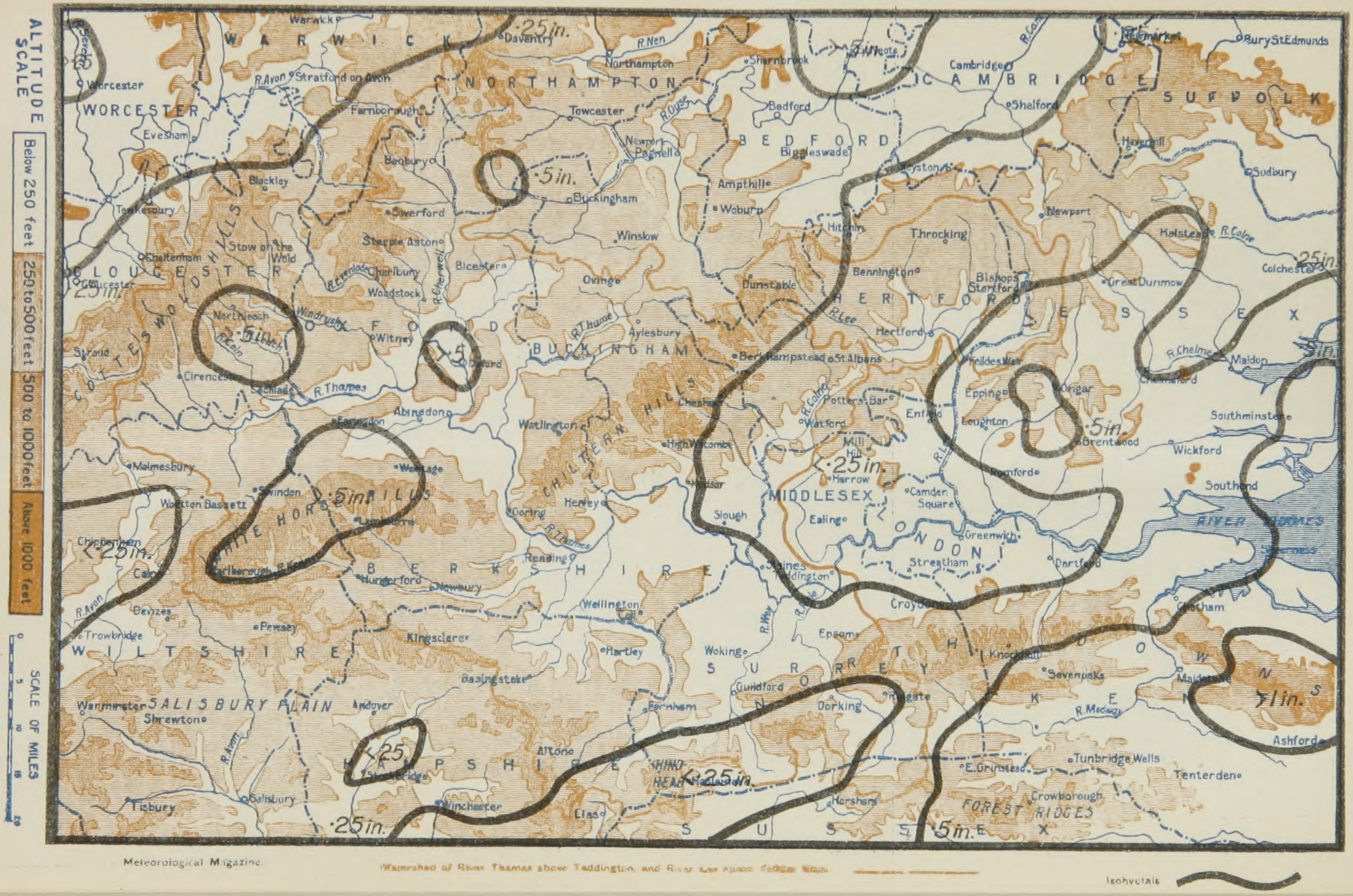
Earthquake Record.—A moderate earthquake was recorded on the seismograph at Eskdalemuir, in S.W. Scotland, on Sunday, February 27th, at 18 h. 36 m. It is calculated that the centre of the disturbance was approximately 1,790 kilometres distant in a south-easterly direction, *i.e.*, in the neighbourhood of Central Italy.

The Weather of February 1921.

THE pressure distribution over west and north-west Europe during the month was largely dominated by a series of important anticyclones. In consequence, strong winds and gales were rare, and the rainfall was small except in the Mediterranean area. Temperature was mostly high for the time of year in western Europe and Iceland, but severe frost prevailed at times over Sweden. Depressions followed paths well to the northward or southward of the British Isles.

A depression which arrived from the Atlantic on the closing day of January, became stationary over Northern England and filled up, and a short spell of quiet weather with local frost and fog over the British Isles followed. Meanwhile a secondary moved eastward over France to Central Europe before filling up, causing rain or snow at several stations. A small anticyclone over Scandinavia increased in size and intensity, and was the dominant feature of the pressure distribution from the 4th to the 9th of the month. From the 5th to the 8th there was a spell of east wind over England, with cold dull weather, but no frost, though over Central Europe there was frost and occasional snow. The west of Ireland came under the influence of Atlantic depressions, and there was a good deal of rain, Valencia Observatory having 16 mm. on the 3rd, 26 mm. on the 4th, and 18 mm. on the 7th. One of these systems caused a southerly gale in West Ireland on the 4th, and in the western part of the English Channel on the 5th before it filled up, and there was also a southerly gale on the latter date in Caithness and the Shetlands. Pressure remained low over Iceland, and on the morning of the 8th there was a shallow secondary trough over Ireland, with cold air behind it. This system dispersed, and a large new anticyclone developed rapidly over Ireland, while the Scandinavian anticyclone moved quickly away south-eastward owing to the appearance of a depression over the North Cape. Pressure exceeded 1044 mb. over most of Ireland and south-west Scotland on the morning of the 10th, and subsequently the anticyclone withdrew to a position off north-west Ireland and remained almost stationary till the 17th, decreasing slowly in intensity. A warm current from the Atlantic spread round the stationary anticyclone, and the weather became unseasonably mild over Western Europe, and especially over the British Isles, although the sky was mainly overcast. In Sweden there was some severe frost, the temperature being $-22°$ F. at Saerna on the morning of the 15th. A depression which moved east-south-east from Iceland caused a total rainfall of 34 mm. of rain at Lerwick

THAMES VALLEY RAINFALL.—FEBRUARY, 1921.



H.M. Stationery Office Press, Kingsway W.C.2.

PS. 5550/203. Wt. 105. P.85 1250. 3/21.

on the 14th and 15th, and smaller falls in other parts of Scotland and in Scandinavia and Germany.

In the rear of another depression which moved east-south-east from Iceland, an important change took place in the distribution of pressure. The highest pressure was transferred from south-west Ireland to Scotland by the 18th, and the system withdrew to east central Europe by the 22nd. Severe frost set in over southern Poland and eastern Czecho-Slovakia, with a temperature about 0° F. on several successive mornings. Over western Europe there was a south-east current, with fine weather and frosty nights but warm days. The daily range of temperature was unusually high, being as much as 33° F. at South Farnborough on the 22nd. On the two following days temperature reached 60° F. at a few stations in England and France. On the 25th a large anticyclone developed rapidly off south-west Ireland. There was a warm southerly current over western Europe, and the cold current in front of the fresh anticyclone displaced this and caused rain over the British Isles and North France between the 24th and 26th, and local thunder in England on the night of the 24th. The rainfall on the 25th exceeded 20 mm. locally in south-east England, and was the only important fall in the whole month in that area. On the 26th the barometer at Valencia Observatory reached 1048 mb., but the anticyclone soon moved south and decreased in intensity, and on the 28th a mild westerly current was again established over north-west Europe, with rain in north and west Scotland, and in Norway.

In the Mediterranean area shallow depressions caused some heavy rainstorms, particularly in the first half of the month. There were heavy falls of rain in Italy and South France, and Sanguinaire (Corsica) received 32 mm. on the 5th and 60 mm. on the 6th. At Gibraltar there were 51 mm. on the 10th and 102 mm. on the 11th; the rainstorm was accompanied by a south-east wind which reached the force of a strong gale on the evening of the 11th, and thunderstorms were reported on the 11th both at 7 h. and 18 h., and also at 7 h. on the 12th. At this time there was a shallow depression over Morocco, and this with the anticyclone lying over Ireland led to a cold north-east current over France and Spain, Madrid reporting "snow-lying" on the morning of the 11th. After the 20th the anticyclone over Central Europe extended over Italy, but shallow depressions over north-west Africa and associated secondaries caused further heavy local rainstorms further west, Madrid having 26 mm. on the 26th. A cold north-east wind prevailed in Athens from the 23rd to the 25th, with maximum temperature below 40° F. on these three days and slight snow on the evening of the 23rd.

(*Continued on* p. 56.)

Rainfall Table for February 1921.

STATION.	COUNTY.	Aver. 1881—1915. in.	1921. in.	1921. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days.
Camden Square	*London*	1·67	·18	5	11	·15	25	4
Tenterden (View Tower)	*Kent*	1·97	·64	16	32	·43	25	8
Arundel (Patching Farm)	*Sussex*	2·21	·79	20	36	·50	25	2
Fordingbridge (Oaklands)	*Hampshire*	2·49	·39	10	16	·17	24	8
Oxford (Magdalen College)	*Oxfordshire*	1·58	·56	14	35	·29	25	6
Wellingborough (Swanspool)	*Northampton*	1·61	·30	8	19	·26	25	4
Hawkedon Rectory	*Suffolk*	1·52	·14	4	9	·10	25	5
Norwich (Eaton)	*Norfolk*	1·64	·33	8	20	·10	11	9
Launceston (Polapit Tamar)	*Devon*	3·21	·22	6	7	·13	24	4
Sidmouth (Sidmount)	,,	2·50	·38	10	15	·24	25	3
Ross (Chasedale Observatory)	*Herefordshire*	2·01	·16	4	8	·15	25	2
Church Stretton (Wolstaston)	*Shropshire*	2·20	·37	9	17	·23	25	3
Boston (Black Sluice)	*Lincoln*	1·46	·44	11	30	·28	25	5
Worksop (Hodsock Priory)	*Nottingham*	1·54	·20	5	13	·16	25	3
Mickleover Manor	*Derbyshire*	1·65	·34	9	21	·27	25	5
Southport (Hesketh Park)	*Lancashire*	2·10	·38	10	18	·27	24	5
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·09	·14	4	7	·04	25	7
Hull (Pearson Park)	,, *E. R.*	1·66	·30	8	18	·13	25	8
Newcastle (Town Moor)	*North'land*	1·59	·20	5	13	·05	6	7
Borrowdale (Seathwaite)	*Cumberland*	11·87	1·30	33	11	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	3·00	·06	2	2	·02	24	5
Haverfordwest (Gram. Sch.)	*Pembroke*	3·48	·32	8	9	·14	24	5
Aberystwyth (Gogerddan)	*Cardigan*	3·17	·41	10	13	·27	24	3
Llandudno	*Carnarvon*	2·08	·39	10	19	·32	24	4
Dumfries (Cargen)	*Kirkcudbrt.*	3·88	·42	11	11	·18	23	6
Marchmont House	*Berwick*	2·08	·60	15	29	·34	1	5
Girvan (Pinmore)	*Ayr*	4·27	·98	25	23	·42	24	13
Glasgow (Queen's Park)	*Renfrew*	2·94	·83	21	28	·36	24	9
Islay (Eallabus)	*Argyll*	4·19	2·68	68	64	·49	15	17
Lochgilphead	,,	4·74	4·19	221	56	·53	..	..
Loch Dhu	*Perth*	7·45	2·50	64	34	·60	15,28	11
Dundee (Eastern Necropolis)	*Forfar*	1·88	·46	12	24	·21	24	7
Braemar (Bank)	*Aberdeen*	2·73	·56	14	21	·45	24	4
Aberdeen (Cranford)	,,	2·32	1·13	29	49	·26	6	11
Gordon Castle	*Moray*	1·92	·45	11	23	·24	24	7
Fort William (Atholl Bank)	*Inverness*	7·42	3·79	96	51	·81	15	15
Alness (Ardross Castle)	*Ross*	3·30	·88	22	27	·27	24	11
Loch Torridon (Bendamph)	,,	7·90	3·70	94	47	·61	15	17
Stornoway	,,	4·46	2·52	64	57	·38	3	19
Wick	*Caithness*	2·27	1·13	29	50	·34	24	16
Glanmire (Lota Lodge)	*Cork*	3·95	2·43	62	62	·75	7	8
Killarney (District Asylum)	*Kerry*	5·22	3·32	84	64	1·75	4	11
Waterford (Brook Lodge)	*Waterford*	3·26	2·34	59	72	·55	23	7
Nenagh (Castle Lough)	*Tipperary*	3·12	1·86	47	60	·82	4	13
Ennistymon House	*Clare*	3·40	2·52	64	74	1·09	4	11
Gorey (Courtown House)	*Wexford*	2·81	1·11	28	40	·35	4	7
Abbey Leix (Blandsfort)	*Queen's Co.*	2·68	1·12	28	42	·35	7, 24	10
Dublin (FitzWilliam Square)	*Dublin*	1·89	·70	18	37	·30	24	7
Mullingar (Belvedere)	*Westmeath*	2·78	·34	9	12	·22	24	5
Woodlawn	*Galway*	2·97	1·49	38	50	·50	4	13
Crossmolina (Enniscoe)	*Mayo*	4·46	2·57	65	58	·72	4	12
Collooney (Markree Obsy.)	*Sligo*	3·43	1·94	49	57	·72	4	13
Seaforde	*Down*	3·05	·84	21	28	·39	3	5
Ballymena (Harryville)	*Antrim*	3·24	1·44	37	44	·41	24	11
Omagh (Edenfel)	*Tyrone*	2·98	1·01	26	34	·33	3	13

Supplementary Rainfall, February 1921.

Div.	STATION.	RAIN.		Div.	STATION.	RAIN.	
		in.	mm.			in.	mm.
II	Ramsgate	·65	16	XII.	Langholm, Drove Rd.	·38	10
,,	Sevenoaks, Speldhurst	·69	18	XIII.	Selkirk, Hangingshaw	·47	12
,,	Hailsham Vicarage	·77	20	,,	North Berwick Res.	·30	8
,,	Totland Bay, Aston	·19	5	,,	Edinburgh, Royal Ob.	·51	13
,,	Ashley, Old Manor Ho.	·27	7	XIV.	Biggar	·54	14
,,	Grayshott	·20	5	,,	Leadhills	2·04	52
,,	Ufton Nervet	·32	8	,,	Maybole, Knockdon	1·57	40
III.	Harrow Weald, Hill Ho.	·18	5	XV.	Dougarie Lodge	1·24	32
,,	Pitsford, Sedgebrook	·31	8	,,	Inveraray Castle	2·76	70
,,	Chatteris, The Priory	·49	12	,,	Holy Loch, Ardnadam	2·98	76
IV.	Elsenham, Gaunts End	·12	3	XVI.	Loch Venachar	1·20	30
,,	Lexden, Hill House	·16	4	,,	Glenquey Reservoir	1·20	30
,,	Aylsham, Rippon Hall	·46	12	,,	Loch Rannoch, Dall	1·50	38
,,	Swaffham	·31	8	,,	Trinafour	1·29	33
V.	Devizes, Highclere	·45	11	,,	Coupar Angus	·42	11
,,	Weymouth	·30	8	,,	Montrose Asylum	·45	11
,,	Ashburton, Druid Ho.	·30	8	XVII.	LogieColdstone,Loanh'd	·44	11
,,	Cullompton	·26	6	,,	Fyvie Castle	·60	15
,,	Hartland Abbey	·27	7	,,	Grantown-on-Spey	·70	18
,,	St. Austell, Trevarna	·59	15	XVIII.	Cluny Castle	1·44	37
,,	North Cadbury Rec.	·24	6	,,	Loch Quoich, Loan	14·28	363
,,	Cutcombe,Wheddon Cr.	·18	5	,,	Drumnadrochit	1·09	28
VI.	Clifton, Stoke Bishop	·29	7	,,	Arisaig, Faire-na-Sguir	3·73	95
,,	Ledbury, Underdown	·23	6	,,	Skye, Dunvegan	3·46	88
,,	Shifnal,HattonGrange	·31	8	,,	Glencarron Lodge	6·82	173
,,	Ashbourne, Mayfield	·29	7	,,	Dunrobin Castle	·82	21
,,	Barnt Green, Upwood	·15	4	XIX.	Tongue Manse	1·34	34
,,	Blockley, Upton Wold	·31	8	,,	Melvich Schoolhouse	·95	24
VII.	Grantham, Saltersford	·33	8	,,	Loch More, Achfary	6·31	160
,,	Louth, Westgate	·42	11	XX.	Dunmanway Rectory	3·74	95
,,	Mansfield, West Bank	·31	8	,,	Mitchelstown Castle	1·95	50
VIII.	Nantwich, Dorfold Hall	·29	7	,,	Gearahameen	4·50	114
,,	Bolton, Queen's Park	·44	11	,,	Darrynane Abbey	3·83	97
,,	Lancaster, Strathspey	·31	8	,,	Clonmel, Bruce Villa	2·03	52
IX	Wath-upon-Dearne	·21	5	,,	Cashel, Ballinamona	1·72	44
,,	Bradford, Lister Park	·13	3	,,	Roscrea, Timoney Pk.	1·15	29
,,	West Witton	.08	2	,,	Foynes	2·90	74
,,	Scarborough, Scalby	·36	9	,,	Broadford, Hurdlesto'n	2·16	55
,,	Ingleby Greenhow	..	..	XXI.	Kilkenny Castle	1·74	44
,,	Mickleton	·20	5	,,	Rathnew, Clonmannon	·84	21
X.	Bellingham	·30	8	,,	Hacketstown Rectory	1·74	44
,,	Ilderton, Lilburn	·17	4	,,	Ballycumber, Moorock	..	..
,,	Orton	·15	4	,,	Balbriggan, Ardgillan	·76	19
XI.	Llanfrechfa Grange	·11	3	,,	Drogheda	·88	22
,,	Treherbert,Tyn-y-waun	·22	6	,,	Athlone, Twyford	·76	19
,,	Carmarthen,The Friary	·22	6	,,	Castle Forbes Gdns.	·67	17
,,	Fishg'rd,Goodwick Stn.	·43	11	XXII.	Ballynahinch Castle	2·35	60
,,	Lampeter, Falcondale	·36	9	,,	Galway Grammar Sch.	1·84	47
,,	Crickhowell, Talymaes	1·00	25	,,	Westport House	2·59	66
,,	B'ham W.W.,Tyrmyndd	·30	8	XXIII.	Enniskillen, Portora	·73	18
,,	Lake Vyrnwy	·39	10	,,	Armagh Observatory	·98	25
,,	Llangynhafal, P. Drâw	·59	15	,,	Warrenpoint	·99	25
,,	Oakley Quarries	·93	24	,,	Belfast, Cave Hill Rd.	·78	20
,,	Dolgelly, Bryntirion	·82	21	,,	Glenarm Castle	·70	18
,,	*Snowdon, L. Llydaw	2·23	57	,,	Londonderry, Creggan	1·53	39
,,	Lligwy	·40	10	,,	Sion Mills	1·18	30
XII.	Stoneykirk,ArdwellHo.	·71	18	,,	Milford, The Manse	1·67	42
,,	Carsphairn, Shiel	1·72	44	,,	Killybegs, Rockmount	2·90	74

*** January, 29·11 in. 739 mm.**

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
	Mean of Day M.S.L.	Diff. from Normal	Absolute				Mean Values			
			Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	° F.		° F.		° F.	° F.	° F.	° F.
London, Kew Observatory	1017·4	+0·6	72	12	40	13	64·6	49·6	57·1	0·0
Gibraltar	1016·9	+1·1	83	6, 9	58	24	79·5	68·0	73·7	+1·5
Malta	1017·4	+1·7	84	10, 11	69	25	80·6	71·1	75·9	+0·7
Sierra Leone	1013·3	+0·7	87	18,19,28	68	9	84·4	71·5	77·9	−1·2
Lagos, Nigeria	1014·1	+1·3	87	18	71	9	82·4	73·2	77·8	−0·3
Kaduna, Nigeria	1014·6	+3·1	89	6	63	1	83·9	66·4	75·1	−1·7
Zomba, Nyasaland	1012·8	−1·0	89	15,26,27	55	3, 7, 9	84·4	59·6	72·0	+2·9
Salisbury, Rhodesia	1012·9	−2·4	90	17	46	5, 6	85·8	53·1	69·5	+3·7
Cape Town	1017·4	−1·7	81	27	40	3	64·2	51·0	57·6	−0·3
Johannesburg	1016·1	−1·0	80	24	39	14	72·6	48·3	60·5	+1·2
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	1013·0	−2·0	83	23	31	15	72·2	43·4	57·8	−1·3
Calcutta, Alipore Obsy.	1002·9	−1·6	93	6	76	16	89·2	79·0	84·1	+1·1
Bombay	..	..	90	..	76	..	86·6	78·1	82·3	+1·6
Madras	..	..	103	30	74	21	95·7	78·8	87·3	+2·2
Colombo, Ceylon	1010·1	+0·5	87	13	73	21	85·3	76·4	80·9	−0·5
Hong Kong	1006·9	−1·4	90	3	73	12	85·6	77·6	81·6	+0·6
Sydney	1018·3	+2·3	79	7	44	27	66·9	51·5	59·2	+0·2
Melbourne	1018·5	+2·7	72	29	36	23	62·6	47·6	55·1	+1·1
Adelaide	1018·8	+1·3	77	29	40	27	64·8	49·5	57·1	+0·1
Perth, Western Australia	..	..	..	..	..	..	..	..	..	..
Coolgardie	1016·2	−0·9	89	22	37	30	72·7	47·3	60·0	+1·4
Brisbane	1018·3	+1·2	83	25	51	24	73·9	56·2	65·1	−0·2
Hobart, Tasmania	1016·1	+5·4	69	28	36	19	60·0	44·6	52·3	+1·5
Wellington, N.Z.	1016·0	+2·5	63	27	33	5	55·6	44·0	49·8	−1·7
Suva, Fiji	1013·7	−0·6	85	13	64	10	78·4	69·1	73·7	−0·8
Kingston, Jamaica	1012·8	+0·2	94	14	72	13	90·3	73·7	82·0	+0·5
Grenada, W.I.	1011·7	−0·1	89	5, 7	72	2, 3, 21	85·5	74·7	80·1	−0·1
Toronto	1015·8	−2·0	87	12	37	19	74·9	52·8	63·9	+4·7
Winnipeg	1010·2	−4·6	85	13	34	28, 29	70·9	48·0	59·5	+6·1
St. John, N.B.	1013·9	−3·6	79	26	37	20	63·5	49·8	56·7	+0·8
Victoria, B.C.	1012·1	−4·4	74	1	46	4	60·7	49·2	54·9	−0·7

London, Kew Observatory.—Mean speed of wind 5·3 mi/hr ; 5 days with fog.
Malta.—Prevailing wind direction NW. ; mean speed 3·4 mi/hr.
Sierra Leone.—Prevailing wind direction SW. ; 8 days with thunder heard.
Salisbury, Rhodesia.—Prevailing wind direction NE. ; 1 day with thunder heard.
Colombo, Ceylon.—Prevailing wind direction SW. ; mean speed 6·0 mi/hr.

British Empire, September 1920.

TEMPERATURE Absolute Max. in Sun °F.	TEMPERATURE Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	PRECIPITATION Amount mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible	STATIONS
125	33	79	7·0	2·45	62	+ 14	11	3·5	28	London, Kew Observatory
136	52	73	4·1	0·04	1	− 35	2	..	..	Gibraltar.
144	..	75	3·6	0·32	8	− 22	3	8·6	69	Malta.
..	..	81	8·0	25·33	643	− 84	27	..	..	Sierra Leone.
161	65	74	7·2	0·45	11	−119	5	..	..	Lagos, Nigeria.
..	..	84	..	13·27	337	+ 77	25	..	..	Kaduna, Nigeria.
..	..	66	1·1	0·00	0	− 9	0	..	..	Zomba, Nyasaland.
134	41	42	0·6	0·00	0	− 12	0	..	..	Salisbury, Rhodesia.
..	..	76	6·1	3·65	93	+ 36	13	..	..	Cape Town.
..	37	53	2·9	1·85	47	+ 23	3	8·8	74	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
..	..	54	3·9	0·56	14	− 9	4	..	..	Bloemfontein.
..	73	74	7·9	9·36	238	− 25	11	..	..	Calcutta, Alipore Obsy.
131	71	81	5·9	4·05	103	−172	19	..	..	Bombay.
165	73	67	6·1	0·47	12	−119	5	..	..	Madras.
159	69	73	8·2	2·04	52	− 74	15	..	..	Colombo, Ceylon.
..	..	77	6·8	11·75	298	+ 52	15	6·9	57	Hong Kong.
133	39	69	4·9	1·05	27	− 47	17	6·1	..	Sydney.
132	33	72	6·3	4·80	122	+ 61	17	..	..	Melbourne.
143	28	66	5·8	1·51	38	− 12	11	..	..	Adelaide.
..	..	..	..	..	..	..	..	..	..	Perth, Western Australia.
152	32	45	3·9	0·87	22	+ 7	4	..	..	Coolgardie.
139	44	63	3·9	3·43	87	+ 34	11	..	..	Brisbane.
134	30	71	6·0	1·79	45	− 9	15	6·1	52	Hobart, Tasmania.
135	22	80	7·0	3·60	91	− 8	15	4·6	39	Wellington, N.Z.
..	..	91	7·6	9·51	242	+ 65	28	..	..	Suva, Fiji.
..	..	77	6·3	0·84	21	− 83	10	..	..	Kingston, Jamaica.
142	..	79	5·0	7·61	193	− 12	21	..	..	Grenada, W.I.
134	34	77	3·2	1·75	44	− 37	9	..	..	Toronto.
..	..	83	3·9	3·33	85	+ 35	11	..	..	Winnipeg.
135	33	87	6·5	3·13	80	− 15	11	..	..	St. John, N.B.
..	..	86	5·8	3·62	92	+ 41	14	..	..	Victoria, B.C.

HONG KONG.—Prevailing wind direction E. ; mean speed 10·4 mi/hr ; 3 days with thunder heard.

SUVA, FIJI.—1 day with thunder heard.

GRENADA.—Prevailing wind direction E.

Cloud and Fog.—For the greater part of the month the weather was of a type frequently associated with winter anticyclones, the sky being overcast with a uniform horizontal cloudsheet at about 2,000 or 3,000 feet. There was a spell of fine weather in England from the 20th till the 24th, inclusive. In this period there was morning fog at a few stations, and there was a good deal of fog from the 2nd to the 4th, but for the most part the visibility was fair to good, especially near the coast. C. K. M. D.

Rainfall in the British Isles, February 1921.

THE most noteworthy feature of the month was pronounced deficiency of rainfall such as had not been observed since the very dry Februaries of 1895 and 1891. Everywhere the rainfall was considerably below the average, and, as in 1895 and 1891, the deficiency mainly occurred in England and Wales. Less than 10 per cent. of the average (1881–1915) was recorded in broad bands from north Cornwall to the south of Shropshire, from Preston to Durham, and in Essex and Suffolk. More than 50 per cent. was recorded only in the south of Ireland and west of a line from Galway northwards along the coast to Wick. The grouping of the dry and rather wetter areas exhibited the characteristic arrangement from south-west to north-east. Rainfall of more than 25 mm. (1 inch) was confined to small mountain regions in England and Wales and the western half of Scotland, but it was general in Ireland with the exception of the eastern central basin. At Seathwaite the rainfall was the smallest noted in February since observations began in 1845, January of this year having been the wettest since 1873.

The general rainfall expressed as a percentage of the average was: England and Wales, 15; Scotland, 39; Ireland, 51; British Isles, 34.

In London (Camden Square) the rainfall was the lowest for February in 64 years' record, excepting February 1891 (·01 in.) and 1895 (·12 in.). Only two other months, April 1912 (·04 in.) and May 1896 (·14 in.), had a smaller total. The mean temperature, 40·7°, exceeded the average by 0·8°, but was 5·3° below the record high mean of January. Duration of rainfall, 8·5 hours. Evaporation, ·28 in.

Weather Abroad: February, 1921.

ON February 20th over a foot of snow fell in New York during ten hours, this being the heaviest fall experienced for 20 years. The snow was piled into drifts by the heavy gale, and traffic was completely disorganised. There was also a heavy fall of snow at Jerusalem on the 25th.

Rain began to fall in Jamaica during the first week of February, after months of drought during which some of the banana and cane-growing districts suffered considerably.

Partial but useful rains fell in Queensland and New South Wales during the early and middle parts of the month, but in Western Australia the fall was too light to be of benefit. Near the end of the month heavy rainstorms were occurring in South and Central Australia, and also over a considerable portion of New South Wales.

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Long Period Variations in Terrestrial Phenomena.

By HAROLD JEFFREYS, M.A., D.Sc.

PROFESSOR H. H. TURNER has recently published two papers that cannot fail to be of value to any meteorologist interested in long period changes of climate. In the first* he submitted to harmonic analysis the 1,500-year record of the frequency of earthquakes in China and the 700-year record of the height of the Nile floods. Each analysis showed strong indications of a period of about 240 or 260 years.†

In a more recent paper‡ Professor Turner has obtained a great deal of additional and more accurate information by analysing the rates of growth of Californian Sequoias. The growth rings on the stumps of these giant trees, which have now all been felled, have been carefully measured by

* Monthly Notices of the Royal Astronomical Society, 79, 1919, p. 531.

† The length of the period could not be determined very accurately. Two periods which may both be present can be separated completely when the observations extend over an interval as long as the period of the beats between the putative variations. Thus, with observations extending over 1,500 years, it is possible to distinguish satisfactorily a period of 250 years from one of 300 years on the one hand, or 214 years on the other. Periods differing by smaller amounts, however, cannot be separated completely.

‡ Monthly Notices of the Royal Astronomical Society, 80, 1920, p. 801.

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Huntington, Douglass and others. The thickness of each ring gives the growth of the tree in the corresponding year. In this way a complete record of the growth of eleven trees in each year from B.C. 274 to A.D. 1914 has been obtained and published by A. E. Douglass.* There are four trees that go still further back, but less reliance is placed on the earlier data provided by these. In each tree there is a steady decrease in the rate of growth, which is allowed for in the computation. An analysis of the growths of 2,160 years for periods equal to submultiples of the whole interval gives strong indications of periods near to 270 and 196 years, each with variations of amplitude indicating the presence of another term of nearly equal period. When the 196-year variation was examined more closely, however, it was found that another term with a period of about 100 years was even more strongly marked. This had previously been noticed by Douglass, who had, however, devoted most of his attention to periods of less than a century. The 100-year variation, like the longer ones, shows a periodic variation in amplitude and phase, attributable to an interfering term. The length of the beats indicates that the period of this is 94·4 years, and the number of observations available is such that these two periods can be determined within about two years. Professor Turner then suggests that these are really the third harmonics of two longer periods. With this hypothesis, the range of uncertainty of the longer periods is much reduced, and it is found that they are well represented by two terms of periods 303 and 284 years. The 200-year part again appears to be a compound variation, being a mixture of two whose periods are 189 and 220 years. A second harmonic of the longest period term, with a period of 151·5 years, is also detected. Most of the terms show a decline with time in their coefficients, owing to a decreased response in the tree.

The results show that the secular and long period variations in the rate of growth are represented by a formula of the type—

$$\frac{dR}{dt} = A.\ \exp_{10}\left[at + \Sigma\,(b - ct)\cos\frac{2\pi}{T}(t - t_0)\right]$$

where A is independent of the time and depends only on the particular tree. If t be measured in centuries from A.D. 0, $a = 0{\cdot}0015$, and the values of the parameters for the other terms are as follows (evidently T is the period of the har-

* Climatic Cycles and Tree Growth (Carnegie Institute, 1919). (See *Meteorological Magazine*, March, 1921, p. 47.)

monic term, measured now in centuries, whilst t_0 gives the date of its last maximum):—

T	b	c	t_0
3·03	0·030	0·0020	19·07
2·84	0·044	0·0020	18·99
2·20	0·029	0 ?	17·69
1·89	0·039	0·0020	17·46
1·01	0·025	0·0020	19·17
0·944	0·015	0·0020	19·10

The value of c for the 220-year term is uncertain. The amplitude of this variation apparently remained nearly constant, or even slightly increasing, for three-quarters of the interval discussed, but then showed signs of a decline. This term may be in a class by itself, but its anomalous behaviour may be only accidental.

The 151·5-year term has a coefficient of the order of 0·01, but its value is difficult to determine with any accuracy. The probable value of a harmonic coefficient determined from a random set of values with the same standard deviation is not explicitly stated, but appears to be about 0·007.

The relation of tree-growth to climate is sufficiently obvious, and it is likely that these periodicities represent real variations in climate, especially as indistinguishable periodicities are found in the results obtained from the Nile floods and in the Chinese records of sunspots.

What is more difficult to understand, however, is how these phenomena come to be related to the Chinese earthquakes, which are also well represented by the two longest of Professor Turner's periods. It may be noticed that there was a maximum rate of growth of the Sequoias about 1604, and of the Flagstaff trees about 1610. The nearest earthquake maximum was about 1638, and the nearest Nile flood maximum (probably) about 1660.

Still more remarkable is the fact that the period of the longest unexplained fluctuation of the moon's mean motion is also about 250 years. This has been observed for less than one period, so that modern observations alone are incapable of disentangling it from the secular acceleration, much less from a harmonic variation of nearly the same period. Dr. Fotheringham's independent determination of the secular acceleration from ancient observations, however, has rendered it possible, and has shown that the period of the fluctuation is probably of about the same length. The abnormality in longitude was apparently a maximum about 1790, almost the time of the earthquake minimum.

A very tentative explanation would be that the earth was varying in size, and that a high frequency of earthquakes corresponded to the most rapid expansion. The maximum radius, and hence the minimum velocity of rotation, would then come a quarter of a period after the earthquake maximum, and the earth's angular displacement would therefore be behind its scheduled time by the maximum amount half a period after the earthquake maximum. But the effect of the earth being behind time is that all heavenly bodies appear to be before time, and so the moon's excess in longitude is greatest at this time—in other words, at the earthquake minimum. A plausible connection between the earthquakes and the climatic phenomena is still more difficult to suggest.

The Artificial Control of Weather.

ON March 9th Sir Napier Shaw delivered a lecture on the artificial control of weather before the Cambridge University Aeronautical Society. A resumé of the lecture is given below.

"The control of weather has been a subject of vivid interest from the dawn of history down to the present day. It is woven into the fabric of every form of civilisation. The claims of the rain-maker are in some cases modern ; but they are not exclusively modern, and are not to be regarded as one of the many signs of the progress of physical science in civilised nations. . . . Quite deep down in human nature is apparently the feeling that if man cannot himself control the weather, at least he knows who or what can ; and he can bring influence to bear upon the spirits of the air that will guide the control in the manner desired." Few subjects of speculation are more interesting than the system of control indicated by Greek mythology. Even in the eighteenth century, when as a result of the discovery of the laws of planetary motion the conception of "laws which never shall be broken" was growing on all sides, "the weather was regarded as still at the immediate pleasure of the Almighty Law-giver in Whom had become gathered all the several powers of the Greek immortals." The transition from the mythological position to the theistic position was very gradual, and is perhaps not complete in parts of Europe even to-day.

"In the course of my experience at the Meteorological Office I have had to be responsible for considered opinions on many offers of controlling the weather in some form or other. This was specially the case during the war." Many astonishing suggestions have been made from time to time, but the objects of all of them, good or bad, are curiously limited. "I have never seen any suggestions for beginning where nature begins and turning winter into spring or summer for a particular district by warming the open air or the open sea, or for drying the roads by operating on the humidity of the open air. The objects to which the operations are proposed to be directed are such as the avoidance of hail by the dissipation of thunder clouds. This appeals particularly to the regions which surround the Alps. The production of rain in regions where rain is specially wanted for the maintenance of crops is another object, and, thirdly, the dissipation of fog, and this last has now become transcendently important in flying. The methods proposed are either mechanical or electrical."

The production of noise has always been regarded as influential in controlling the weather, possibly on account of the constant association of rain with the noise of thunder. When firearms were invented their use replaced the ringing of church-bells formerly in vogue among the peasants. The belief in the efficacy of firearms expresses itself periodically in European vine-growing districts. "It was epidemic in a very severe form at the end of last century because somebody had devised a new gun or mortar; pointed upwards it discharged a vortex ring of smoke which could be seen to reach the clouds." The mortars were increased in size until they were 40 feet high, and much money was spent, but the result was indecisive, persons in more northerly latitudes thinking the influence disproved, and those in more southerly ones thinking it proved.

Subsequent French proposals for setting up *paragrêles* "in the form of tall structures carrying metallic points for the discharge of electricity to neutralise the electricity of the thunderclouds" were interrupted by the war.

A variation of the gunfire method is the use of a violent detonation such as is produced by dynamite explosions, heavy gunfire, and so on. "It draws its support largely from the fact that many battles have ended in, or been followed by, downpours of rain. Historically, battles are summer phenomena, and doubtless many summer days of less momentous importance have closed with downpours of rain. . . . There is no ground *a priori* for supposing that concussion would have any effect at all upon the condensation of vapour and clouds. And in any attempt to prove the influence by rainfall which occurred subsequently to the explosions we have no means of comparing actuality with what would have happened if the explosion had not occurred. . . . The effect of extensive gunfire may be regarded either as physical, arising from the detonations, or chemical . . . The direct effect of the detonation is probably nothing at all, and the chemical effect inconsiderable compared with the daily combustion of fuel in the Manchester district."

Mr. Cole, a Canadian airman, suggests rain production by means of liquid air sprayed from an aeroplane. While a certain amount of condensation is thus assured there is a risk that the rain might evaporate before reaching the ground.

Other rain-making suggestions are even less attractive. The method of throwing dust from an aeroplane on to clouds 5,000 feet high, tried at Pretoria, was unsuccessful, as might by expected, since if cloud is already present dust is superfluous. A similar proposal, using a balloon, was made some years before the war for the dissipation of London fog.

"An electrical installation in Australia for discharging electricity from kites was said to have produced enough rain to fill a large tank in a region that was suffering from lack of rain; but the observations of the time showed that the whole country for hundreds of miles around was uniformly fortunate."

"In the present generation not only are the laws of motion of the heavenly bodies regarded as never to be broken, in spite of the fact that Einstein and others may alter the form; but there are many new laws of physics and chemistry which have an equal claim to be regarded as inexorable in the study of weather; and, moreover, the powers of the laboratory and the workshop have become so much enlarged that the new spirit of humanity is not disposed to take the vagaries of the spirits of the air lying down. If we really understand them we ought to be able to direct the operation of the forces of nature; and we find a disposition to ask whether we cannot ourselves take over the forces of the air, and if not, why not?" Many opinions of the futility of human effort have been proved to be wrong; all awkward corners may be turned by new inventions. These matters are largely questions of scale; for practical purposes impossibility is reached when the money and material required exceed the limit of what is available. "We can do anything with a quantity of air in a small enclosure in a laboratory. We can, certainly, by artificial means, make cloud or rain in the enclosure and disperse it or evaporate it at will after it has been formed. We could easily find out whether the detonation of a pistol or a small charge of dynamite at a suitable distance would produce any effect upon an artificial cloud, though I have never heard of the experiment being tried. The important question is whether we can extend such operations from the laboratory to the open air. We are here up against the important consideration that a cube of air 10 metres each way weighs more than a ton. If it is foggy it may contain 5 kilogrammes of water drops, and a millimetre of rain over the same area weighs 100 kilogrammes. The amount of heat released by the condensation of a kilogramme of water is about 600 kilogramme-centigrade units, which are equivalent to $2 \cdot 5 \times 10^{13}$ ergs, or approximately one horse-power-hour ($2 \cdot 7 \times 10^{13}$ ergs). Hence evaporating a 10-metre cube of air containing fog is equivalent to 5 horse-power-hours, and a millimetre of rain over the 10 metre square, 100 horse-power-hours; over a square kilometre, a million horse-power-hours."

Another idea, the basic theory of which is probably at fault, apart from questions of scale, is the prevention of development of fog at sea by pouring oil on the water and so stopping evaporation in the environment of the ship.

The modern problem of clearing fog from aerodromes has been the subject of several suggestions. The chief of these are local heating by means of coal fires, mechanical driving away of foggy air by propellers capable of giving a speed of 100 kilometres per hour to the propelled stream, and electrical methods. Again it is a question of scale. Both within a laboratory and on the larger scale of furnace flues a brush discharge of electricity will clear away dust, smoke and cloud like magic. Sir Oliver Lodge's experiments in clearing Liverpool from fog were not decisive, and in any case it is not very desirable to have an installation for brush discharge, which comes pretty near to sparking, in the neighbourhood of an aerodrome.

"What it comes to, then, is that all the suggestions for the human control of weather oppress one not by any mistaken conception of physical processes, but by the 'scale effect.' Within our knowledge we are lords of every single specimen of the atmosphere which we can bottle up and imprison in our laboratories, our furnace flues and our greenhouses; but in the open air the ordinary inexorable laws which control the behaviour of the atmosphere when we are awake and when we are asleep, have such enormous masses of energy in the form of warmth and water vapour in reserve that our own little reserves are not equal to making any serious impression on the course of nature." The course of the weather may, however, be affected by the explosion of a great volcano, and it would be interesting to consider "how far our reserves of available energy compare with the destruction of Pompeii, the disappearance of the island of Krakatoa, or the eruptions of Mt. Pelée and La Souffrière."

Meteorological Office Standard Wind Vane.

THE Meteorological Office Standard Wind Vane (Fig. 1) is the outcome of experiments undertaken by the Royal Aircraft Establishment in 1917 in order to design and construct a vane suitable for use with the Dines Pressure-Tube Anemometer on Pyestock Tower.

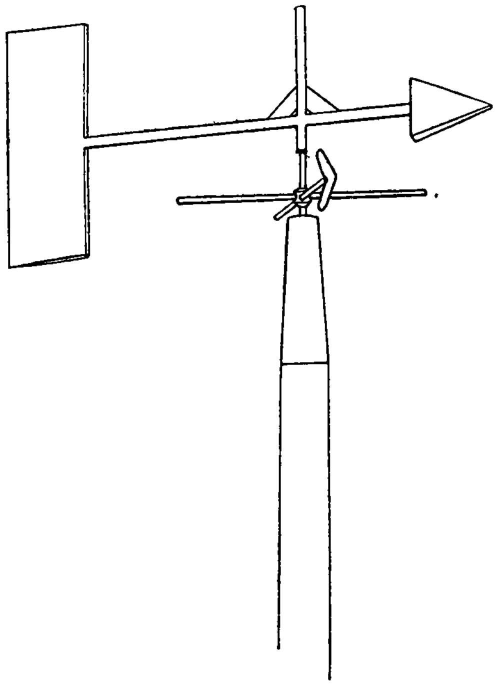


FIG. 1.

It was found that the original pattern of vane, similar to that illustrated in the Observer's Handbook with the Direction Recorder, would not respond to changes of direction of light winds. This may be understood when one considers that the usual exposure involves a length of about 40 feet of direction-transmitting tubing connecting the head to the recorder, whereas 150 feet were required at Pyestock, the vane being exposed at a height of 152 feet above the ground and the recorder situated at the base of the tower. This tubing is, of course, rigidly connected to the moving head and its weight is borne by the bearing of the head on its spindle. This abnormal weight of tubing naturally brought into play a much larger frictional force at the bearing, which the turning moment of the vane, with small angles of incidence to a light wind, was unable to overcome. The result was loss of sensitivity of the vane to changes of direction of light winds. Consequently, a new head was designed, the vane having the same area as the original, but about eight times the turning moment. This was accomplished by setting the tail so that its centre of pressure was at a maximum distance from the axis of rotation. Also, the tail was given a "streamline" cross-section as in an aeroplane tail (*see* Fig. 2), as this gives

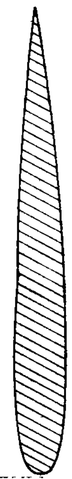


FIG. 2.—CROSS-SECTION OF TAIL.

a greater couple than a flat plate of similar dimensions. This property of aerofoils is most marked when the angles of incidence of winds are small.

Two heads were compared in a wind channel; either vane was set at an angle to the wind and the corresponding turning moment was determined. It was estimated that with a wind of 100 feet per second (68 m.p.h.) the turning moment of the fish-tail vane when set at 10° from the wind would be 2 foot-pounds, but the moment for the new vane in like circumstances would be 13 foot-pounds. These results are in accordance with the expectation of the designers.

From the results mentioned above it was clear that the new vane was more efficient than the original "fish-tail" pattern, and all new heads were ordered to the specification of that designed for Pyestock, excepting that the vanes were to be made of copper instead of aluminium. Experience with an aluminium head at Spurn had shown that, even when stove-enamelled initially, aluminium weathers badly. Although this alteration necessarily increased the moment of inertia of a head and possibly slightly decreased its efficiency, the effect must have been negligible judging by a recent report on the establishment of the anemometer at Gorleston. Whereas it is possible to orientate a "fish-tail" head in relation to the recording apparatus by holding it still whilst at the top of the mast, at Gorleston this was found impossible with the new pattern head even in a gentle air, and other means of orientation had to be devised. A comparative test of the two heads in action was carried out by Captain Cave in 1918 on Salisbury Plain, where two anemobiagraphs were available. It was found that the trace given by the new head was the more sensitive with winds under 5 miles per hour, although with winds over 10 miles per hour there was no appreciable difference in the two records. It has also been noticed that the new head will adjust itself to the direction of a light wind after a calm, whilst a flag remains undisturbed. The direction of very light winds is often of importance, as in the case of the initial stages of land and sea breezes which respond to local pressure gradients not shown on the ordinary synoptic chart, and therefore the advent of this efficient vane is of considerable value.

The vane shown in Fig. 1, with the forearms indicating the cardinal points, is a vane pure and simple, and is not intended for recording. In design it is similar to the direction-recording vane, but of two-thirds the size, as, of course, it has no work to do. The head is very nicely balanced about the top of the cylindrical portion and turns on a hard steel point on the top of the central spindle.

The Royal Meteorological Society.

IN accordance with custom, the March meeting of the Royal Meteorological Society was devoted to a formal lecture. The meeting was held on March 16th in the rooms of the Royal Astronomical Society, with the President (Mr. R. H. Hooker) in the chair, and the lecture, which was delivered by Dr. G. C. Simpson, Director of the Meteorological Office, was on "The South west Monsoon."

It has been held that the south-west monsoon owes its origin to the great difference of temperature which exists during the summer months between the heated land surface of India and the surrounding oceans, the general idea being that the warm air over the land rises, and damp air from the sea flows into India to take its place, thus giving rise to the strong south-west winds, the rainfall itself being due to the cooling of the air as it rises over India. This theory has to face the difficulties that the temperature over India is much higher in May before the monsoon sets in than it is during the monsoon itself; that the temperature is higher in years of bad monsoon than in years of good monsoon; and also that the part of India which has the highest temperature and the lowest pressure and where ascending currents should be the greatest, is a region of practically no rainfall throughout the monsoon.

The true explanation of the south-west monsoon can only be obtained by taking a wide view of the weather conditions over large parts of the Earth's surface during the sum mer of the northern hemisphere. It is then seen that the south-west winds are not due to the temperature in India, but are a relatively small part of a general circulation of the atmosphere caused by a region of high pressure over the South Indian

Ocean and a region of low pressure which extends over the whole of Central Asia. From the region of high pressure air passes northwards in the south-east trades as far as the equator, where it gets caught in the circulation around the low pressure over Asia. On account of the particular arrangement of sea and land, and of the deflection of wind-currents due to the Earth's rotation, this air travels for 4,000 miles over the sea before it reaches India, where it arrives very warm and exceedingly humid. The air would probably sweep right across India to its goal in Central Asia without producing much rainfall if it were not for the unique distribution of mountains around India. From the north of the Mekran coast, following the line of Afghanistan, the Himalayas and the mountains of Burma, there extends an unbroken wall of mountains, nowhere lower than 5,000 feet, directly athwart the air currents already discussed. These mountains catch the air, which is being driven by a pressure distribution extending from the southern Indian Ocean to the centre of Asia, in a kind of trap, out of which there is no escape except by ascension. The humid air, which begins to form rain as soon as it rises even 500 feet, is actually forced to rise between 10,000 and 20,000 feet. In consequence, large amounts of water are precipitated over the greater part of the Indian area.

Discussions at the Meteorological Office.

ON March 7th, Mr. Whipple opened a discussion on Meteorological Optics with special reference to the articles by Professor Humphreys in the *Journal of the Franklin Institute*.* These articles have been incorporated in Humphreys' book on the Physics of the Air† which has been published recently. The absence of such a connected account of the subject of meteorological optics in the English language has been a reproach to physicists on both sides of the Atlantic, and Professor Humphreys has done well to fill the gap. Mr. Whipple mentioned, however, a few sections which he considered open to criticism, notably the theories of some of the rarer halo phenomena and of the "glory."

In the discussion, several interesting personal experiences were mentioned. Captain Douglas stated that it was usual when flying through cloud to see a corona before emergence and a "glory" on looking back at the cloud after emergence. Dr. Ghosh, of Calcutta, had seen rainbows formed by the drops of water condensed from fog on the surface of a pond; and Dr. Simpson mentioned some of the more striking forms

* Journal of the Franklin Institute, Vol. 188, pp. 433–488 and 607–674.

† Physics of the Air, by W. J. Humphreys. Philadelphia: Lippincott, 1920. Part III.

of mirage seen in the Antarctic, and also discussed the theory of condensation nuclei.

The discussion on March 21st was opened by Lieut.-Colonel Gold, who gave an account of R. Emden's paper on "Radiative Equilibrium and Atmospheric Radiation."

In the paper the atmosphere is regarded as a series of horizontal layers bounded by planes, and each layer contains the same mass. The total radiation passing through unit area from one of the layers is 2π times the radiation emitted normally (for a black body the total radiation from unit area is only π times the normal radiation). The absorption of radiation by any layer depends not only on the total quantity of the incident radiation, but also on the proportion of the total which comes from different directions; and the total absorption is not usually 2π times the absorption of the radiation incident normally.

The radiation for the atmosphere is different for different spectral regions, and although these are known with some precision in their general features, the finer details are not known. Accordingly, alternative approximations are made as follows :—

(*a*) Radiation is regarded as gray, *i.e.*, having a constant ratio for any wave length to the radiation of that wave length from a black body having the same temperature. With this assumption, Emden deduces that radiation equilibrium will be stable, and if conditions are steady, will give an isothermal atmosphere.

(*b*) Radiation is divided into two parts :—

(1) Solar, of which 10 per cent. is absorbed by the earth's atmosphere in vertical transmission.

(2) Earth or atmospheric radiation, of which 90 per cent. is absorbed in vertical transmission.

With this assumption, radiation equilibrium would lead to a temperature distribution in which the lapse rate in the lower 3 kilometres is much greater than the adiabatic lapse rate. The lower layers would therefore be unstable.

If the assumptions of (*b*) are applicable to the actual atmosphere, there ought to be a steady fall of temperature at 2 to 3 kilometres, due to radiation, and a steady rise of temperature at the earth's surface. This latter would be accentuated by the transfer of heat from the earth's surface to the atmosphere, which Emden neglects.

In the absence of solar radiation, Emden finds rates of cooling by radiation comparable with those found by Colonel Gold in 1909, namely, about 1° C. in the course of the night.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

Simultaneous Lunar Halo and Corona.

I OBSERVED a brilliant phenomenon of this nature at 9.40 p.m., March 20th, 1921. There was a complete coloured lunar halo, an annulus and a coloured triple corona. The annulus was about 1° in diameter, and the three red rings of the corona about 3°, 5° and 8°. The 5° ring was brilliant. The cloud sheet was so smooth that its movement could not be discerned. Occasionally, however, flecks of alto-stratus passed, moving from the WNW. The surface wind was strong SW., and the air temperature 72° F. It seems probable that the halo and the annulus were formed by the cirro-stratus, the lower portion of which was falling into air above freezing in temperature, and that the triple corona was produced by a thin alto-stratus, which may have been within the lower portion of the cirro-stratus. On the previous evening, under similar weather conditions, there was a lunar halo, an annulus, and a bright corona (red 4° diameter, approximately), associated with cirro-stratus, and a much larger corona when passing thin alto-cumulus clouds, but all were not visible, complete, at once.

CHARLES F. BROOKS.

Weather Bureau, Washington, D.C., March 25th, 1921.

Lunar Halo and Mock Moons.

ON the evening of March 23rd the occurrence of two mock moons was witnessed here independently by two observers besides myself.

At 19 h. 25 m. G.M.T. the half of the lunar halo higher in the sky than the moon was visible, but the colours in the halo were only faintly seen on the side to the north of the moon.

Mock moons were distinctly visible on the ring forming the halo, and at the same distance above the horizon as the moon itself. During the succeeding ten minutes they became steadily brighter, but as the circumference of the circle of light was not clearly marked the diameter of the mock moons can only be given as approximately three times that of the moon.

In addition to the mock moons there was a band of light stretching for about 8° from the southerly mock moon, parallel to the horizon, the width of it being slightly less than that of the halo.

During the occurrence of the phenomenon the sky was covered to about $\frac{8}{10}$ with cirrus clouds, and the phenomenon disappeared by 20 h. G.M.T., when these clouds moved away.

R. S. READ.

Meteorological Office, Lympne Aerodrome, March 29th, 1921.

Irregular Solar Halo and Mock Suns.

ON Tuesday, April 5th, 1921, an irregular solar halo with two mock suns was observed from Kew Observatory. The phenomenon was first noticed at about 9 h. 40 m. G.M.T., and continued up to about 10 h. 30 m. G.M.T., when it was covered by cumulus clouds.

The sun was covered at first by a sheet of cirro-stratus cloud, while towards the north and west were long bands of cirrus clouds running approximately from north to south. Small fracto-cumulus clouds then began to appear, and later increased in size and number until they obscured the phenomenon.

The radius of the halo was about 33° measured from the sun to the outer edge. On the east of the sun, a length of about 20° of the mock sun ring was seen, while on the west the length of this ring was 10°. The eastern mock sun was the more brilliant and had a reddish tint.

R. E. WATSON.

Kew Observatory, Richmond, April 6th, 1921.

Meteorological Observations during the Eclipse of April 8th.

THE observations taken at Greenwich were on the plan adopted on April 17th, 1912, when a midday eclipse of rather greater magnitude took place. The dry and wet bulb thermometers were read at 5 minute intervals and the solar radiation thermometer at $2\frac{1}{2}$ minute intervals.

At first contact, 7 h. 35 m. G.M.T., the shade temperature was 43·2°, which increased to 45·6° by 8 h. 20 m., decreased to 44·2° by 8 h. 50 m., and increased to 49·8° by 10 h. 5 m., the time of last contact. The relative humidity decreased from 81 per cent. at 7 h. 35 m. to 72 per cent. at 8 h. 25 m., increased to 74 per cent. by 9 h. 0 m., and decreased to 58 per cent. by 10 h. 5 m.

The solar radiation reading was 67·0° at 7 h. 35 m., increased to 70·5° by 7 h. 50 m., when a few small clouds began to pass, making the readings irregular till 8 h. 20 m., when the sky became cloudless again. At 8 h. 52 m. 30 s. the lowest reading, 47·5°, was obtained, five minutes after the greatest phase of the eclipse, the subsequent readings showing a regular increase to 101·5° just after the last contact. Apparently, therefore, the drop due to the eclipse was about 38° F.

It is interesting to record that the register of atmospheric electricity, which had risen by the time of commencement of the eclipse to 300 volts per metre (approximately), fell steadily to 125 volts by 9 h., after which it rose again, becoming apparently normal before the end of the eclipse.

WALTER W. BRYANT.

Royal Observatory, Greenwich, London, S.E.10, April 9th, 1921.

The following readings taken here to-day may be of interest:—

H.	M.	Dry Bulb. °F.	Wet Bulb. °F.	Grass in full Sun. °F.
8	10	44·7	40·0	49·8
8	24	44·9	40·1	47·6
8	35	44·3	39·7	36·6
Darkest period—				
8	59	42·3	38·8	36·6
9	35	44·4	40·6	—
10	6	47·3	41·7	—

It was never nearly dark enough to show even the brightest stars.

H. NOWELL FFARINGTON.

Worden, Leyland, Lancs, April 8th, 1921.

ABOUT the temperature changes during the solar eclipe there is little to be said, except that there was little lag after the maximum phase, when the temperature rose rapidly.

The indirect changes were of greater interest, particularly those connected with turbulence. The anemogram shows a decrease in gustiness, and before the maximum phase the gusts seemed less frequent, but afterwards were more frequent than before the eclipse. The wind showed a marked tendency to back. These changes all accompany a decrease in the coefficient of upward diffusion of turbulence due to a fall of temperature, and are regular diurnal variables.

The most striking event was the formation of cloud. It formed in precisely the same way as anticyclonic stratus forms during the night, but it never grew very thick, remaining transparent. It probably lay in the damp layer at the top of the turbulent region.

Mr. W. H. Dines has suggested loss of heat by radiation as a possible cause of similar cloud formation, but Sir Napier Shaw has pointed out that dynamical warming will probably result through air cooled in this manner being forced to descend, and this should result in an ultimate increase of temperature. That cloud can be formed by direct cooling was clearly demonstrated. After all, if air beneath the damp layer is also losing heat, the descent of the damp layer need not be great. In this case perhaps the cloud formed before the dynamical warming had time to operate and disappeared as soon as it did, since the cloud formed slightly before, and disappeared practically at, the maximum phase instead of remaining after owing to lag of temperature.

R. FRANCIS GRANGER.

Lenton Fields, Nottingham, April 12th, 1921.

Units for Meteorological Work.

As a subscriber to your Magazine for over 30 years allow me to protest against the use of millibars and millimetres instead of the good old English inches and tenths.

The former entail constant calculations, and I fail to see the utility of them.

Speaking to a F.R.Met.Soc. a short time ago about them, he simply replied "I hate them." ROBERT CROSS.

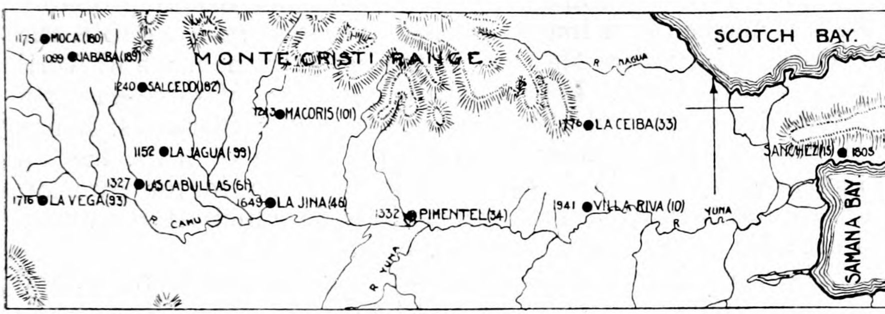
Worstead, Norwich, March 28th, 1921.

[The case for the newer units has been set out many times, and not many people would deny that they have advantages, though these advantages are perhaps more apparent to the physicist who has to handle meteorological data than to the observer. The question appears to be whether the advantages outweigh the serious objections that, being familiar with the old units, we find it difficult to think in terms of new ones, and that so many observers of long standing are equipped with instruments graduated by the old system. A new generation of meteorologists has, however, grown up in the last ten years, and to these the millibar and millimetre are more familiar than the inch. When one knows that 1,014 millibars is the average pressure for London at sea-level, one does not trouble oneself about the number of inches of mercury it represents, though there is undoubtedly a strong temptation to convert the current reading from one scale to another instead of familiarizing oneself with new terms. The editors of a magazine like this, which circulates among readers of all shades of opinion, require advice in deciding how far they should give statistics in duplicate in two units, and how far they should expect their readers to accustom themselves to reading figures in the newer units. It must be admitted that doubling the entries is a clumsy device at the best, but all the same it may be desirable to adopt it for a while, and we shall hope to get the views o readers on the point.—ED. M.M.]

NOTES AND QUERIES.

The Rainfall of San Domingo.

METEOROLOGICAL data from the Dominican Republic, which occupies the eastern half of the island of San Domingo, are extremely rare, and records which have been received at the Meteorological Office from Mr. W. A. Elders, the General Manager of the Samana and Santiago Railway, and which refer to 12 rain gauges installed by him during and since 1913, are especially welcome. The railway occupies the trough-like valley of the Yuna river and its tributaries, and extends westwards from Samana Bay, in the north-east of the island. The distribution of the stations is shown on the accompanying map, the distance between La Vega and



Rainfall in San Domingo in mm. (heights in metres).

Sanchez being very nearly 60 miles. The figures in brackets to the right of the name show the height in metres, and the figures without brackets indicate the mean annual fall in millimetres for the seven years 1913, 1914, and 1916 to 1920. The incomplete series have been extended to the full period by comparison with La Vega and Sanchez.

In the West Indies the prevailing trade wind blows from east-north-east, and this wind readily penetrates into the Yuna Valley through Samana Bay and Scotch Bay, giving annual falls exceeding 1,600 mm. at most stations near the main stream and its continuation the Camu river. The north-western district, however, between Las Cabullas, Macoris and Moca, lies to the south-west of the Monte Cristi Range, which here rises sharply to an elevation of over a thousand metres. This range probably has a heavy precipitation on its northern side, but by the time the trade wind has passed its crest it has lost much of its moisture; hence the rainfall in its "shadow" is appreciably less than in the more open valley, averaging only 1,200 mm. At Port au Prince, on the west coast, which is similarly sheltered, the annual mean from 1888 to 1912 is 1,379 mm. The small total at Pimentel, 1,332 mm, is probably due to the local conditions of exposure.

The series of seven years is only sufficient to show the general trend of the annual variation, but the following table for Sanchez and La Vega is of interest. Data for Port au Prince have been added for comparison:—

——	Jan.	Feb.	Mar.	Apr.	May	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Sanchez	97	82	103	129	163	199	212	224	149	132	211	104
La Vega	117	92	86	143	193	174	183	103	123	174	256	72
Port au Prince	31	57	95	165	244	88	62	135	201	182	78	41

Apart from November, whose prominence would probably be less marked if a longer series of years were available, the rainiest months are May to September at Sanchez and April to July at La Vega. In summer the frequency of north-easterly winds decreases and that of easterly winds increases, hence Sanchez, on the southern slopes of a range of hills, has an increased rainfall in these months. La Vega, in the interior, shows indications of two wet periods, in which it resembles Port au Prince, in the west of the island.

The variation from year to year is fairly considerable, and is quite different at Sanchez and La Vega. The range in the interior is much greater than on the coast, though the average is not greatly different.

——	1913.	1914.	1916.	1917.	1918.	1919.	1920.	Average.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Sanchez	2,070	2,007	1,628	1,866	1 422	1,777	1,864	1,805
La Vega	1,581	1,399	2,242	2,561	1,793	1,390	1,048	1,716

The railway passes through a rich agricultural district, and the study of the rainfall is therefore likely to be of considerable economic importance. C. E. P. Brooks.

Extension of the Meteorological Equipment at Rothamsted.

The Rothamsted Experimental Station recently set up a Statistical Department under the charge of Mr. R. A. Fisher, M.A., Fellow of Caius College, Cambridge, assisted by Miss W. A. Mackenzie, B.Sc., late of the London School of Economics, and a thorough statistical examination of the

Rothamsted data has been begun. The field records date back to 1843 and are unusually complete from 1852 onwards; the ordinary meteorological records also go back for many years.

The data are unusually homogeneous, and satisfactory from the statistical point of view. Nowhere in the world is there such a mass of material capable of throwing light on the relationships between weather and crops.

From a preliminary survey of the data it has become evident that refinements in the measurements will be needed both in dealing with the soil and with the weather. It is essential that statistical deductions should be tested by direct experiments, and for these the ordinary observational methods are not sufficient.

The Soil Physics Laboratory is equipped for carrying the necessary refinements into the measurements of soil-factors, but the Meteorological section is not. After consultation with the Meteorological Office and the instrument makers, it is proposed to set up a Negretti and Zambra Natural Syphon Rain Gauge to give a continuous record of rainfall, a Transmitting Thermometer, large size, for continuous records of soil temperatures, an Anemobiograph, and a Cup Integrator (with N.P.L. certificate) for continuous wind records.

Unfortunately the Treasury Minute with regard to new expenditure prevents the station from approaching the Ministry of Agriculture for the necessary funds, and the Committee is, therefore, left to raise the money itself. The total sum required is 160*l.*

Colonel Mellish, of Hodsock Priory, has opened the list with a donation of 10*l.*, and it is hoped to complete the list at an early date so that the improved measurements may begin at once. The secretary of the Rothamsted Experimental Station, Harpenden, will be happy to give information to any who would feel disposed to help the scheme.

Terminal Hours for Maximum and Minimum Temperature.

It has been generally regarded as the correct practice to take extreme temperatures for periods of 24 hours, maximum and minimum thermometers being set at a certain hour on one day and read at the same hour the next day. At the telegraphic stations the thermometers have been set at 7 h., an hour which nearly coincides with the minimum of the diurnal variation of temperature, and as a result there is frequently uncertainty as to whether a minimum temperature actually occurred near the time at which the thermometer was set or near the time at which it was read. The same difficulty occurs, though not with equal frequency, in the observations at auxiliary climatological stations where the readings are at 9 h. and at the normal climatological stations where (in accordance with international convention) they are at 21 h. Indeed, no arrangement of the sort can give satisfactorily the highest and lowest points of the curve of temperature variation in all circumstances.

For some years past the rule with regard to grass minimum thermometers has been to set in the late afternoon or evening and to read in the morning, thereby avoiding the anomaly of counting two ground frosts for one cold morning. A similar rule is now being adopted for the extreme thermometers in the screen, at any rate, at the stations of two important classes.

From March 1st, 1921, the extreme temperatures used for the telegraphic stations have been the maximum for the day, *i.e.*, from 7 h. to 18 h., and the minimum for the night, *i.e.*, from 18 h. to 7 h. The thermometers in question are set twice a day, so that the night-maxima and day-minima will be available for reference, but they will not be utilised in the ordinary statistical summaries.

At the health resorts contributing daily reports for circulating to the newspapers a like change was made on April 3rd, the first day of Summer Time. The day-maxima and night-minima for these stations refer to the periods 9 h. to 17 h. and 17 h. to 9 h., respectively. Maxima for 9 h. to 9 h. and minima for 17 h. to 17 h. are to be placed on record, but statistics will be based on the day-maxima and night-minima.

The previous practice at the health resorts involved the use of different extreme temperatures for the telegraphic reports and for the statistical summaries, a course which has frequently led to confusion.

The drawback to improvements in the routine of meteorological observations is the break of continuity in the record. The effect of the changes which have been mentioned must be to lower the average of the maximum temperatures and to raise the average of the minima. The displacements of the averages are very small in summer, but in winter they may reach half a degree Fahrenheit. It is hoped that precise statistics by which normal values may be corrected will soon be available for publication.

Official Publications.

Report of Proceedings of the Third Meeting of the Commission for Weather Telegraphy, London, 1920.

An account of the proceedings of this commission was published in the December number of the *Meteorological Magazine*. The report, which is now issued, contains, in addition to the minutes of the meetings and full accounts of the various specifications adopted, a useful summary of the revised codes. The memoranda which formed the basis of the discussions at the meeting are set out in a series of appendices.

News in Brief.

News is received from the Naval Attaché, Buenos Aires, that the Argentine sloop "Uruguay," under the command of Lieutenant Domingo Casamajor, sailed on February 16th, 1921, with the reliefs for the staff of the Argentine Meteorological Observatory on Laurie Island, South Orkneys. She may call at South Georgia on the return voyage.

On April 7th and 14th, at 3 p.m., Mr. C. T. R. Wilson, F.R.S., delivered two lectures on "Thunderstorms" (the Tyndall Lectures) before the Royal Institution.

The Weather of March.

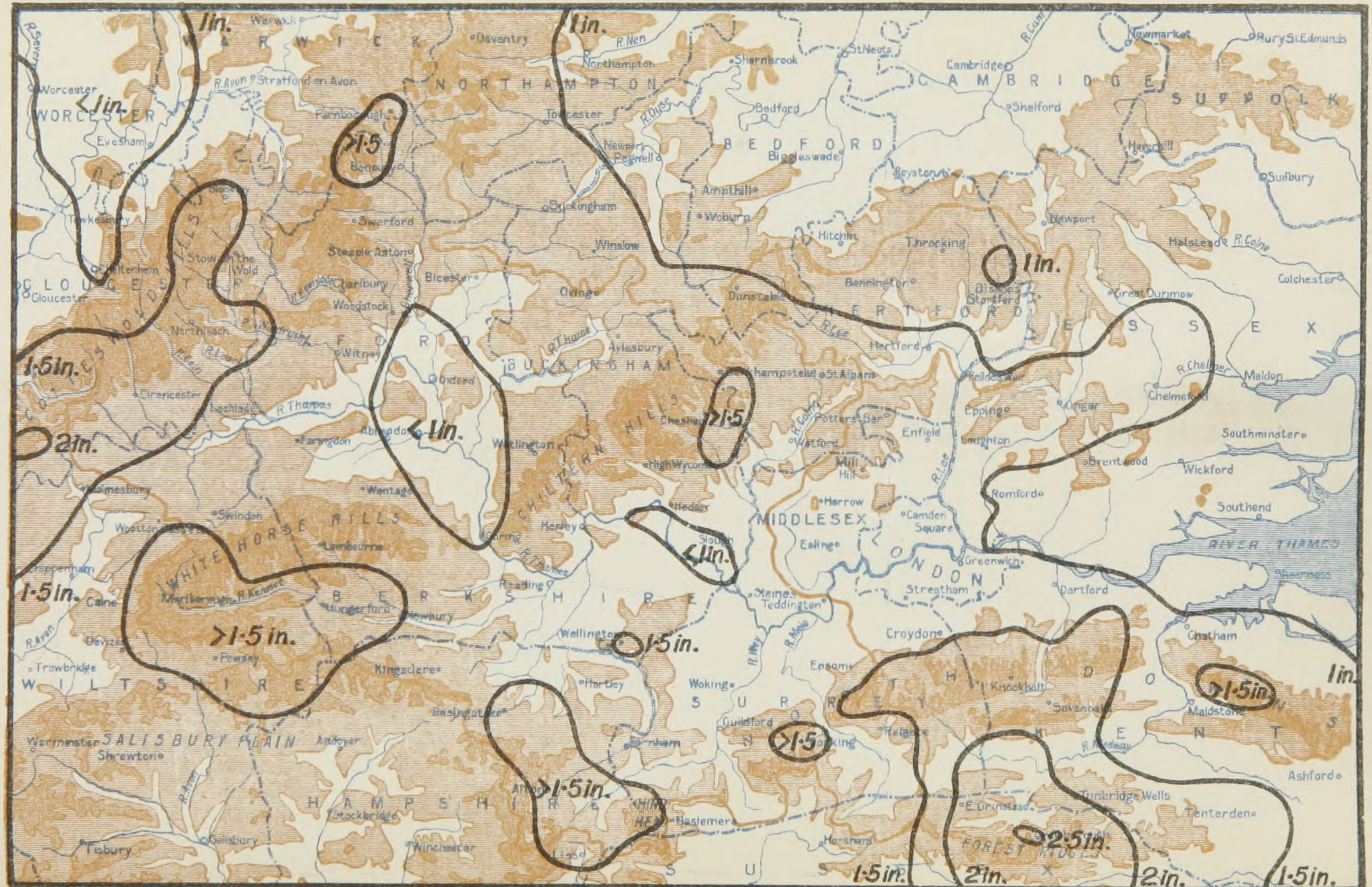
The conditions over north-west Europe during March were of a westerly to south-westerly type, with frequent depressions in the neighbourhood of the Arctic circle, and relatively high pressure between the Azores and Central Europe. In the west and north of the British Isles the weather was stormy and unsettled, with a good deal of rain. In the south and east, and the adjacent regions on the Continent, the weather was mostly fair and dry. As in the two preceding months, there was a marked absence of severe wintry weather over western Europe generally, and even in Sweden there was little frost after the 9th. Brief incursions of polar air were accompanied by snow in the northern districts of the British Isles at times in the first week, and in the western districts on the night of the 28th, but milder weather followed at once in every case.

Except locally in the early hours of the 25th, fog was almost entirely absent during the month. Low clouds were prevalent in the western but not in the eastern districts. In south-east England there was one day with persistent very low cloud.

The month opened with deep depressions moving eastward near the Arctic circle, bringing heavy rain to west Scotland, 22 mm. being measured at Eskdalemuir on the 3rd. Temperature was variable, and there was snow in parts of Scotland on the 2nd, and a heavier fall on the 5th, on the north side of a small depression which formed off north-west Ireland and moved eastward. Near sea-level in the south of Scotland there was rain or sleet on this occasion, amounting to 20 mm. at Renfrew and 19 mm. at Leith. An associated "V"-shaped secondary crossed England on the following day and caused rain or sleet generally. In south-east England a fine warm day was followed by a very cold wet evening, the wind veering suddenly from west to north. The cold snap was very brief, as pressure fell rapidly in Ireland and a warm westerly type was again established by the 8th, which proved the beginning of a long spell of mild weather, with a series of deep depressions moving north-east across Ireland, and an anticyclone over Central Europe. In the south-east half of England the weather was fair, but the western and northern districts were affected by a series of small secondaries which moved quickly north-eastward, causing gales and heavy rain in places, and occasional local thunder and hail. Among the more notable rainfall measurements during this period were 21 mm. at Blacksod Point on the 10th (partly in the form of sleet), 25 mm. at Valencia Observatory on the 12th, 27 mm. at Eskdalemuir on the 13th, and another 27 mm. at the same station on the 15th. The pressure distribution became more westerly by the 18th, and small secondaries moving eastward caused moderate falls of rain in all districts, including south-east England. On the afternoon of the 20th there were thunderstorms at Felixstowe and Yarmouth, in a cold north-west current. Next day fair mild weather set in again except in the western districts, Aberdeen having a maximum of 60° F. By the 23rd there was again a very deep depression over Ireland, and an anticyclone over Central Europe, with rain in the west and north-west, but fair weather in the south-east. The anticyclone moved westward, and the weather was brilliantly fine in southern England on the 24th and 25th. At South Farnborough temperature reached 65° F. on the 24th and 64° F. on the 25th, but fell to 25° F. in the screen on the night of the 24th.

The anticyclone continued to move westward, and the weather became cloudy and showery and colder generally on the 26th. On the 28th a deep depression from the Atlantic reached the north of Scotland and caused a gale in many

THAMES VALLEY RAINFALL — MARCH, 1921.



Meteorological Magazine.

Isohyets.

ALTITUDE SCALE

Below 250 feet	250 to 500 feet	500 to 1000 feet	Above 1000 feet

SCALE OF MILES 0 5 10 15 20

H.M. Stationery Office Press, Kingsway, W.C.2.

P.S. 3330/341. Wt.28. P.15. 1250. 4/21.

places in England and Ireland, and rain generally, as much as 33 mm. at Eskdalemuir. In the evening the depression suddenly became stationary and began to fill up, but a "V"-shaped secondary caused snow in Ireland, Wales and parts of the west of England during the night, and showers of hail and rain and local thunder in other parts of England during the 29th. There was local frost on the night of the 29th, the minimum at Howden being 24° F. Mild weather soon set in again as the depression and its secondary filled up rapidly and pressure fell decidedly in Ireland. On the last day of the month an anticyclone approaching from south-west caused fair mild weather to set in over England and east Scotland, temperature reaching 63° F. at Ross-on-Wye and 62° F. at Aberdeen. C. K. M. D.

Rainfall in the British Isles, March 1921.

THE rainfall was again markedly below the average in England except in the extreme west, being less than half the average in the east Midlands. An excess of more than 50 per cent. occurred over the whole of the western half of Scotland and locally in Ireland, and more than twice the average fell in the West Highlands. In the latter district the area with more than 250 mm. (10 inches) was exceptionally large for the season, extending from Bute to Cape Wrath. More than 500 mm. (20 inches) fell in the west of Inverness-shire and in the centre of the English Lake District. As much as 250 mm. (10 inches) fell only locally in the Welsh uplands. In the dry district of the east less than 25 mm. (1 inch) fell practically everywhere between the Thames estuary and Northumberland, the 25 mm. line through the Midlands being as far to the west as Leicester. Only relatively small areas in the east of Scotland and Ireland had less than 75 mm. (3 inches).

The general rainfall expressed as a percentage of the average was:—England and Wales, 101; Scotland, 170; Ireland, 129; British Isles, 133.

In London (Camden Square) the mean temperature was 46·8° F., or 4·6° F. above the average. The duration of rainfall was 28·1 hours, and the evaporation ·96 in.

Weather Abroad: March, 1921.

NUMEROUS depressions affected the Scandinavian area, causing frequent gales and rain, but no very large individual rainfall records were made at any of the stations from which reports are received. There were occasional reports of snow, but on the whole the month was unusually mild. Further south the weather was mainly fair, but the secondaries which

(*Continued on* p. 84.)

Rainfall Table for March 1921.

STATION.	COUNTY.	Aver. 1881—1915. in.	1921. in.	1921. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days
Camden Square	*London*	1·83	1·19	30	65	·30	6	13
Tenterden (View Tower)	*Kent*	2·14	1·57	40	73	·44	29	17
Arundel (Patching Farm)	*Sussex*	2·15	1·27	32	59	·42	17	9
Fordingbridge (Oaklands)	*Hampshire*	2·33	1·53	39	66	·27	28	21
Oxford (Magdalen College)	*Oxfordshire*	1·53	·85	22	56	·13	28	15
Wellingborough (Swanspool)	*Northampton*	1·79	·77	20	43	·16	19	16
Hawkedon Rectory	*Suffolk*	1·90	·87	22	46	·20	19	13
Norwich (Eaton)	*Norfolk*	1·91	1·19	30	62	·22	19	13
Launceston (Polapit Tamar)	*Devon*	2·98	3·40	86	114	·58	13	23
Sidmouth (Sidmount)	"	2·54	1·65	42	65	·26	14	19
Ross (Chasedale Observatory)	*Herefordshire*	2·03	1·33	34	66	·27	13	18
Church Stretton (Wolstaston)	*Shropshire*	2·36	2·62	66	111	·52	14	22
Boston (Black Sluice)	*Lincoln*	1·56	·82	21	53	·16	19	15
Worksop (Hodsock Priory)	*Nottingham*	1·69	·85	22	50	·17	27	17
Mickleover Manor	*Derbyshire*	1·78	1·27	32	71	·18	3	20
Southport (Hesketh Park)	*Lancashire*	2·23	2·80	71	126	·35	13	24
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·26	1·95	50	86	·26	3	19
Hull (Pearson Park)	" *E. R.*	1·82	1·02	26	56	·18	25	16
Newcastle (Town Moor)	*North'land*	2·11	1·08	27	51	·18	25	14
Borrowdale (Seathwaite)	*Cumberland*	11·15	20·05	509	180	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	3·21	3·21	82	100	·53	3	26
Haverfordwest (Gram. Sch.)	*Pembroke*	3·41	5·10	130	150	·77	15	26
Aberystwyth (Gogerddan)	*Cardigan*	3·47	4·42	112	127	1·18	2	17
Llandudno	*Carnarvon*	2·17	1·97	50	91	·30	28	19
Dumfries (Cargen)	*Kirkcudbrt.*	3·61	6·82	173	189	1·35	15	29
Marchmont House	*Berwick*	2·65	2·35	60	89	·71	5	18
Girvan (Pinmore)	*Ayr*	3·77	7·24	184	192	·81	14	28
Glasgow (Queen's Park)	*Renfrew*	2·61	5·41	137	207	·77	5	25
Islay (Eallabus)	*Argyll*	3·82	6·54	166	171	·61	27	30
Mull (Quinish)	"	4·43	8·60	218	194	·92	8	30
Loch Dhu	*Perth*	6·59	13·70	348	208	1·50	8	27
Dundee (Eastern Necropolis)	*Forfar*	2·06	2·20	56	107	·75	5	16
Braemar (Bank)	*Aberdeen*	2·93	3·90	99	133	·90	16	23
Aberdeen (Cranford)	"	2·58	2·28	58	88	·73	5	14
Gordon Castle	*Moray*	2·32	2·04	52	88	·51	29	18
Fort William (Atholl Bank)	*Inverness*	6·60	14·94	380	226	1·55	23	30
Alness (Ardross Castle)	*Ross*	3·26	3·79	96	116	·86	8	27
Loch Torridon (Bendamph)	"	7·50	15·78	401	210	1·46	8	31
Stornoway	"	4·10	6·69	170	163	·55	9	31
Wick	*Caithness*	2·27	1·61	41	71	·32	5	24
Glanmire (Lota Lodge)	*Cork*	3·10	3·19	81	103	·60	12	28
Killarney (District Asylum)	*Kerry*	4·71	5·84	148	124	·69	28	28
Waterford (Brook Lodge)	*Waterford*	2·75	3·31	84	120	·70	15	22
Nenagh (Castle Lough)	*Tipperary*	3·09	4·06	103	131	·52	17	27
Ennistymon House	*Clare*	~~3·40~~	6·14	156	181	·63	28	27
Gorey (Courtown House)	*Wexford*	2·31	3·19	81	138	1·17	25	19
Abbey Leix (Blandsfort)	*Queen's Co.*	2·62	3·21	82	123	·35	15	22
Dublin (FitzWilliam Square)	*Dublin*	1·94	1·99	50	103	·46	14	21
Mullingar (Belvedere)	*Westmeath*	2·70	2·73	69	101	·57	28	23
Woodlawn	*Galway*	3·14	3·69	94	118	·70	28	28
Crossmolina (Enniscoe)	*Mayo*	4·52	6·62	168	147	·86	3	30
Collooney (Markree Obsy.)	*Sligo*	3·39	4·12	105	121	·45	3	29
Seaforde	*Down*	2·92	3·43	87	117	·48	15	26
Ballymena (Harryville)	*Antrim*	3·15	3·70	94	117	·39	17	25
Omagh (Edenfel)	*Tyrone*	3·14	5·11	130	163	·51	3	31

Supplementary Rainfall, March 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II	Ramsgate	·94	24	XII.	Langholm, Drove Rd.	7·84	199
,,	Sevenoaks, Speldhurst	1·67	42	XIII.	Selkirk, Hangingshaw	4·10	104
,,	Hailsham Vicarage...	1·71	43	,,	North Berwick Res. ...	1·78	45
,,	Totland Bay, Aston ..	1·06	27	,,	Edinburgh, Royal Ob.	2·08	53
,,	Ashley, Old Manor Ho.	1·33	34	XIV.	Biggar...............	4·46	113
,,	Grayshott..........	1·53	39	,,	Leadhills	12·85	326
,,	Ufton Nervet........	1·26	32	,,	Maybole, Knockdon ...	6·21	158
III.	Harrow Weald, Hill Ho.	1·44	37	XV.	Dougarie Lodge.......	5·12	130
,,	Pitsford, Sedgebrook..	·86	22	,,	Inveraray Castle......	14·57	370
,,	Chatteris, The Priory.	·89	23	,,	Holy Loch, Ardnadam	12·66	322
IV.	Elsenham, Gaunts End	1·26	32	XVI.	Loch Venachar	9·30	236
,,	Lexden, Hill House ..	·74	19	,,	Glenquey Reservoir ...	9·80	249
,,	Aylsham, Rippon Hall	1·08	27	,,	Loch Rannoch, Dall...	7·14	181
,,	Swaffham...........	1·15	29	,,	Trinafour............	10·26	261
V.	Devizes, Highclere ...	1·48	38	,,	Coupar Angus........	2·46	62
,,	Weymouth..........	1·25	32	,,	Montrose Asylum	2·29	58
,,	Ashburton, Druid Ho.	4·17	106	XVII.	LogieColdstone,Loanh'd	1·67	42
,,	Cullompton	2·18	55	,,	Fyvie Castle..........	1·94	49
,,	Hartland Abbey	3·46	88	,,	Grantown-on-Spey ...	1·50	38
,,	St. Austell, Trevarna .	3·43	87	XVIII.	Cluny Castle	6·75	171
,,	North Cadbury Rec. .	2·09	53	,,	Loch Quoich, Loan ...	28·50	724
,,	Cutcombe,Wheddon Cr.	3·88	99	,,	Drumnadrochit	4·96	126
VI.	Clifton, Stoke Bishop.	1·96	50	,,	Arisaig, Faire-na-Sguir	..	..
,,	Ledbury, Underdown.	1·09	28	,,	Skye, Dunvegan	9·91	252
,,	Shifnal.HattonGrange	1·57	40	,,	Glencarron Lodge	11·92	303
,,	Ashbourne, Mayfield .	2·05	52	,,	Dunrobin Castle	2·36	60
,,	Barnt Green, Upwood	1·04	26	XIX.	Tongue Manse	3·50	89
,,	Blockley, Upton Wold	1·73	44	,,	Melvich Schoolhouse ..	1·88	48
VII.	Grantham, Saltersford	·76	19	,,	Loch More, Achfary...	12·10	307
,,	Louth, Westgate	1·05	27	XX.	Dunmanway Rectory..	6·10	155
,,	Mansfield, West Bank	1·19	30	,,	Mitchelstown Castle...	2·84	72
VIII.	Nantwich, Dorfold Hall	1·50	38	,,	Gearahameen	10·50	267
,,	Bolton, Queen's Park.	3·28	83	,,	Darrynane Abbey	5·56	141
,,	Lancaster, Strathspey.	4·07	103	,,	Clonmel, Bruce Villa ..	3·76	96
IX.	Wath-upon-Dearne...	·73	18	,,	Cashel, Ballinamona...	2·73	69
,,	Bradford, Lister Park.	2·01	51	,,	Roscrea, Timoney Pk..	2·45	62
,,	West Witton.........	2·28	58	,,	Foynes...............	3·62	92
,,	Scarborough, Scalby..	1·07	27	,,	Broadford. Hurdlesto'n	3·64	92
,,	Middlesbro', Albert Pk.	·86	22	XXI.	Kilkenny Castle.......	2·65	67
,,	Mickleton...........	2·80	71	,,	Rathnew, Clonmannon	2·54	64
X.	Bellingham	2·60	66	,,	Hacketstown Rectory .	2·85	72
,,	Ilderton, Lilburn ...	1·66	42	,,	Balbriggan, Ardgillan .	2·34	59
,,	Orton...............	9·31	236	,,	Drogheda.............	2·36	60
XI.	Llanfrechfa Grange ..	3·09	78	,,	Athlone, Twyford	3·33	85
,,	Treherbert,Tyn-y-waun	13·34	339	,,	Castle Forbes Gdns....	2·64	67
,,	Carmarthen,The Friary	4·66	118	XXII.	Ballynahinch Castle...	7·03	179
,,	Fishg'rd,Goodwick Stn.	5·81	148	,,	Galway Grammar Sch.	5·14	131
,,	Lampeter, Falcondale	6·01	153	,,	Westport House	6·27	159
,,	Crickhowell, Talymaes	2·50	64	XXIII.	Enniskillen, Portora...	3·50	89
,,	B'ham W.W.,Tyrmyndd	6·41	163	,,	Armagh Observatory ..	2·61	66
,,	Lake Vyrnwy.......	6·05	154	,,	Warrenpoint	3·06	78
,,	Llangynhafal, P. Drâw	1·65	42	,,	Belfast, Cave Hill Rd..	3·37	86
,,	Oakley Quarries	12·47	317	,,	Glenarm Castle	3·76	96
,,	Dolgelly, Bryntirion..	7·92	201	,,	Londonderry, Creggan.	4·23	107
,,	Snowdon, L. Llydaw.			,,	Sion Mills...........	4·92	125
,,	Lligwy	3·86	98	,,	Milford, The Manse ...	5·11	130
XII.	Stoneykirk,ArdwellHo.	3·77	96	,,	Narin, Kiltoorish	6·69	170
,,	Carsphairn, Shiel.....	13·70	348	,,	Killybegs, Rockmount .	6·83	174

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean of Day M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	°F.		°F.		°F.	°F.	°F.	°F.
London, Kew Observatory	1015·3	+1·6	71	5	32	28	59·4	44·6	52·0	+2·1
Gibraltar	1015·8	+0·6	78	4	51	28, 31	71·3	58·0	64·7	−1·4
Malta	1012·6	−3·1	87	4	57	27	76·3	66·9	71·6	+1·8
Sierra Leone	1012·6	+0·7	90	5, 20, 28	69	sev.	86·9	70·9	78·9	−1·3
Lagos, Nigeria	1012·8	+1·1	87	7	70	16	84·6	74·4	79·5	+0·4
Kaduna, Nigeria	1013·4	+3·1	91	7	63	12, 13, 19	87·6	66·2	76·9	−0·8
Zomba, Nyasaland	1009·8	−0·7	97	7	56	11	87·3	64·9	76·1	+2·0
Salisbury, Rhodesia	1010·3	−2·1	94	17	52	18	88·0	59·3	73·7	+3·5
Cape Town	1018·6	+1·2	81	31	43	4	68·4	52·2	60·3	−0·7
Johannesburg	1014·3	+0·2	89	20	32	7	72·8	51·2	62·0	−0·6
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	93	20	35	7	77·9	48·9	63·4	−1·2
Calcutta, Alipore Obsy.	1009·2	−0·2	93	1	71	31	87·8	75·6	81·7	+1·0
Bombay	1007·5	−2·2	94	26	74	31	90·0	78·5	84·3	+2·0
Madras	1008·8	−0·1	98	11	73	27	89·5	76·5	83·0	+0·9
Colombo, Ceylon	1010·4	+0·6	87	25	72	20	85·8	75·0	80·4	−0·1
Hong Kong	1013·5	−0·1	87	4	68	18	80·6	72·5	76·5	−0·4
Sydney	1017·6	+2·7	82	8	49	3	71·4	55·9	63·7	+0·2
Melbourne	1016·7	+2·1	86	31	38	2	68·0	49·9	58·9	+1·3
Adelaide	1016·8	+0·7	90	31	42	25	73·3	52·4	62·9	+1·0
Perth, Western Australia	1017·3	+0·5	87	19	46	2	71·8	53·5	62·7	+1·7
Coolgardie	1015·3	+0·1	96	29	41	1, 22	81·0	51·1	66·1	+2·5
Brisbane	1017·4	+1·2	92	27	53	1	78·2	60·5	69·3	−0·4
Hobart, Tasmania	1013·6	+3·0	77	10	38	1	65·4	47·4	56·4	+2·4
Wellington, N.Z.	1012·6	+0·3	64	22	49	26	59·2	48·5	53·9	−0·4
Suva, Fiji	1012·5	−0·7	82	25	65	7	79·6	69·1	74·3	−1·7
Kingston, Jamaica	1011·8	−0·1	94	21	68	5	90·8	73·8	82·3	+1·8
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..
Toronto	1017·9	−0·1	81	21	33	29, 30	64·4	45·5	54·9	+8·0
Winnipeg	1012·9	−2·4	83	7	16	28	60·1	37·7	48·9	+8·1
St. John, N.B.	1015·2	−1·3	67	1	35	31	58·5	44·6	51·5	+6·2
Victoria, B.C.	1014·5	−3·1	59	9	37	31	52·8	44·3	48·5	−1·9

LONDON, KEW OBSERVATORY.—Mean speed of wind 6·5 mi/hr ; 1 day with thunder heard, 12 days with fog.

GIBRALTAR.—1 day with thunder heard, 2 days with fog.

MALTA.—Prevailing wind direction NW. ; mean speed 6·3 mi/hr.

SIERRA LEONE.—Prevailing wind direction SW. ; 25 days with thunder heard.

SALISBURY, RHODESIA.—Prevailing wind direction NE. ; 1 day with thunder heard.

British Empire, October 1920.

Temperature: Absolute: Max. in Sun ° F.	Temperature: Absolute: Min. on Grass ° F.	Relative Humidity %	Mean Cloud Am'nt 0–10	Precipitation: Amount in.	Precipitation: Amount mm.	Precipitation: Diff. from Normal mm.	Precipitation: Days	Bright Sunshine: Hours per day	Bright Sunshine: Percentage of possible	STATIONS
122	22	82	5·5	1·68	43	− 26	9	3·7	34	London, Kew Observatory.
130	46	75	3·9	2·70	69	− 15	9	..	..	Gibraltar.
144	..	76	6	4·15	105	+ 37	12	6·4	57	Malta.
..	..	75	5·5	7·69	195	−129	20	..	..	Sierra Leone.
164	66	66	7·2	5·06	129	− 67	14	..	..	Lagos, Nigeria.
..	..	83	..	2·91	74	+ 14	9	..	..	Kaduna, Nigeria.
..	..	76	3·0	3·03	77	+ 39	6	..	..	Zomba, Nyasaland.
153	44	49	3·1	0·58	15	− 16	5	..	..	Salisbury, Rhodesia.
..	..	68	4·6	2·12	54	+ 10	10	..	..	Cape Town.
..	32	56	4·5	5·03	128	+ 67	12	8·2	65	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
..	..	49	3·3	3·38	86	+ 43	7	..	..	Bloemfontein.
..	65	67	4·9	5·73	146	+ 47	4	..	..	Calcutta, Alipore Obsy.
139	63	70	3·5	0·34	9	− 38	2	..	..	Bombay.
..	..	84	6·8	21·47	545	+259	16	..	..	Madras.
161	70	74	7·5	15·27	388	+ 31	22	..	..	Colombo, Ceylon.
..	..	70	4·7	6·19	157	+ 32	14	7·8	67	Hong Kong.
141	43	66	5·4	1·72	44	− 31	12	6·5	..	Sydney.
145	33	67	5·9	3·72	94	+ 28	14	..	..	Melbourne.
152	31	57	4·7	2·90	74	+ 30	9	..	..	Adelaide.
..	31	60	4·9	1·45	37	− 17	12	..	..	Perth, Western Australia.
149	38	36	2·5	0·31	8	− 11	6	..	..	Coolgardie.
150	47	63	5·5	2·16	55	− 14	11	..	..	Brisbane.
146	30	63	6·2	0·88	22	− 35	15	8·0	61	Hobart, Tasmania.
136	21	78	6·9	3·41	87	− 20	12	5·4	41	Wellington, N.Z.
..	..	83	..	5·40	137	− 61	22	..	..	Suva, Fiji.
..	..	74	5·9	1·23	31	−159	7	..	..	Kingston, Jamaica.
..	..	..	..	..	..	..	..	..	..	Grenada, W.I.
..	..	88	4·3	3·83	97	+ 35	10	..	..	Toronto.
..	..	75	3·7	0·21	5	− 33	3	..	..	Winnipeg.
..	..	81	4·8	3·21	82	− 33	6	..	..	St. John, N.B.
..	..	89	6·7	4·03	102	+ 37	20	..	..	Victoria, B.C.

BLOEMFONTEIN.—Highest rainfall for October; lowest absolute min. temp. for October.

MADRAS.—17 days with thunder heard.

COLOMBO, CEYLON.—Prevailing wind direction WSW.; mean speed 4·8 mi/hr; 3 days with thunder heard.

HONG KONG.—Prevailing wind direction E.; mean speed 10·3 mi/hr.

brought rain to the south-east of England also affected the adjacent regions of the Continent. In France the only large rainfall readings recorded in the *Daily Weather Report* were 51 mm. at Lyons on the 7th and 25 mm. at Biarritz on the 20th. In the Mediterranean area the conditions were mainly anticyclonic, but shallow depressions caused occasional heavy falls of rain. On the 6th 59 mm. of rain fell at Gibraltar, 30 mm. at Sanguinaire (Corsica), and there were some heavy falls in Italy. Limasol (Cyprus) had 28 mm. on the 9th and 26 mm. on the 13th. There were readings of 40 mm. at Malta on the 10th, and also at Sanguinaire on the 21st.

Abnormally high temperatures have prevailed all the winter in Switzerland, even at the greater altitudes. Early in January the famous Rhine Falls at Schaffhausen had vanished* and the river-bed was largely dry. Although frequent snow-falls occurred in the higher regions in February, the winter has been singularly deficient in this respect. The six weeks ending March 13th were particularly sunny. The Rhine and Rhone dwindled to half their ordinary volume. The level of the lakes fell considerably and most of the steamer service had to be suspended. Electric service was very limited because of the lack of water power. There was practically no snow under 4,000 feet, and such a dry season has not been experienced for 90 years.

At the beginning of the month torrential rains fell in South Australia, causing such serious floods that the ports had to be closed and traffic on the Trans-continental railway suspended. At the same time good rain fell throughout practically the whole of New South Wales. A message received on the 17th stated that heavy rain had put out the fires in South Gippsland (Victoria).

In Canada on the 28th the St. Lawrence river experienced the earliest spring opening for the past 40 years, the normal time being about April 20th. A message despatched from Toronto on the 21st states that there have been two severe storms in Ontario: a cloud-burst at Port Hope on Lake Ontario and a wind storm in Bruce County (Lake Huron). There was not much loss of life, but considerable damage to property.

The Newfoundland sealing fleet which went out on the 10th was unable to find the herds owing to heavy ice.

A telegram dated March 18th stated that famine had been declared in parts of the Bellary and Anantapur districts of the Madras Presidency. Light to heavy rain fell in parts of Burma, Bengal, Bihar and Orissa, and North-west Frontier Province, but the weather continued dry in other provinces.

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* Presumably because all the available water was required for the power-station.

To face page 85.

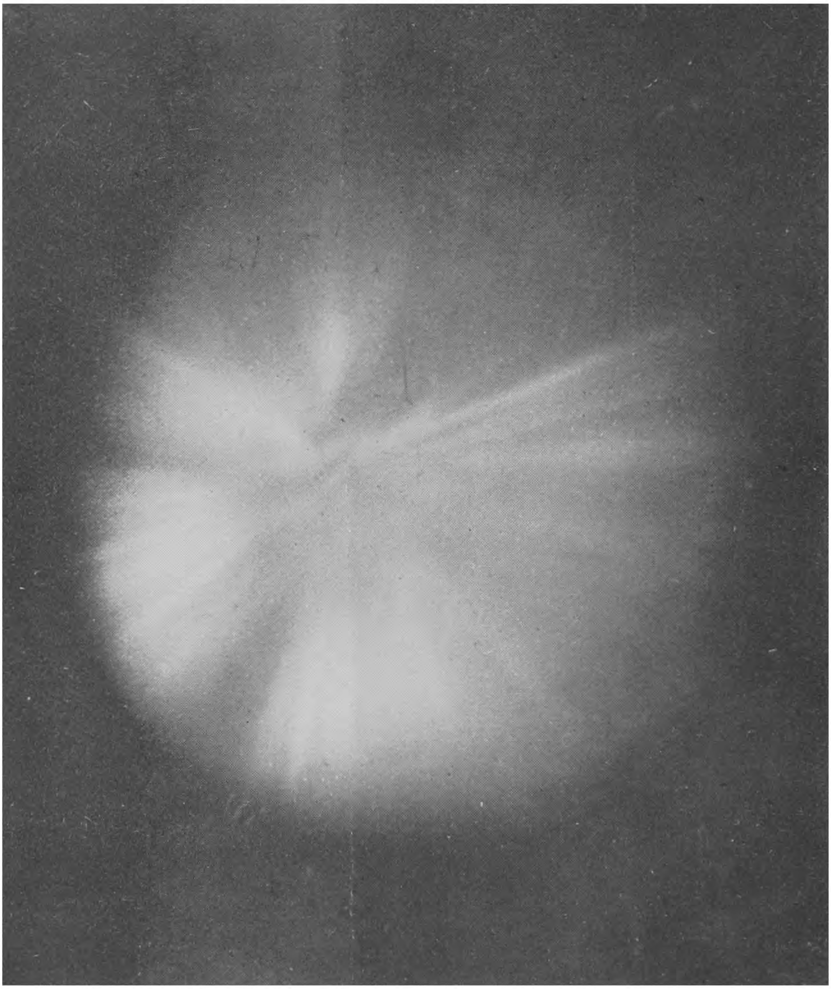

FIG. 1.—Corona of 23rd March, 1920, observed in Norway.

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Recent Work on Aurora.

BY C. CHREE, Sc.D., F.R.S.

THE installation of an observatory in Shetland, having as one of its objects auroral observations, suggests a brief account of recent work on aurora. In this subject we owe much to Norwegian physicists, especially Professors Birkeland, Störmer, Vegard and Krogness. Aurora has many forms, of which arcs and curtains are the most frequently portrayed. But many, if not all, auroras are built up of rays. Aurora is usually a rapidly changing phenomenon, and the impression left on the ordinary observer may sometimes be more exactly reproduced by drawings than by photographs. The drawings of rays (Figs. 2–5) accompanying this article are from originals which refer to observations made in Jan Mayen in 1882.* Three of these drawings obviously suggest a radiant point, the fourth (Fig. 2) does not. The photograph (Fig. 1), which we owe to the kindness of Professor Störmer, represents a remarkable corona observed in Norway on the morning of March 23rd, 1920. As is generally known, Professor Störmer has devised a satisfactory method of measuring auroral heights by taking photographs simultaneously from the two ends of a base. (The photographs include stars, and the positions of the aurora relative to the stars on the two photographs enable the exact position of the aurora in space to be determined.) The corona shown here

* Die Internationale Polarforschung 1882–83. Die Österreichische Polarstation Jan Mayen, II. Band, I. Abtheilung, Plates VI. and VII.

a (64)14639 Wt 105—P 35 1250 5/21 E & S A 2 came near the end of a great auroral display (and magnetic storm), and the other base station had unfortunately exhausted its plates. The corona was remarkable, according to Professor Störmer, for its beautiful blue colour. The corona represents the convergence of auroral rays. The point of convergence has been observed at many stations, and found to make at least a close approach to the magnetic zenith. For instance, 11 observations made by Vegard and Krogness near Bossekop in 1913 gave values for the altitude of the point of convergence varying from 75·3° to 75·8°, the mean local value of the magnetic dip being 76·7°. This fits in with the theory, which we owe principally to Birkeland and Störmer, that aurora represents the passage through the earth's atmosphere of electrical rays, whether α (positive) rays or β (negative) rays, coming, it is supposed, from the sun. A group of α or β rays would naturally follow a spiral track about the earth's lines of magnetic force which give the direction of the dipping needle. The cylinder or cone on which the spiral is traced should be of larger diameter for the heavy α ray than for the β ray. According to Vegard and Krogness, an auroral ray produced by ordinary α rays could not be of less diameter than 12 km.; which is much in excess of their photographic determinations. These considerations seem to have converted (or perverted) Vegard, who used to be an ardent champion of α rays, into an acquiescence, perhaps temporary, in the β ray theory.

An obstacle to the acceptance of either theory undiluted is the large diameter of the auroral zone (or zone of maximum frequency) and the low geographical latitudes to which aurora extends. Another difficulty in the way of any theory which postulates rays all of one sign is the scattering that might be expected.

In latitudes such as the South of England aurora is seldom seen, and magnetic storms (*i.e.*, large long-continued disturbances) are rare. Thus their long known tendency to synchronize has naturally suggested a connection. Strong evidence of this can readily be derived without going further than the Geophysical Journal of the Meteorological Office. For some time the Journal has contained a monthly table specifying the dates when aurora has been seen in the United Kingdom, and giving the magnetic "character figures" (0 ≡ quiet, 1 ≡ moderately disturbed, 2 ≡ highly disturbed) assigned at Eskdalemuir and Kew to the days preceding and following the midnight to which the aurora is assigned. The mean "character" at the latter station for the auroral nights of 1919 was 1·12, the corresponding mean from the whole year being only 0·69.

To face page 86.

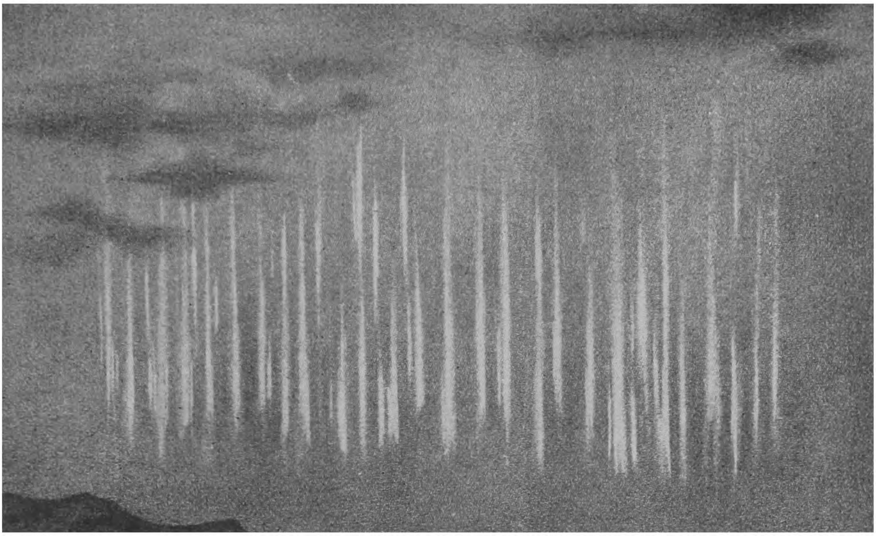

FIG. 2.—Rays at Jan Mayen, not showing convergence. (Strahlenreihe.)

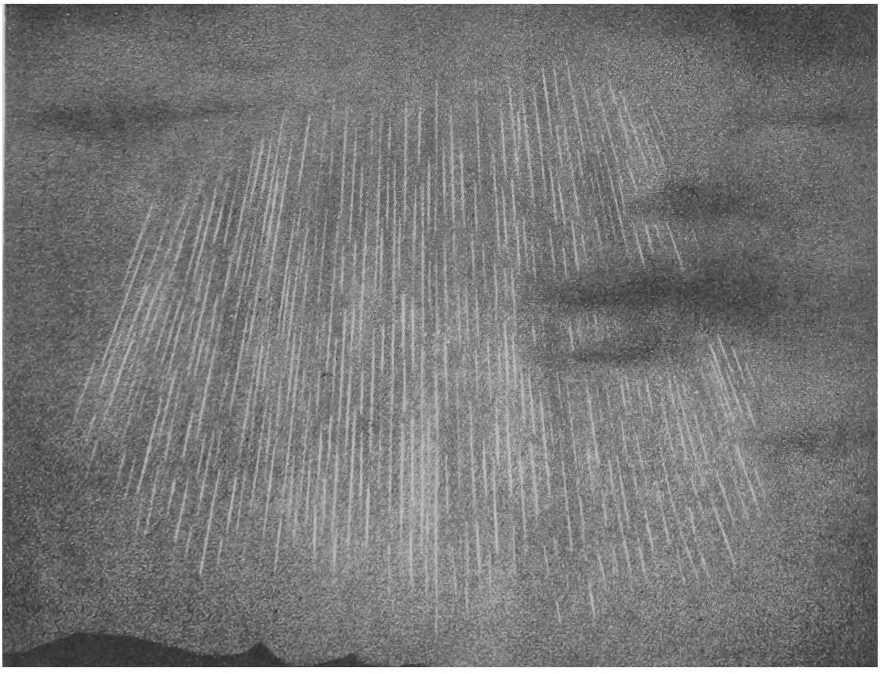

FIG. 3.—Rays at Jan Mayen, showing convergence. (Schleier.)

33185—1250

To face page 87.

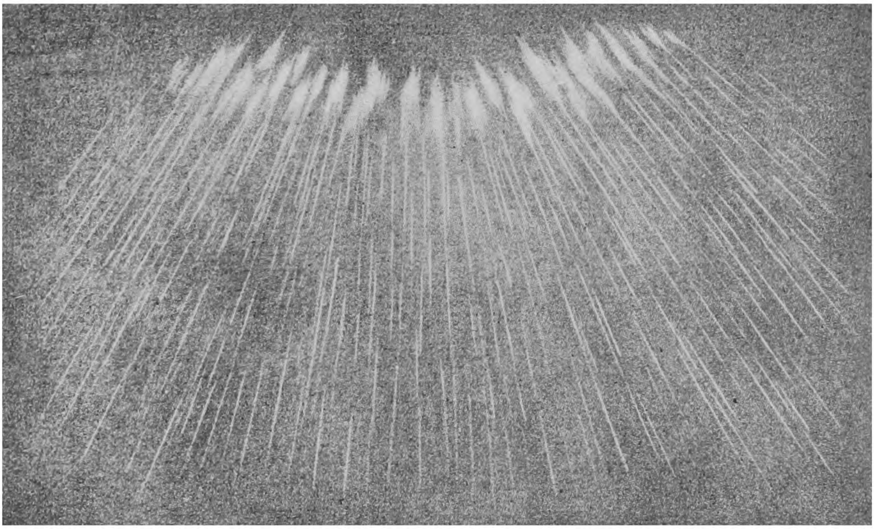

FIG. 4.—Rays at Jan Mayen, showing convergence. (Fadenwurf.)

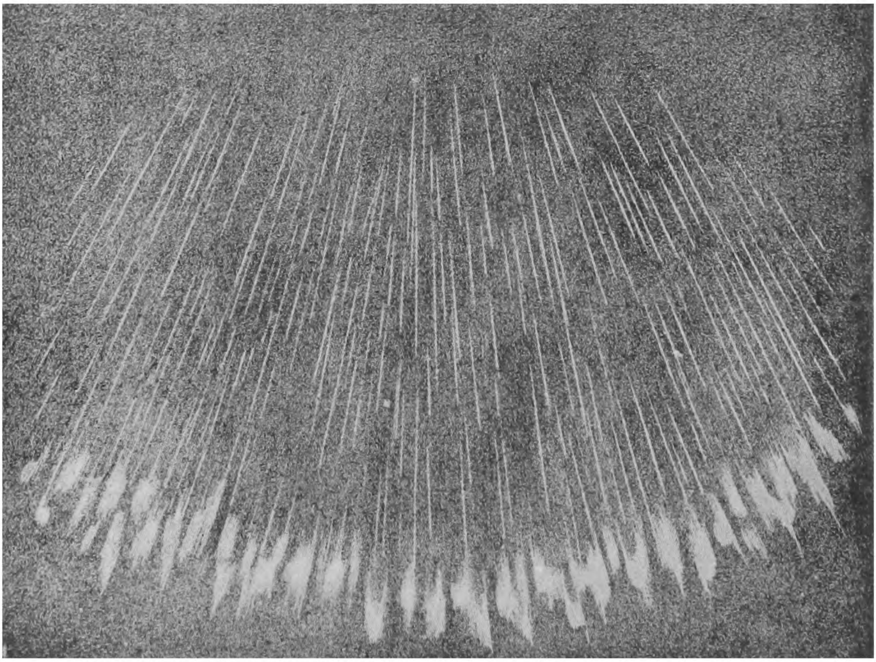

FIG. 5.—Rays at Jan Mayen, showing convergence. (Fadenmantel.)

A study confined to temperate latitudes being one-sided, some figures from the Scott Antarctic Expedition of 1911–12 may be of interest. In June and July 1911 (*i.e.*, midwinter) aurora was reported at 251 hours. The auroras being grouped in four classes in descending order of brightness, and magnetic "character figures" being assigned to individual hours, the resulting means were as follows* :—

Auroral class - - -	I.	II.	III.	IV.
Magnetic "character" -	1·27	1·01	0·92	0·58

The mean magnetic "character" from all hours of the two months was 0·83. The fact that the hours when the faintest auroras were reported showed actually less than the average amount of magnetic disturbance would be curious if aurora were seen as seldom in high latitudes as in England. But in high latitudes aurora seems to be the rule, rather than the exception, when the absence of cloud and of strong moonlight permit of its being seen.

The spectrum of aurora offers another promising field of investigation. There is a characteristic auroral line, which Mr. Slipher† in America and Lord Rayleigh‡ in England have found may be photographed on most, if not all, nights, so that aurora invisible to the eye may be detected.

There are many other lines in the auroral spectrum some of which have been identified as due to nitrogen. If the spectrum is that of the surrounding gas, observations at different heights may convey information as to the composition of the atmosphere. From this point of view, rays such as one described in a recent paper by Professor Störmer, whose lowest and highest points were at heights of 140 and 400 km. respectively, might afford the same kind of information about the atmosphere that deep underground borings supply about the earth's geological structure. The heights just mentioned do not represent the extreme auroral limits. Heights under 90 km. have been measured on a good many occasions, and on March 22–23, 1920, one of Professor Störmer's heights exceeded 500 km.

It is also hoped that investigations into the spectrum of aurora may throw light on the electrical conditions of the upper atmosphere, and on the nature of the electrical rays which traverse it. Relations to wireless phenomena are also possible. In short, while the study of aurora may seem at present remote from practical applications, it would be rash to assert that such will always be the case.

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* A difficulty in the way of estimating the exact degree of parallelism between magnetic disturbance and aurora is that neither element lends itself readily to exact numerical measure.

† Astrophysical Journal, Vol. XLIX., p. 266. ‡ Nature, Vol. 107, p. 137.

OFFICIAL NOTICES.

Sunshine Records.

OBSERVERS are requested to note that interpolations should not be made for the absence of "burn" during the eclipse of April 8th.

Official Publications.

Professional Notes, No. 15.—Diurnal Variation in Wind Velocity and Direction at Different Heights. By J. Durward, M.A. Price 9*d.* net.

THIS publication summarises the results of 1,736 pilot balloon observations (single theodolite) which reached 3,000 feet at Noyelle-Vion, on the British Front in France, from 1917 onwards. Ascents were made every four hours and provide a good basis for the investigation of the diurnal variation. The discussion is extended to a height of 6,000 feet, and each of the four quadrants is taken separately; it is found that the surface diurnal variation (maximum during day) is reversed in the free air, the minimum occurring about noon between 1,000 and 3,000 feet, but later, the higher one goes. At 4,000 and 6,000 feet there is a tendency for west winds to decrease and east winds to increase by day; three possible explanations for this are put forward. The importance of an analysis of this sort in making forecasts of the wind at different levels is obvious, as the variation is of quite sufficient magnitude to need allowing for, and in case of a long-distance flight may make all the difference between success and failure. In an addendum, accounts are given of similar investigations in Italy and at Batavia.

Professional Notes, No. 16.—The Use of Light Filters in the Observation of Pilot Balloons. By R. A. Watson Watt, B.Sc. Price 9*d.* net.

IN October 1919, Mr. R. A. Watson Watt began a series of experiments in the use of light filters in pilot balloon observations, and observers who are engaged in this work will welcome an account of his methods which greatly increase the distance to which a balloon can be followed, especially in haze, and at the same time make the conditions of observing less fatiguing. The Note deals briefly with the purposes of a light filter, the types of filter employed in the investigation with their transmission data and absorption curves, and the great advantages to be derived from using them, which will readily be conceded by anyone with experience of following a balloon with and without a suitable filter. The choice of the best colour to employ depends on the state of the sky, the intensity of illumination, and the colour of the balloon. The most useful filters are yellow and red, particularly the "drastic reds." A white or light orange balloon against a cloudless blue sky has been found to give very satisfactory results with a red filter; when the background is a uniform sheet of white alto-stratus, alto-cumulus or cirro-stratus a dark blue or black balloon is preferable. The use of the very dense "monochromatic" filter is of great advantage when the balloon is nearly in line with the sun. A table showing the increase in balloon trajectories obtained by the use of filters reveals an advantage of 50 to 100 per cent. in favour of this method. In an appendix, a brief description is given of the making and mounting of an eye-piece filter system. Some time, care and patience are required for this operation, but when properly mounted the eye-piece is extremely easy to manipulate.

Professional Notes, No. 17.—Report on the Thunderstorm which caused Disastrous Floods at Louth on 29th May 1920. By E. V. Newnham, B.Sc. Price 9*d*. net.

A BRIEF description of the Louth floods has already appeared in this Magazine (June 1920, page 83); Mr. Newnham's longer report, based on a personal visit to the district, summarises all the available meteorological data. It appears that the rainfall exceeded 100 mm. (4 in.) over a strip of country twenty miles long and reached 121 mm. (4·75 in.) on the wolds west of Louth. (The scale of figure 1 is twenty and not ten miles to the inch.) This heavy fall in a few hours was concentrated in a narrow valley which became temporarily blocked, the breaking of the block being the immediate occasion of the flood. The ultimate cause of the downpour is shown to lie in two converging currents, one from south-west and the other from south-east, both very warm and moist, and at least 4,000 feet in depth, meeting near Louth. North of the Wolds a cold easterly current was blowing in from the North Sea, so that altogether conditions were very favourable for the ascent of great quantities of moist air and the resulting heavy precipitation.

The Herbertson Memorial Lecture.

THE second of the Memorial Lectures founded by the Geographical Association as a tribute to the late Professor Herbertson was delivered by Dr. H. R. Mill at the Royal Geographical Society on April 6th. Dr. Mill began by sketching the contributions of Edinburgh to the modern geographical movement, mentioning especially the work of Sir John Murray, Professor Geddes, the Geikies, and Drs. Buchan and Bartholomew. He then described his ideal of a regional geography of the British Isles, and pointed out that circumstances had led him to work at one aspect only of the great plan, namely, the relation of rainfall to configuration of the land. It was often assumed that surface relief controlled the distribution of rainfall, but years of rainfall mapping have shown that rain falling during thunderstorms or in cyclonic disturbances of comparatively small size is distributed in accordance with meteorological rather than geographical conditions, since it is probably determined at heights considerably above any part of the land. Moisture-laden air, rising because of some meteorological cause, produces rain whatever the land surface may be; but in the case of air flowing in from the sea or across low land, and forced upwards by hills, the amount of rain depends on the slope of the ground and the direction of the wind.

Dr. Mill spoke of the difficulties of mapping rainfall observations. At present the half-inch to the mile map can be used as a basis in most cases; the inch to the mile map rarely. Experience gives an almost instinctive insight into the sympathy between land forms and isohyets, but there are difficulties. The mapping of the rainfall on the slopes of uniformly rising ground such as the western face of the Welsh mountains, the Lake District, or Bowland Forest, so customarily gives increase of rainfall with height that it is disconcerting to find higher figures in the valleys to the east. It is a fact that places a few hundred feet above sea-level have higher rainfall than places a few thousand feet above sea-level to the windward of them, *e.g.*, the Stye below the Styehead Pass in the Lake District and the valley east of the Monmouthshire Black Mountains. Dr. Mill considered that this was due in part to the bodily transport of masses of rain-laden air over the ridge by high winds, and in part to the continual progress of the air blowing along the windward hill-slopes upward as well as onward. The general principles laid down in his article to British Rainfall, 1915, p. 28, were still sound, and these exceptions merely emphasized the rules. The lecture concluded with a consideration of the importance of the mapping of average rainfall, especially at the present day, when the difficulties of coal extraction are leading men's thoughts to the possibilities of water-power. The configuration of the land ensures that the heaviest rainfall descends on the head waters of a river, and therefore this is the region where most power can be generated. Special investigations are required to ascertain how much water flows off the surface and occupies the river bed at each point, how much evaporates, and how much percolates to deep-seated underground reservoirs. In order that a thorough survey into the hydrometric data and the consequent natural resources of the land may be made, co-operation between many departments, engineering, forestry, agriculture, geology, meteorology, is necessary; and trained geographers should then be able to co-ordinate the results for the benefit of the nation at large. The financing of such a comprehensive University School of Geography would be a great gift to the nation.

The Royal Meteorological Society.

THE usual monthly meeting of the Royal Meteorological Society was held on Wednesday, April 20th, in the Society's Rooms, Mr. R. H. Hooker (President) in the chair.

A paper was read by Mr. C. E. P. Brooks, entitled "The Evolution of Climate in North-West Europe." Mr. Brooks has previously discussed the influence of geographical conditions on climate, and has traced the widespread effect of comparatively small changes in the distribution of land and water. In the present paper he sets out to give a continuous account of the variation of climate in North-West Europe since the last Glacial Period. Several successive "phases" are distinguished:—

1. The Close of the Glacial Period, 30,000 to 18,000 B.C.
2. The Retreat of the Glaciers, 18,000 to 6,000 B.C.
3. The Continental Phase, about 5,000 B.C.
4. The Maritime Phase, about 4,000 B.C.
5. The Forest Phase, about 3,000 B.C.
6. The Peat Bog Phase, about 500 B.C.
7. The Recent Phase.

Charts are drawn to illustrate the probable meteorological conditions associated with each of these phases. Evidence is produced for the gradual shrinkage of a great anticyclone which covered Scandinavia and neighbouring regions during the first two of the "phases." The Maritime Phase, when the winters were warm, is associated with a sinking of the land and a great extension of the Baltic. The Forest Phase implies a much drier climate than the present, the Peat Bog Phase a wetter.

To explain the climatic changes the mere geographical conditions are found sufficient in some cases, but in other cases different possibilities have to be taken into account. For example, the cessation of the Peat Bog Phase is shown to be contemporaneous with a marked drop in the rainfall of California and south-western Asia, known from Huntington's studies of the rings of trees, and must therefore be due to some widespread cause. Some of the changes of the last 3,000 years are seen to fit in very well with Pettersson's astronomical theory according to which periodical increases in the activity of the tides produce more thorough mixing of the waters of the oceans and take high temperatures further north.

Dr. G. C. Simpson, who opened the discussion, thought that the fact that cosmical causes were invoked to explain some of the changes of climate weakened the case for the predominating influence of the distribution of land and water in other phases. He was not satisfied that the formation of an incipient ice sheet would necessarily modify the atmospheric circulation sufficiently to account for its subsequent growth.

Professor Myres pointed out the importance to anthropologists of a knowledge of climatic conditions in the past. Much attention had been given to such questions in connection with the early history of Mesopotamia and Egypt.

In reply to Dr. Simpson, Mr. Brooks was able to give some results of mathematical analysis which tended to show that given sufficient area above the snow-line the growth of an ice-sheet would proceed rapidly.

A paper by Lieutenant Gordon C. Steele, V.C., R.N., entitled "A brief Review of the Influence of Meteorology on Naval Warfare," was, in the absence of the author, read by Captain Sir David Wilson-Barker.

The influence of meteorology on naval warfare can best be realised by briefly reviewing its effects in the past and comparing it with the present time. Starting as far back as the old war galleys propelled by oars, we find a certain independence of wind which their successors, the sailing ships, did not enjoy. The advent of steam, as we may suppose, rendered the warship independent of wind for movement and all that it involves; but, at the same time, the progress of modern armament and the introduction of the long-range gun made the meteorological conditions of visibility of first rate importance. In fact, we may recollect that in almost every action fought in the late war some reference was made to the state of the weather. The last five years have seen new acquisitions to naval service, most notably the coastal motor-boat, a naval air wing, and such weapons as the smoke screen, and even the possibility of the use of poisonous gas at sea is now in sight.

Analysing the effect of meteorological conditions on these new arms, we notice that the last two are absolutely contingent on weather conditions and the others are so in a large degree. We are, therefore, justified in summing up that modern invention has not overcome the influence of meteorology on naval warfare, but we still find ourselves confronted with many of the old problems our ancestors had to deal with.

Moreover, its influence can be traced in the policy of ship construction. For example, in a programme of shipbuilding, the general climatology of the sea or ocean forming the probable theatre of war in a great measure determines the gun-range at which an action will be fought and consequently the amount of armour to be allocated under these conditions. From these considerations we are able to appreciate the value of an efficient Meteorological Service to the Navy.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

Optical Phenomena.

SOME interesting optical phenomena were witnessed at Croydon on the afternoon of April 11th. The day had been misty, with a considerable amount of low drifting cloud. Through breaks in these low layers cirrus and cirro-stratus clouds were visible. Early in the afternoon the low clouds gradually dispersed, the cirrus and cirro-stratus becoming more clearly distinguishable through the mist.

About 1.25 p.m. G.M.T. the upper arc of a 22° halo was noted. This arc was very strongly developed, the colours being particularly bright. To the right of the sun an arc of another circle (apparently a mock sun ring) was visible parallel to the horizon. This arc, which was a pale white colour, was at an elevation of about 42°. If produced it would have passed through the sun. It stretched from a point 30° to the right of the sun to the point immediately opposite (*i.e.*, 180° away from the sun), where it was intersected by another arc, also of a pale white colour. This last arc, however, was very short—not more than 20°—and was visible for a few minutes only.

By 1.45 p.m. only the arc of the 22° halo was visible, with its intensity greatly diminished.

Although a sharp look-out was kept, no mock suns were observed. Coronæ were observed at 12.55 p.m. and at 3 p.m.

G. R. Hay.

Meteorological Office, Civil Aviation Aerodrome, Croydon, April 12th, 1921.

[In reply to a question concerning his observation, Capt. Hay writes that the arc through the anthelion was visible for too short a period to enable measurements to be made, but that he sketched it at the time; the inclination to the east of the vertical appears to have been about 15° and the arc was concave to the east.—Ed. M.M.]

A remarkable atmospheric phenomenon was witnessed from Carreg-y-Llan Quarries this afternoon:—

Mock sun ring. At 4.30 p.m. the sun was observed on the circumference of a large and complete circular ring of white against a blue sky relieved only by long parallel bands of fairly thick cirrus cloud.

Halo of 22°. Parhelia, or mock suns. On either side of the sun, at the points of intersection of a faint rainbow of half the diameter (or less) of the white circle, and the same, a brilliant rainbow iridescence was noticeable; the portion of the rainbow above the sun was considerably flattened, while the portion below appeared to be sharpened—as far as could be seen, cliffs intervening to obscure a view of the base. The white ring might at a guess be placed at 45° elevation.

Upper arc of contact. These effects were visible up to 6 p.m., when an additional and more brilliant rainbow arc, inverted, became visible at a distance approximately equal to the radius of the complete rainbow.

Harold C. King.

Victoria Hotel, Llithfaen, near Pwllheli, Carnarvonshire, April 19th, 1921.

[An account of a solar halo observed on April 20th, which is accompanied by accurate measurements and sketches, has been received from Eskdalemuir, and will be published in the next issue of this Magazine.

Solar halos with brilliant parhelia were also reported from Newquay on the 25th and Felixstowe on the 30th; a moon-pillar was observed at South Farnborough on April 24th.]

Simultaneous Halo and Corona.

CAPTAIN DOUGLAS's observation of the simultaneous halo and corona of December 25th, 1920 (*Meteorological Magazine*, January 1921, p. 274) may be paralleled by a recent occurrence here observed at 20 h. on January 19th, 1921. Although the sky appeared to be cloudless there was a faint complete lunar halo and a small corona. At the time there was a light south wind at the surface. My explanation of this phenomenon was that there was a thin cirro-nebula, the lower part of which had fallen into air having a temperature above freezing. The crystals of the upper portion would have been responsible for the halo, while the droplets formed by melting of the crystals in the lower portion would have accounted for the small corona. I do not see that the occurrence of super-cooled water-drops was necessarily involved in the case cited by Captain Douglas any more than in the case cited here.

Some discussion of the simultaneous occurrence of halos and coronas has been published in the *Monthly Weather Review* (Washington, D.C.) January 1919, Vol. 47, p. 21, and June 1920, Vol. 48, p. 333. CHARLES F. BROOKS.

Weather Bureau, Washington, D.C., February 26th, 1921.

[A letter from Mr. C. F. Brooks describing a similar phenomenon observed on March 20th, 1921, was published in the last number of the *Meteorological Magazine*, p. 69.]

The Terminal Velocity of Snow Flakes.

THE two heavy snow showers experienced in London in the afternoon and again in the early evening of Friday, April 15th, during the northerly type of weather then prevailing, were both characterised by a period during which the surface wind became dead calm. I took advantage of an opportunity during the calm period in the second heavy shower to measure the rate of fall of the snow flakes in still air. At the time, the snow consisted of dry flakes of many sizes, and a rough division into three groups was made by eye: large, averaging, say, three-quarters of an inch in diameter, medium and small, the latter averaging, say, one-quarter of an inch in diameter. Individual flakes were easily followed and the time taken to fall through a known height of 5·7 m. was measured by stop-watch. Unfortunately, the time available was short and only a very limited number of observations were made—27 in all. They gave the following approximate terminal velocities :—

Large flakes - - - - 1·8 m/s,
Medium flakes - - - 1·5 m/s,
Small flakes - - 1·1 m/s,

the larger flakes having the greater rate of descent.

These figures apply, of course, to snow of the particular texture of this occasion, but they may be used to obtain some idea as to the distance which snow, once formed, may be carried by the wind before reaching the ground. Thus, in the case of the medium flakes falling from a height of two kilometres through a column of air having a mean speed of 8 m/s (18 miles per hour), the distance would be only 24 k. (15 miles).

M. A. GIBLETT.

W. Hampstead, April 20th, 1921.

Velocity of Vertical Air Currents.

IN the report in the March issue of this Magazine of my contribution to the discussion of Mr. G. A. Clarke's paper on a pilot balloon ascent at Aberdeen, read before the Royal Meteorological Society, I am credited with saying that I had never met with such a large vertical current as that discussed by Mr. Clarke. This report is somewhat inaccurate. What I actually said was that I had only once met with a downward current of sufficient magnitude to prevent the balloon rising, while rising currents of over seven miles per hour (the rate found by Mr. Clarke) had been encountered four times in sixty-six ascents. The largest rising current ever measured by me was of eleven miles per hour.

J. S. DINES.

April 29th, 1921.

I NOTE that in the *Meteorological Magazine* for March 1921, p. 38, it is stated that in a long series of observations with two theodolites vertical currents of six miles per hour had not been observed. In this connection two ascents made here on April 4th, 1921, may be of some interest.

1. *Start*, 11 h. 9 m. G.M.T. *Clouds*, Fr.Cu. 5.
Surface, 43 ft./sec. at 300°.

Minute.	Velocity.	Direction.	Rate of Ascent.	Vertical Current.
	Ft./sec.		Ft./min.	Ft./min.
1	53	305	883	+ 383
2	34	313	877	377
3	31	324	1,393	893
4	41	313	1,447	+ 947

2. *Start*, 14 h. 20 m. G.M.T. *Clouds*, Fr.Cu. 7.
Surface, 42 ft./sec. at 315°.

Minute.	Velocity.	Direction.	Rate of Ascent.	Vertical Current.
	Ft./sec.		Ft./min.	Ft./min.
1	42	326	586	+ 86
2	41	325	759	259
3	44	326	1,300	800
4	44	320	1,630	1,130
5	39	313	1,325	+ 825

Both balloons were filled to give an upward velocity of 500 feet per minute, and it will be observed that the maximum ascensional velocity is 1,630 feet per minute, or an upward current of 1,130 feet per minute (12 miles per hour). The average upward current in the second ascent from the 3rd to the 5th minutes is 918 feet per minute, or 10 miles per hour.

Slight snow fell at 15 h. 10 m.; the sky from 16–18 h. bore evidence of its disturbed state, large cumulo-nimbus with false cirrus being observed to the north and north-east.

J. DURWARD.

School of Artillery, Larkhill Camp, April 18th, 1921.

Units for Meteorological Work.

MAY I add a few words to the crisp little protest of Mr. Robert Cross in the April issue of this Magazine.

Mere clinging to accustomed usage is to be deprecated in scientific work if better methods or more expressive terms can be found. But the question is admissible whether millimetre is to be preferred to inch, and whether its use is likely to lead to a more popular understanding of rainfall news in this country. To each part of this question I judge that an emphatic *No* must be given.

1. If scientific facts can be equally well expressed in terms, one of which is simple and clear, the other more or less obscure and unfamiliar, it is pedantic to insist upon the more difficult.

2. The term "inch" is firmly embedded in the British mind. It is easily visualised, and thus no reader, however uninstructed, can fail to know what is meant by "an inch of rain."

If it is desired to make meteorology a close science, by all means let us invest it with a jargon of its own; but if we desire to popularise it, in order that the greatest possible number may take an intelligent interest in weather observation, let us use plain English. For purposes of comparison with foreign records it is not difficult to convert the terms.

Lexden, Colchester, April 21st, 1921. SAMUEL F. HURNARD.

NOTES AND QUERIES.

Fog and Mist.

THE indefiniteness of the terms fog, mist and haze has largely discounted the value of all statistics showing the frequency of these phenomena. The usage of ordinary life depends to a large extent on locality. To the townsman fog suggests the "London particular," yellow and smoky, but at sea a fog is white and objects can be seen, at any rate by day, at considerable distances. A definition of "fog" based on visibility must be of the nature of a compromise between the customs of land and sea. Such a compromise is made in a recent instruction issued by the Meteorological Office to observers.

According to this instruction, in daylight hours the use of the word fog is to be restricted to those occasions when the range of visibility falls short of one kilometre (1,100 yards). An entirely satisfactory criterion for use at night is not available. A light at night does not necessarily become invisible at the same distance as an object by day, when there is the same amount of opaque matter present in the air, but lights at different distances give the best assistance at present available for estimating the degree of obscurity. The official instruction is that "at night the descriptive terms and abbreviations are to be used to denote as nearly as possible the same degree of atmospheric obscurity." It is to be hoped that it will be found possible eventually to express this standard in terms of the distance of visibility of a light. The general adoption of the official definition will be a decided advance, however. Every observer should select a fixed object as near as may be to the specified distance of 1,100 yards. Fog is to be logged when this object cannot be seen by daylight.

As to the distinction between mist and haze, the rule of the Office is based on the amount of moisture present, as indicated by the readings of the dry and wet-bulb thermometer; provisionally a relative humidity of 80 per cent. has been adopted, but experience suggests that the rule itself requires modification. Investigations are in progress with a view to effecting an improvement.

The new instruction to which reference has been made includes a code for degrees of fog and mist, in terms of visibility. This code and the visibility code adopted by the International Commission for Weather Telegraphy are incorporated in the following table:—

Fog Letters.	Description.	Specification. Objects not visible in Daylight at a distance of—	Visibility. Code Number.
8 f.	Very dense fog	25 metres *or* 27 yards	..
7 f.	Dense fog -	50 " 55 "	0
6 f.	Thick fog -	100 " 110 "	..
5 f.	Rather thick fog	200 " 220 "	1
4 f.	Fog - - -	500 " 550 "	2
3 f.	Moderate fog -	1,000 " 1,100 "	3
..	..	2,000 " $1\frac{1}{4}$ miles	4
2 m. *or* 2 z.	Mist *or* thick haze.	4,000 " $2\frac{1}{2}$ "	5
..	..	7,000 " $4\frac{1}{2}$ "	6
1 m. *or* 1 z.	Slight mist *or* haze.	12,000 " $7\frac{1}{2}$ "	7
..	..	30,000 " $18\frac{1}{2}$ "	8
..	..	Objects visible at above 30,000 m., *or* $18\frac{1}{2}$ miles.	9

The fog and mist code has been used in the Daily Weather Report since March 1st, 1921.

Radiation from the Sky.

OBSERVATIONS on radiation from the sky are now made at Benson, Oxon., on most days. The instrument, which was described in the *Meteorological Magazine*, October, 1920, p. 189, measures primarily the equivalent radiative temperature of the part of the sky to which it is directed, but by using Stefan's formula for the radiation given off by a black body the strength of the radiation can be written down.

The strength of radiation from a definite source of light and heat is naturally measured as so much energy in a given time per unit area, so many watts per square centimetre. The radiation from a limited part of the sky depends on the solid angle which that part of the sky subtends, so that the strength of the radiation is given as so many watts per square centimetre per steradian, the word "steradian" being used in accordance with American practice for the unit of solid angle, *i.e.*, the solid angle subtended at the centre of a sphere of radius R by an area R^2 on its surface.

Very many different units have been used. Mr. Dines finds the gramme calorie per day of 24 hours a convenient measure of power. In the tables showing the results of observations J will be used for the total radiation received by a horizontal surface, the unit being the gramme calorie per day per square centimetre, I will be used for the intensity of radiation received from a part of the sky and interrupted by a surface at right angles to the rays, the unit being the gramme calorie per day per steradian per square centimetre.

Instead of I, we tabulate πI, the advantage being that if I were the same for all parts of the sky, then πI would be equal* to J. The radiation from the earth is denoted by X, the unit being the same as for J.

For comparison with the units in more general use abroad and in official publications in this country we have the relations:—

$$1440 \text{ gm. cal./day cm.}^2 = 1 \text{ gm. cal./min. cm.}^2.$$
$$20 \text{ gm. cal./day cm.}^2 = 1 \text{ milliwatt/cm.}^2.$$

The system of observation provides for separate estimates of the energy of the rays, mostly luminous, which will pass through a glass plate, and of the dark heat-rays which are totally reflected from such a plate.

RADIATION MEASURED AT BENSON, 1921.
Averages for readings between 9 h. and 15 h.

——	—	Jan.	Feb.
Cloudless Days: Atmospheric radiation only (dark heat-rays):—			
Radiation from sky in zenith - -	πI	431	445
Total radiation from sky - -	J	468	472
Total radiation from horizontal black surface on earth.	X	656	690
Net radiation from earth - -	X − J	188	218
Cloudless Days: Diffuse solar radiation (luminous rays):—			
Radiation from sky in zenith - -	πI_0	25	35
Total radiation from sky - -	J_0	41	60
Cloudy Days: Diffuse solar radiation (luminous rays):—			
Radiation from sky in zenith - -	πI_1	64	64
Total radiation from sky - - -	J_1	71	70

The Observatory at Apia, Samoa.

THE observatory at Apia, Samoa, is the most important meteorological station in the Pacific; in fact, it is the only first-class station among the Pacific Islands. Its establishment in 1902 by the Königlichen Gessellschaft der

* For $J = \int I \cos Z \, d\omega = 2\pi \int_0^{\pi/2} I \sin Z \cos Z \, dZ$, where $d\omega$ is the element of solid angle and Z is the zenith distance.

Wissenschaften of Göttingen was due to the initiative of Weichert, the famous seismologist. The original intention was to make observations, meteorological, magnetic and seismological, for the year of the German South Polar Expedition, but the Government, which had from the first supported the enterprise, in 1904 renewed the grant for a period of five years. This grant was presumably again renewed in 1909.

The observations have been carried on continuously since the founding of the station, and were not appreciably interfered with by the recent hostilities. It is therefore satisfactory to learn that the observatory is now under the control of the External Affairs Department of New Zealand, so that this valuable series of observations is assured of continuity.

Thunderstorm at Edmonton on April 19th.

A VIOLENT thunderstorm which visited Edmonton between 6 and 7 p.m. on April 19th provides features of interest. We learn from the "Tottenham and Edmonton Herald" that lightning struck a poplar tree 40 feet high, not only splitting, but uprooting it, leaving a hole 4 feet wide. Apparently the adjacent house itself was struck almost simultaneously by a second flash, which ran from a chimney stack along a gutter and water pipe. Practically every window was blown out and several ceilings collapsed, besides other damage. Windows in the neighbourhood were broken over an area a hundred yards in diameter. Two people were burnt on the head and neck. One of these was a boy who was deaf; he and another lad, also deaf, partially recovered their hearing as the result of the shock. The storm was accompanied by snow as well as rain.

The general meteorological conditions were as follows:—An anticyclone centred over the British Isles on the 12th was replaced by a very extensive cold northerly current of air, which was maintained until the 20th. The temperature in the free air was very low at this time: 0° F. at 8,000 feet at Baldonnel and at 9,000 feet at Shoeburyness on the 15th, 0° F. at 10,000 feet at Baldonnel on the 16th and 18th. Thunderstorms occurred locally on the 17th, 18th and 19th; that at Edmonton was one of the last to occur because the supply of polar air was cut off about that time and the temperature aloft began to increase.

The extensive damage to windows is an unusual feature of a thunderstorm. It does not seem possible for such damage to be caused by the sound waves of ordinary thunder or by induced electric currents. Perhaps something akin to an explosion of ball lightning occurred.

Reviews.

El Clima de Punta Arenas a través de 31 años de Observaciones. Por José Re, S.S. 1920, pp. 122, charts.

THE Observatory "Monseñor José Fagnano," so called after its founder and first director, was established on the shores of the Magellan Straits in July, 1887, by the Salesian Mission, the head of which was the Rev. Don Bosco, a keen meteorologist, who initiated several stations in South America. The erection of an observatory at this point was first mooted at the International Committee for Polar Meteorology in 1880, but at that time the difficulties were too great. From 1888 regular observations were taken three times daily, and a first-class equipment of autographic instruments was speedily acquired, which has been kept up to date, though of late years with increasing difficulty.

Earlier summaries of the observations have been published by a former director, the Rev. P. Marabini; the present book reviews the whole set of data from the beginning of 1888 to the end of 1918, in fifty-four tables, dealing with temperature, pressure, rainfall, humidity, cloudiness, wind, sunshine (1916 to 1918), and evaporation. The data are given year by year, with averages for the whole period, and are illustrated by graphs, which in the case of temperature and pressure include daily means for ten years. Unfortunately no information is given as to the "phenomena"—days of rain, etc., and even important data like snow and fog are omitted. Several slips also appear in the arithmetical work, while the printing of minus signs is very slipshod, and anyone making extensive use of the normal values would be well advised to verify them wherever possible. Still more serious is it that the observations themselves are not always above suspicion; for example, the absolute minima for the seven months November to May are all shown as occurring in the season 1889 to 1890, but this is evidently due to a defect in the minimum thermometer, for during this period the mean daily minimum drops several degrees relatively to the temperature at 7 h. Further, the contemporaneous observations at Staten Island to the eastward show no such cold spell.

Faults like these are greatly to be regretted, for in their absence the amount of detail would make the book of great value to students of climatic variation, one or two interesting points being brought to light even in a casual examination. The spring rise of temperature shows a decided check between late October and mid November—a phenomenon resembling our May frosts on the opposite of the globe. It is also interesting to note that although there is no evidence of the secular variation of temperature, there is a decided fall in both the daily and the monthly range after the year 1897. Several other interesting climatic features are pointed out in the accompanying text, particularly the unexpectedly high rates of evaporation, considering the general climate of the locality.

In 1911 another meteorological station was established at Punta Arenas by the Chilian Meteorological and Geophysical Institute, which must not be confused with the Salesian Observatory. It is interesting to note that in spite of their close proximity the temperature and rainfall at these two stations show considerable differences. C. E. B.

Meteorology, an Introductory Treatise. By A. E. M. Geddes. Pp. xx + 390, pl. 20, figs. 103. Blackie, 1921. 21s. net.

THIS is an elementary general textbook of meteorology, and one of the best of its kind yet published. The historical side is treated somewhat shortly, and the author devotes far the greatest part of his attention to modern methods and results. A brief but useful statement of propositions in the theory of correlation is given. The composition of the atmosphere at different heights and the distribution of dust particles are described in Chapter II.; Chapter III. deals with radiation, and Chapter IV. with temperature. Modern instruments are freely described, and a few pages on the temperature of the sea are included. Chapter V. concerns the theory of winds, especially the general circulation, land and sea breezes, and mountain winds. Chapter VI., on the water vapour of the atmosphere, occupies 53 pages, and treats the subject very thoroughly. The inclusion of some fine cloud photographs by G. A. Clarke adds further to the value of this chapter. Sunshine recorders are described, and an account is given of Taylor's fog results. Chapter VII. deals with the minor circulations of the atmosphere, including temperate and tropical cyclones, tornadoes, waterspouts, and line squalls. Chapter VIII. is devoted to the free atmosphere; it includes the results of W. H. Dines and others on the temperature and height of the stratosphere and the correlation between pressure and temperature at different heights. Atmospheric electricity, optics, and acoustics are described in succeeding chapters, and the last deals with weather forecasting and climate.

The profuse illustrations of high quality, including some coloured plates, form an important feature of the book. Ample references are given to literature quoted, and the index is good. H. J.

News in Brief.

Sir Napier Shaw will give the "Rede" Lecture at Cambridge on June 9th, on the subject of "The Air and its Ways."

On April 23rd, Mr. G. I. Taylor delivered the Wilbur Wright Memorial Lecture before the Aeronautical Society at the rooms of the Royal Society of Arts. The subject of the lecture was "Scientific Methods in Aeronautics."

On May 6th a Geophysical Discussion was held at the Royal Astronomical Society's Rooms, Burlington House, Dr. G. C. Simpson in the chair. The discussion, which was on "The Structure of the Atmosphere up to Twenty Kilometres," was opened by Sir Napier Shaw and continued by Col. E. Gold and Mr. W. H. Dines.

Messrs. Gauthier-Villars et Cie. announce the publication of the *Atlas Meteorologique de Paris*, by M. Joseph Lévine. The volume, the price of which is 20 francs, contains nine plates showing the variation of the meteorological elements from the year 1700, as well as thirty numerical tables and a *résumé* of the climate of Paris.

News is received that the observatory at Chatham Islands was destroyed by fire in 1915, and that the observer unfortunately perished at the same time.

An evaporation tank is now in use at Valencia Observatory, Cahirciveen. It is made of concrete instead of iron, as is more usual, and is believed to be the only evaporation tank in use in Ireland.

The Weather of April.

The pressure distribution over north-west Europe underwent some very marked fluctuations during April, and the weather and temperature were in consequence very changeable. Between the 15th and the 20th very cold weather was general, and snow fell in many places in the British Isles and on the Continent. Night frosts were of frequent occurrence during the month, and reports in the Press showed that damage was done in many parts of England.

At the beginning of the month a belt of high pressure extending from the Azores to Central Europe maintained fair warm weather over the greater part of the British Isles. Temperature reached 69° F. in the screen at Aberdeen on the 1st, the highest figure yet recorded at that station in

THAMES VALLEY RAINFALL —— APRIL, 1921.

Meteorological Magazine.

Watershed of River Thames above Teddington and River Lee above Feildes Weir

Isohyets

ALTITUDE SCALE

Below 250 feet	250 to 500 feet	500 to 1000 feet	Above 1000 feet

SCALE OF MILES 0 5 10 15 20

H.M. Stationery Office Press, Kingsway, W.C.2.

Ps. 3331/342. Wt. 26. D.P. 15. 1250. 5/21.

the first week in April. After the 3rd, depressions moving eastward along the Arctic circle caused cooler and less settled weather, especially in the north. Between the 6th and the 8th an anticyclone moved north-eastward over the British Isles to Scandinavia, and on the 7th and 8th the weather was cloudless over practically the whole of the British Isles, but there was a cold north-east wind and frost at night locally. A depression which was centred off the south-west coast of Italy on the morning of the 8th moved westward to the north-west of Spain by the 11th. A small secondary to this depression also moved west, and caused rain at a few German stations on the 8th and showery weather over England on the 9th. There were hail showers in many places, snow on the high ground in Derbyshire, and a thunderstorm at Sheffield, during which two horses were killed by lightning. In the rear of the secondary, fine weather appeared over Poland on the 8th and spread westward, extending from east to west over England during the 10th. At South Farnborough a maximum temperature of 68° F. was recorded on that day. The weather remained fair over the British Isles till the 13th, with warm days inland, but in France there were a few local thunderstorms, and some heavy rain in the extreme south.

At about this time there was a very complete change in the conditions over north-west Europe. The Scandinavian anticyclone broke up after the 10th, part of it moving away to south-east and the remainder passing in a south-westerly direction over the British Isles. A depression from the west reached the North Cape and became much deeper, and by the morning of the 13th there was a powerful northerly current between this depression and an anticyclone over Greenland, which soon spread over the whole of western Europe and caused a spell of very cold weather. At Kew Observatory the maximum temperature was 69° F. on the 13th, 50° F. on the 14th, and 41° F. on the 15th. There was also a large fall in the temperature of the upper air, amounting to 27° F. at 13,000 feet at Baldonnel (near Dublin) between the mornings of the 13th and 14th, with a further fall of 6° F. by the 15th, the figure being then −15° F. The incursion of the cold air caused a rain-line to advance over the British Isles during the 13th and the ensuing night, but the fall was nowhere very large. At 7 a.m. (G.M.T.) on the morning of the 14th there was a practically continuous line of rain from the Scilly Islands to Memel, on the Baltic, which continued to move south-eastward. A secondary depression, which developed near the Faröe Islands on the afternoon of the 13th, moved south-east to Denmark and became much deeper, intensifying the northerly current over the British Isles and causing a gale on our eastern coasts and in the Irish Sea. Snow and hail showers fell very generally over the British Isles from the 14th to the 16th, but the amounts were not large. Frosts were experienced at night over a very large area; on the night of the 15th the screened thermometer fell to 18° F. at Eskdalemuir and to 21° F. at Benson, while at Howden a grass minimum of 13° F. was recorded. Maxima below 40° F. were observed at some northern stations. The Danish depression moved away north-north-east and filled up, but a new depression from Iceland moved in a south-easterly direction over the British Isles to France on the 17th, causing a fall of snow in many places, including London and Paris. Except on high ground the snow melted as it fell. The centre of the depression moved across south-east England during the afternoon, with dull weather and rain or snow in a cold south wind to the east of the centre, and variable skies with hail showers and local thunder in the warm north-west wind to the west. At 13 h. the temperature was 39° F. at Kew, but 48° F. at South Farnborough. The rainfall during the passage of the depression was general over the British Isles, but did not amount to an inch at any of the telegraphic reporting stations. The heaviest rainfall during the cold period was in eastern France, Belfort receiving a total of 77 mm. (3·1 inches) of rain and melted snow from the 14th to the 17th (inclusive).

In the rear of the depression of the 17th pressure rose decidedly over the British Isles, but the upper air temperature remained very low for a time, and thunderstorms were experienced locally over the British Isles on the 18th, and in eastern England on the 19th. On the evening of the 19th there was a sharp thunderstorm in North London, damage being done by lightning at Edmonton. There was further snowfall in parts of Scotland in the early hours of the 18th, and sharp night frosts were again experienced generally. Meanwhile cold disturbed weather continued further east. A depression moved up from the Adriatic to east Poland on the 17th and 18th, and then turned north-north-west and became very deep, being centred near Stockholm on the morning of the 19th. Severe gales occurred over Sweden, but the depression afterwards filled up quickly.

After the 20th conditions became rather milder over the British Isles, being influenced by two depressions which moved north-east over Iceland. The first of these depressions affected Spitzbergen and caused unusually heavy precipitation, apparently mainly in the form of rain. The measurement was 60 mm. (2·4 inches) on the 22nd and 36 mm. (1·3 inches) on the 20th; the total from the 19th to the 24th being

132 mm. (5·2 inches). A "V"-shaped secondary caused rain in Ireland on the night of the 20th, and then filled up, but another one followed it and caused rain over the whole of the British Isles, and local thunderstorms in Southern England, on the afternoon of the 23rd.

Another rapid change then took place in the pressure distribution. The depression which lay between Iceland and Greenland on the 23rd filled up rapidly, and an anticyclone spread up from the south-west and joined another anticyclone which had formed over Northern Scandinavia, forming a long ridge of high pressure. The "V-shaped" secondary which crossed the British Isles on the 23rd dispersed quickly, its southern extremity being absorbed by another disturbance which moved westward from Poland, secondary to a deeper depression which had formed over the Mediterranean. The secondary depression which moved west caused heavy rain on the Continent on the 23rd (Hamburg, 50mm., Belfort, 95 mm.), and small amounts in eastern England on the night of the 24th. For the rest of the month the pressure distribution was dominated by a large anticyclone over Scandinavia, which moved slowly westward, being centred near the Faröe on the 30th. There was a general easterly to north-easterly current over western Europe, with mainly fair weather. In the British Isles there was much cloud till 27th, but it then became fair. Local thunderstorms were experienced at a few western and midland stations on the 27th and 28th, and on the south coast on the 30th. Temperature reached 70° F. at several stations in southern England and on the Continent, and exceeded 80° F. in southern France.

Visibility over the British Isles was mainly good during the month, but there was local morning fog on the opening days and on the 26th and 27th. There was also some local sea-fog in the last week, especially on the east coast. Clouds were very low all day in south-east England on the 17th and 24th.

In the Mediterranean area the weather was mainly of an unsettled cyclonic type. There were some heavy falls of rain, including one of 42 mm. at Gibraltar on the 10th, of 37 mm. at Rome on the 16th, and of 38 mm. at Malta on the 22nd. A fall of 115 mm. (4·6 inches) at Gibraltar on March 31st, which was overlooked in last month's article, is worthy of mention. C. K. M. D.

Rainfall of the British Isles: April, 1921.

The rainfall appears to have been deficient in all parts of the country except a portion of East Anglia. The deficiency was greatest in the south-west of England and Wales, the south of Ireland, and south and centre of Scotland, in all of which districts less than half the average fell. A narrow

(*Continued on* p. 112.)

Rainfall Table for April 1921.

STATION.	COUNTY.	Aver. 1881–1915. in.	1921. in.	1921. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days
Camden Square	*London*	1·54	1·29	33	84	·34	17	10
Tenterden (Ashenden)	*Kent*	1·62	1·48	38	91	·48	17	9
Arundel (Patching Farm)	*Sussex*	1·75	·91	23	52	·35	16	9
Fordingbridge (Oaklands)	*Hampshire*	1·83	1·23	31	67	·44	16	12
Oxford (Magdalen College)	*Oxfordshire*	1·54	·91	23	59	·28	13	12
Wellingborough (Swanspool)	*Northampton*	1·49	·90	23	60	·25	13	11
Hawkedon Rectory	*Suffolk*	1·54	1·76	45	114	·50	13	13
Norwich (Eaton)	*Norfolk*	1·71	1·71	43	100	·55	13	11
Launceston (Polapit Tamar)	*Devon*	2·34	·74	19	32	·18	17	8
Sidmouth (Sidmount)	,,	2·13	·88	22	41	·28	16	8
Ross (Chasedale Observatory)	*Herefordshire*	1·89	·63	16	33	..	..	..
Church Stretton (Wolstaston)	*Shropshire*	2·16	1·33	34	62	·46	14	11
Boston (Black Sluice)	*Lincoln*	1·35	1·03	26	76	·30	13	12
Worksop (Hodsock Priory)	*Nottingham*	1·47	1·05	27	71	·22	*13	12
Mickleover Manor	*Derbyshire*	1·73	1·17	30	68	·26	13	12
Southport (Hesketh Park)	*Lancashire*	1·85	1·40	35	76	·57	13	10
Harrogate (Harlow Moor Ob.)	*York, W. R.*	1·84	1·26	32	68	·27	9	13
Hull (Pearson Park)	,, *E. R.*	1·56	1·02	26	65	·38	13	13
Newcastle (Town Moor)	*North'land*	1·64	1·35	34	82	·32	†18	11
Borrowdale (Seathwaite)	*Cumberland*	7·42	2·40	61	32	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	2·53	·84	21	33	·28	16	10
Haverfordwest (Gram. Sch.)	*Pembroke*	2·62	1·02	26	39	·44	22	10
Aberystwyth (Gogerddan)	*Cardigan*	2·61	1·82	46	70	·62	13	8
Llandudno	*Carnarvon*	1·81	1·15	29	64	·61	13	11
Dumfries (Cargen)	*Kirkcudbrt.*	2·67	1·26	32	47	·46	16	11
Marchmont House	*Berwick*	2·02	·68	17	34	·11	‡16	10
Girvan (Pinmore)	*Ayr*	2·97	1·78	45	60	·56	22	10
Glasgow (Queen's Park)	*Renfrew*	1·97	·58	15	29	·20	16	6
Islay (Eallabus)	*Argyll*	2·87	2·40	61	84	·59	22	13
Mull (Quinish)	,,	3·30	3·18	81	96	·86	16	17
Loch Dhu	*Perth*	4·74	2·20	56	46	·75	16	9*
Dundee (Eastern Necropolis)	*Forfar*	1·70	1·04	26	61	·62	17	7
Braemar (Bank)	*Aberdeen*	2·31	·83	21	36	·15	14	8
Aberdeen (Cranford)	,,	2·05	1·73	44	84	·73	17	11
Gordon Castle	*Moray*	1·75	·68	17	39	·18	13	10
Fort William (Atholl Bank)	*Inverness*	4·43	2·27	58	51	·42	§12	13
Alness (Ardross Castle)	*Ross*	2·42	1·53	39	63	·42	14	10
Loch Torridon (Bendamph)	,,	5·22	3·92	100	75	·77	14	16
Stornoway	,,	3·03	2·50	63	83	·36	12	14
Wick	*Caithness*	1·99	1·03	26	52	..	..	..
Glanmire (Lota Lodge)	*Cork*	2·80	·71	18	25	·32	16	10
Killarney (District Asylum)	*Kerry*	3·31	·93	24	28	·32	16	12
Waterford (Brook Lodge)	*Waterford*	2·54	·57	15	22	·22	16	6
Nenagh (Castle Lough)	*Tipperary*	2·51	1·11	28	44	·40	16	15
Ennistymon House	*Clare*	2·75	1·21	31	44	·35	16	14
Gorey (Courtown House)	*Wexford*	2·19	·56	14	26	·28	16	5
Abbey Leix (Blandsfort)	*Queen's Co.*	2·61	·75	19	29	·22	22	11
Dublin (FitzWilliam Square)	*Dublin*	1·90	·80	20	42	·23	17	11
Mullingar (Belvedere)	*Westmeath*	2·37	1·06	27	45	·30	22	8
Woodlawn	*Galway*	2·45	1·19	30	49	·28	20	11
Crossmolina (Enniscoe)	*Mayo*	3·14	2·48	63	79	·42	16	13
Collooney (Markree Obsy.)	*Sligo*	2·64	1·77	45	67	·39	16	13
Seaforde	*Down*	2·62	1·47	37	56	·36	13	10
Ballymena (Harryville)	*Antrim*	2·64	1·47	37	56	·33	14	12
Omagh (Edenfel)	*Tyrone*	2·63	1·72	44	65	·27	22	15

* Also 16. † Also 24. ‡ Also 18 § Also 22.

Supplementary Rainfall, April 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	1·03	26
"	Sevenoaks, Speldhurst	1·43	36
"	Hailsham Vicarage	1·38	35
"	Totland Bay, Aston	·83	21
"	Ashley, Old Manor Ho.	1·37	35
"	Grayshott	·96	24
"	Ufton Nervet	·99	25
III.	Harrow Weald, Hill Ho.	1·05	27
"	Pitsford, Sedgebrook	1·22	31
"	Chatteris, The Priory	1·06	27
IV.	Elsenham, Gaunts End	1·77	45
"	Lexden, Hill House	1·45	37
"	Aylsham, Rippon Hall	1·56	40
"	Swaffham	1·57	40
V.	Devizes, Highclere	·68	17
"	Weymouth	·89	23
"	Ashburton, Druid Ho.	·82	21
"	Cullompton	·67	17
"	Hartland Abbey	·96	24
"	St. Austell, Trevarna	1·08	27
"	North Cadbury Rec.	·88	22
"	Cutcombe, Wheddon Cr.	1·32	33
VI.	Clifton, Stoke Bishop.	·82	21
"	Ledbury, Underdown.	·87	22
"	Shifnal, Hatton Grange	1·65	42
"	Ashbourne, Mayfield	1·58	40
"	Barnt Green, Upwood	·94	24
"	Blockley, Upton Wold	1·13	29
VII.	Grantham, Saltersford	1·03	26
"	Louth, Westgate	1·33	34
"	Mansfield, West Bank	·98	25
VIII.	Nantwich, Dorfold Hall	1·14	29
"	Bolton, Queen's Park.	2·41	61
"	Lancaster, Strathspey.	1·58	40
IX.	Wath-upon-Dearne	·83	21
"	Bradford, Lister Park.	1·29	33
"	West Witton	1·01	26
"	Scarborough, Scalby	1·63	41
"	Middlesbro', Albert Pk.	1·00	25
"	Mickleton	·90	23
X.	Bellingham	·74	19
"	Ilderton, Lilburn	·64	16
"	Orton	1·08	27
XI.	Llanfrechfa Grange	·85	22
"	Treherbert, Tyn-y-waun	1·87	47
"	Carmarthen, The Friary	1·74	44
"	Fishg'rd, Goodwick Stn.	·90	23
"	Lampeter, Falcondale	1·60	41
"	Cray Station	2·50	63
"	B'ham W.W., Tyrmyndd	1·90	48
"	Lake Vyrnwy	2·51	64
"	Llangynhafal, P. Drâw	1·63	41
"	Oakley Quarries	3·44	87
"	Dolgelly, Bryntirion	2·15	55
"	Snowdon, L. Llydaw.	..	..
"	Lligwy	1·84	47
XII.	Stoneykirk, Ardwell Ho.	1·12	28
"	Carsphairn, Shiel	2·81	71
XII.	Langholm, Drove Rd.	1·72	44
XIII.	Selkirk, Hangingshaw	·96	24
"	North Berwick Res.	·72	18
"	Edinburgh, Royal Ob.	·61	15
XIV.	Biggar	·96	24
"	Leadhills	1·99	51
"	Maybole, Knockdon	2·10	53
XV.	Dougarie Lodge	1·41	36
"	Inveraray Castle	3·21	81
"	Holy Loch, Ardnadam	2·57	65
XVI.	Loch Venachar	1·65	42
"	Glenquey Reservoir	2·20	56
"	Loch Rannoch, Dall	·68	17
"	Trinafour	1·19	30
"	Coupar Angus	·92	23
"	Montrose Asylum	1·11	28
XVII.	LogieColdstone, Loanh'd	1·26	32
"	Fyvie Castle	1·61	41
"	Grantown-on-Spey	1·32	33
XVIII.	Cluny Castle	1·59	40
"	Loch Quoich, Loan	6·80	173
"	Drumnadrochit	2·95	75
"	Glenelg Manse	1·92	49
"	Skye, Dunvegan	3·32	84
"	Glencarron Lodge	3·14	80
"	Dunrobin Castle	..	..
XIX.	Tongue Manse	1·39	35
"	Melvich Schoolhouse	1·04	26
"	Loch More, Achfary	4·94	125
XX.	Dunmanway Rectory	1·16	30
"	Mitchelstown Castle	1·00	25
"	Gearahameen	2·70	69
"	Darrynane Abbey	1·48	38
"	Clonmel, Bruce Villa	·56	14
"	Cashel, Ballinamona	·68	17
"	Roscrea, Timoney Pk.	·86	22
"	Foynes	·90	23
"	Broadford, Hurdlesto'n	1·21	31
XXI.	Kilkenny Castle	·61	16
"	Rathnew, Clonmannon	·47	12
"	Hacketstown Rectory	·92	23
"	Balbriggan, Ardgillan	·78	20
"	Drogheda	·54	14
"	Athlone, Twyford	1·16	30
XXII.	Castle Forbes Gdns.	1·12	28
"	Ballynahinch Castle	2·02	51
"	Galway Grammar Sch.	1·35	34
XXIII.	Westport House	1·66	42
"	Enniskillen, Portora	1·03	26
"	Armagh Observatory	·90	23
"	Warrenpoint	·95	24
"	Belfast, Cave Hill Rd.	1·50	38
"	Glenarm Castle	1·71	43
"	Londonderry, Creggan.	1·98	50
"	Sion Mills	1·54	39
"	Milford, The Manse	1·94	49
"	Narin, Kiltoorish	1·55	39
"	Killybegs, Rockmount	2·21	56

Climatological Table for the

STATIONS	PRESSURE: Mean of Day M.S.L. mb.	PRESSURE: Diff. from Normal mb.	TEMPERATURE Absolute: Max. °F.	Date	Min. °F.	Date	Mean Values: Max. °F.	Min. °F.	½ max. and min. °F.	Diff. from Normal °F.
London, Kew Observatory	1019·4	+5·2	58	15	24	23	49·6	36·9	43·3	−0·7
Gibraltar	1018·5	+2·0	69	4	47	30	64·6	55·0	59·8	+0·1
Malta	1016·4	+0·7	74	3	51	21	62·7	58·6	60·7	−2·3
Sierra Leone	1012·8	+1·7	91	2, 19	69	3, 9	88·1	72·1	80·1	−1·1
Lagos, Nigeria	1013·3	+2·5	89	11	70	22	86·6	74·9	80·7	−0·6
Kaduna, Nigeria	1013·3	+3·1	91	4, 18, 23	54	30	88·7	64·0	76·3	+1·3
Zomba, Nyasaland	1009·8	+0·8	94	27	55	4	85·9	64·5	75·2	+0·1
Salisbury, Rhodesia	1008·5	−1·1	95	25, 26	52	3	87·3	57·7	72·5	+1·6
Cape Town	1015·4	−0·3	87	27	49	29	75·9	57·0	66·5	+3·4
Johannesburg	1012·2	+0·8	85	25	47	1	76·5	54·2	65·3	+1·9
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	94	24	45	27	85·4	56·7	71·1	+2·7
Calcutta, Alipore Obsy.	1011·9	−1·4	88	3	56	28	83·6	65·4	74·5	+1·4
Bombay	1009·8	−2·1	93	26	71	30	89·5	74·6	82·1	+1·8
Madras	1010·1	−1·6	92	9	68	30	84·5	73·9	79·2	+0·5
Colombo, Ceylon	1009·3	−0·8	88	15	71	29	84·8	74·1	79·5	−0·8
Hong Kong	1015·9	−1·7	83	4	61	26	75·0	67·4	71·2	+1·5
Sydney	1015·3	+1·6	98	24	55	7	77·7	61·4	69·5	+2·5
Melbourne	..	..	..	..	..	..	..	..	..	..
Adelaide	1016·0	+0·9	93	15, 26	46	2	77·4	56·0	66·7	−0·2
Perth, Western Australia	1014·3	−1·0	97	23	52	8	81·9	59·8	70·9	+5·2
Coolgardie	1013·5	+0·4	99	17	44	10	85·4	56·9	71·1	+0·3
Brisbane	1015·9	+1·6	90	20	58	1	82·2	65·1	73·7	+0·2
Hobart, Tasmania	1010·5	+1·2	78	14	38	2	64·5	47·9	56·2	−1·0
Wellington, N.Z.	1009·0	−2·6	68	28	39	2	61·0	49·6	55·3	−1·6
Suva, Fiji	1010·9	−0·2	88	8	68	11	82·6	71·6	77·1	−0·1
Kingston, Jamaica	1012·8	+0·1	92	5	69	17	89·1	72·3	80·7	+1·4
Grenada, W.I.	1011·7	+1·1	90	27	73	sev.	83·4	74·6	79·0	−0·3
Toronto	1019·8	+3·0	62	9	20	12, 13	42·0	31·5	36·7	+0·4
Winnipeg	1020·7	+4·0	47	5	0	9	32·9	17·8	25·3	+4·5
St. John, N.B.	1018·3	+4·4	57	3	14	29	39·8	26·9	33·3	−3·4
Victoria, B.C.	1016·3	+0·8	58	18	35	10	50·5	41·6	46·1	+1·7
September.										
Perth, Western Australia	1017·4	−0·4	84	26	43	29	67·8	50·2	59·0	+0·8

London, Kew Observatory.—Mean speed of wind 5·8 mi/hr ; 16 days with fog.
Gibraltar.—2 days with thunder heard, 5 days with gale.
Malta.—Wind direction variable, mean speed 8·8 mi/hr.
Sierra Leone.—Prevailing wind direction SW.
Salisbury, Rhodesia.—Prevailing wind direction NE.
Hong Kong.—Prevailing wind direction ENE. ; mean speed 1·0 mi/hr.

British Empire, November 1920.

Temperature Absolute Max. in Sun ° F.	Temperature Absolute Min. on Grass ° F.	Relative Humidity %	Mean Cloud Am'nt 0–10	Precipitation Amount in.	Precipitation Amount mm.	Precipitation Diff. from Normal mm.	Precipitation Days	Bright Sunshine Hours per day	Bright Sunshine Percentage of possible	STATIONS
93	19	87	6·4	1·32	34	− 22	12	1·6	18	London, Kew Observatory.
120	41	79	5·6	9·90	251	+ 90	14	..	..	Gibraltar.
123	..	82	7	8·62	219	+138	20	3·3	32	Malta.
..	..	73	5·0	2·25	57	− 78	7	..	..	Sierra Leone.
159	63	81	6·5	2·79	71	+ 5	12	..	..	Lagos, Nigeria.
..	..	64	..	0·43	11	+ 10	1	..	..	Kaduna, Nigeria.
..	..	77	4·6	3·10	79	− 63	6	..	..	Zomba, Nyasaland.
153	48	54	2·4	3·04	77	− 22	9	..	..	Salisbury, Rhodesia.
..	..	62	4·9	0·77	20	− 7	9	..	..	Cape Town.
..	43	60	4·2	3·92	100	− 8	15	9·3	70	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
..	..	48	2·8	0·98	25	− 33	6	..	..	Bloemfontein.
..	47	52	1·7	trace	trace	− 14	0	..	..	Calcutta, Alipore Obsy.
139	61	60	1·7	0·00	0	− 10	0	..	..	Bombay.
..	..	88	7·4	30·08	764	+439	18	..	..	Madras.
162	67	76	9·0	14·49	368	+ 61	26	..	..	Colombo, Ceylon.
..	..	73	7·1	7·05	179	+143	8	5·0	46	Hong Kong.
147	48	61	5·7	2·06	52	− 22	8	..	..	Sydney.
..	..	..	..	..	..	..	..	..	..	Melbourne.
152	35	52	5·3	2·29	58	+ 28	8	..	..	Adelaide.
160	42	51	3·6	0·22	6	− 14	5	..	..	Perth, Western Australia.
163	42	35	3·5	0·66	17	0	4	..	..	Coolgardie.
151	52	65	5·1	6·28	160	+ 65	14	..	..	Brisbane.
148	34	62	6·8	1·69	43	− 22	20	..	..	Hobart, Tasmania.
139	29	76	6·4	2·70	69	− 23	15	5·4	37	Wellington, N.Z.
..	..	79	6·7	4·10	104	−138	17	..	..	Suva, Fiji.
..	..	75	5·6	0·37	9	− 71	5	..	..	Kingston, Jamaica.
139	..	81	5·8	11·49	292	+ 84	25	..	..	Grenada, W.I.
..	..	84	7·3	3·80	97	+ 22	16	..	..	Toronto.
..	..	91	5·5	1·50	38	+ 14	6	..	..	Winnipeg.
..	..	78	4·9	3·54	90	− 22	13	..	..	St. John, N.B.
..	..	88	7·5	3·11	79	− 85	16	..	..	Victoria, B.C.

September.

..	36	67	4·2	2·53	64	− 21	12	..	..	Perth, Western Australia.

BOMBAY.—October pressure should read 1009·5, −0·2

Madras.—6 days with thunder heard.

COLOMBO, CEYLON.—Wind direction variable, mean speed 4·1 mi/hr. 7 days with thunder heard.

GRENADA.—Prevailing wind direction E.; 1 day with thunder heard.

TORONTO.—7 days with fog.

WINNIPEG.—6 days with fog.

VICTORIA.—1 day with fog.

strip along the south coast of Ireland received only 25 per cent. of the average. Considerable areas in the Thames Valley and in the east of Great Britain between Yorkshire and Perthshire, as well as in the south-east of Ireland, had a total rainfall of less than 25 mm. (1 inch). Only restricted areas in England, Wales, and Ireland had as much as 50 mm. (2 inches). The West Highlands were, however, rather wetter.

The general rainfall, expressed as a percentage of the average, was:—England and Wales, 59; Scotland, 61; Ireland, 46; British Isles, 56.

In London (Camden Square) the month was fine and pleasantly mild, but with a cold snap and snow showers between the 15th and 17th. The mean temperature was 49·5° F., or 1·5° F. above the average. Duration of rainfall, 25·1 hours. Evaporation, 1·91 inches.

Weather Abroad: April, 1921.

The serious drought which had prevailed in France and Switzerland throughout March was broken by welcome rains in Switzerland on April 4th, when the Alps again became snow-covered, and in France on April 14th. Temperature in France, which had been unusually high, fell rapidly, and on the 15th the rain turned to snow and sleet, which lasted for several days. About this time frost did considerable damage to the fruit trees and vines in Holland and Switzerland. On the 19th three waterspouts were seen over the Mediterranean from Mentone. Further east, following a gale in the Mediterranean, heavy rainfall caused a sudden rise of the Tigris, which burst its banks and damaged the railway between Kut-el-Amara and Bagdad. In America the tornado season (April to July) began with a visitation in Southern Arkansas on the night of April 15th–16th, causing the loss of 50 lives, besides hundreds injured and much material damage. The district was at the time in the south-eastern quadrant of a fairly deep depression; this is the most favourable condition for the occurrence of tornados, a warm southerly surface current being overlain by a colder westerly upper current.

A severe eruption of the volcano of Popocatepetl, in Mexico, occurred early in April. This is a recrudescence of the activity which began in the spring of 1920, after 200 years of quietude. In the past the dust associated with volcanic eruptions has been responsible for considerable meteorological effects, especially a diminution in the heat and light from the sun, and brilliant sunset coloration, a noteworthy example being Krakatoa in 1883, and it will be interesting to observe if similar effects follow in this case.

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Sunspots and Weather.

By C. E. P. BROOKS, M.Sc.

THE recent development of an unusually large sunspot with associated electrical and magnetic phenomena on the earth has raised again the perennial question of the relation of sunspots to terrestrial weather. But although the literature of the subject is enormous, we are still far from definite conclusions; what we have realised is its complexity.

When sunspots were first discovered and were attributed to variations of solar activity, the idea of connecting them with changes in the earth's temperature followed naturally, and as long ago as 1651 Riccioli concluded that temperature rose with decreasing sunspots, and *vice versâ*. In 1844 the discovery of an eleven-year periodicity in spots caused a renewal of the study, and in 1873 Köppen published results of a very complete investigation showing that temperature reaches a maximum shortly before spot minimum and a minimum about spot maximum, the range averaging 1·3° F. within the tropics and 1·0° F. in temperate latitudes. It has since been found that at stations where mean daily maximum and minimum temperatures are available the former show a much closer inverse relation to sunspot numbers than the latter, so that, as a rule, in the tropics the mean daily range increases towards spot minimum.

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About the time of Köppen's investigation Lockyer discovered that the sun is radiating most heat at spot maximum; this variation has since been determined as nearly 5 per cent.

Solar variations undoubtedly cause marked fluctuations of terrestrial magnetism and auroral frequency, but there is no evidence that either of these elements is a factor of weather, and, so far as we know, solar influence acts entirely through these comparatively small changes in radiation, and these changes, as we have seen, when averaged over a year are in the opposite direction to the variations of terrestrial temperature.

Blanford (1875) suggested that the paradox was due to increased cloudiness at spot maximum resulting from greater evaporation over the water areas, with consequently greater rainfall, both cloud and rainfall lowering the temperature of the land areas. In conformity with this, various authors have found a positive correlation of sunspots with rainfall in the tropics and also with elements such as lake levels, which depend on rainfall. The most remarkable case is the level of Lake Victoria Nyanza which, for the period 1896 to 1915 gave a coefficient of +·80. Blanford's theory involves an opposition between the variations of temperature over land and water areas, which may or may not be true. In the future a study of the temperature variations in the free air will probably throw much light on this problem.

Poey, in the West Indies, and Meldrum, in the Indian Ocean, have demonstrated a close parallelism between the curves for sunspots and the number of tropical hurricanes, but for the West Indies this parallelism is denied by Fassig. Mean pressure in the tropics is in general lowest at spot maximum, but the relationship is nowhere close.

Outside the tropics the reaction of terrestrial weather to sunspots is mainly indirect, through the medium of areas of high and low pressure. In America Kullmer and Bigelow have found that at spot maximum the storm tracks shift a degree or two southward, and also concentrate on the Atlantic coast, while at the same time the absolute storminess increases; at spot minimum the reverse holds. A study of eleven years' wind data in the Falkland Islands also suggests that at spot maximum the storminess is greatest.

In Europe at spot maximum the storms appear to travel chiefly along the Atlantic coast and, to a less extent, through the Mediterranean, while at spot minimum the interior of the continent is more favoured. But in spite of this the eleven-year period in rainfall, though probably real, is very vague, and in Europe at least it is completely masked by a 5·6-year period. The distribution of the phase angles of this half-sunspot period, as determined from the period 1850 to 1905, is very interesting. Over the whole of northern and western Europe from Finland and Scandinavia through Germany, Great Britain, and France to Italy the maximum rainfall occurs from six to fifteen months after spot maximum and minimum. A similar variation has been found by A. Wallén in the level of the great Swedish lakes, but retarded a few months. This area is separated by a very sharp line from Eastern Europe—Poland, Austria, and Russia (except Petrograd)—in which the phase angle is rotated through about 90 degrees, so that the rainfall maximum occurs a year before spot maximum and minimum. The amplitude of the variation is 10 per cent. on either side of the mean rainfall. This double sunspot variation was explained by Hellmann as due to a combination of two causes—the direct effect of the solar variations on the weather of Europe and the indirect effect due to changes brought about in the circulation at the equator. This hypothesis still requires verification.

The eleven-year period is much complicated by the fact that terrestrial weather also shows relationships with the occurrence of solar prominences, which have a periodicity of $3\frac{3}{4}$ years. This relationship is especially marked in the case of pressure, and has recently been used by C. Braak with some success in seasonal forecasting for Java. On the whole this short period dominates the eleven-year period in terrestrial weather, perhaps because it is reinforced by purely terrestrial cycles of about the same length. There is also a two-year periodicity which still further complicates matters.

An attempt in a different direction was that of G. T. Walker, who made direct correlations of sunspots with pressure, temperature and rainfall. The coefficients obtained, though fairly definite in some districts, were nowhere high; this is partly owing to the lag in terrestrial effects following the maxima or minima of sunspots. The present writer avoided this by taking advantage of the fact that after smoothing over eleven years the sunspot numbers show a steady decline from 1870 to 1913; he accordingly calculated the "secular variation" of pressure, temperature and rainfall over this period. These two investigations gave similar results, tending to show that numerous sunspots cause an increase in the intensity of the atmospheric circulation, with a deepening of the lows, *i.e.*, greater storminess, and an intensification of the highs. It also appeared that at times of many sunspots the "abnormality" or departure from the mean is greatest, so that numerous sunspots may give drought or flood, great heat or great cold, while a year of few spots will be a normal year.

All these investigations refer to variations in the average spotted area of the sun during a year. The sudden appearance for a short time of a large and vigorous spot may appreciably affect the sun's radiation while it is visible without making much difference to the annual average. The influence of such short variations in solar radiation has been investigated recently by H. H. Clayton, of the Argentine Weather Service. Clayton's results are very complex, and only the briefest summary can be attempted here.

He finds that in summer at Buenos Aires an excess of solar radiation is followed after a day or two by high temperatures; in winter the effects are irregular, but on the whole reversed. In conformity with the results of other investigations the greatest effect on weather is found to be due to spots near the limb of the sun. Finally, this article may close with the following quotation, very *apropos* for the present phenomenon, which appears to contain a good deal of truth :—

> "(1) If there were no variation in solar radiation the atmospheric motions would establish a stable system with exchanges of air between equator and pole and between ocean and land in which the only variations would be daily and annual changes set in operation by the relative motions of the earth and sun; (2) the existing abnormal changes which we call weather have their origin chiefly, if not entirely, in the variation of solar radiation."

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OFFICIAL NOTICES.

Issue of Meteorological Reports by Wireless Telegraphy.

ARRANGEMENTS have been made for the issue of the observations made at 1 h. G.M.T. at stations in the British Isles in a collective message from the Air Ministry at 6 h. G.M.T. It is hoped that these messages will prove of considerable value to those stations where wireless watch is not maintained during the night, because it will enable them to construct a chart for 1 h. two hours before the chart for 7 h. is available. In the summer months this is of special importance. The report is issued in the same code as that for other collective messages (*see Meteorological Magazine*, February 1921, p. 5).

From the same date (June 1st) reports from ships in the Atlantic, when they are received, have been included at the end of the collective messages issued from the Air Ministry. These reports (in figure code) are preceded by the word "Ships." The figure groups give the position of the ship, barometer, wind, temperature, visibility, cloud and weather. The details of the code will be supplied on application to *The Director, Meteorological Office, Air Ministry, Kingsway, W.C.* 2.

A further improvement, also introduced from June 1st, is the inclusion of 10 h. observations at Valencia Observatory, Renfrew and Plymouth in the route report issued at 10 h. 35 m. G.M.T.

The first and last of these arrangements are the result of the Anglo-Franco-Belgian conference on questions associated with Aeronautics, held at the Air Ministry in May 1921.

Meteorological Stations.

Holyhead.—The Experimental, Anemometrical and Telegraphic Reporting Station at Holyhead has been taken under the direct control of the Meteorological Office from June 1st, 1921. Hitherto the station has been under the supervision of the Harbour Engineer.

Holyhead has been a telegraphic reporting station since 1861, and anemometer records have been made continuously since 1869. The Stokes "Bridle Anemometer," first used at Holyhead, is now in the Science Museum. An account by Mr. R. H. Curtis of the anemometers at Holyhead, with comparisons of the exposures and records, will be found in the *Quarterly Journal of the Royal Meteorological Society*, Vol. XXII., 1896, p. 235.

In 1813, the telegraphic reporting station was removed from the Sailors' Home and amalgamated with the anemometer station at Salt Island.

The station is now in the charge of Mr. S. T. A. Mirrlees; and Mr. W. Davies, who has been observer for some years, is still to hold that position.

Shaftesbury.—Mr. A. Macdonell, of the Abbey House, Shaftesbury, who has been responsible for this station since 1915, is unable to carry on the observations, owing to change of residence. The work will be taken over by Mr. G. P. Barter, The Old Rectory, Tout Hill, Shaftesbury.

Royal Agricultural Show.

THE Royal Agricultural Show is to be held this year at Derby from June 28th to July 2nd. The Meteorological Office is exhibiting diagrams and instruments illustrative of the relation between weather and agriculture. A climatological station will be in operation, pilot balloons will be sent up, and forecasts will be issued daily.

Official Publications.

Cloud Forms. 1921. Price 1s. 6*d.* net.

"Cloud Forms," first published in 1918, is now issued in a second edition. The original photographs and text have been reproduced, and an appendix has been added to include a set of Captain Douglas's pictures of clouds photographed from above. Space has also been found for an additional photograph by Mr. G. A. Clarke showing a ripple-marked squall cloud.

British Meteorological and Magnetic Year Book. Part III (1). *Daily Readings at Meteorological Stations of the First and Second Orders*, 1920.

THIS volume is issued in continuation of the annual series of "Meteorological Observations at Stations of the Second Order," which have been published since 1873. It consists of tables of daily observations made at 9 h. and 21 h. at eight selected stations in the British Isles. An annual supplement is included, which gives mean values for each month and for the whole year, of the various elements at eleven stations, together with extreme temperatures and maximum rainfall.

"Geophysical Discussion" in the Rooms of the Royal Astronomical Society.

ON May 6th, at 5 p.m., Sir Napier Shaw opened a discussion on "The Structure of the Atmosphere up to 20 kilometres," Dr. G. C. Simpson being in the chair. Sir Napier commenced by describing the actual distribution of temperature in the atmosphere, pointing out that the coldest regions of the whole atmosphere are in the stratosphere above the equator, and that the isothermal surfaces in the stratosphere are approximately vertical. The most interesting places from which to take observations of the stratosphere would be the poles and the equator; but unfortunately the poles are in regions inhospitable for observers, and at the equator the tropopause, the level at which the temperature ceases to decrease with height, is so high as to be rarely accessible to a balloon.

The distribution and thermodynamics of water vapour formed the chief topic of the paper. If the mixing of the air were complete and there were no evaporation, the vapour pressure everywhere would be controlled by the saturation pressure at the coldest part of the stratosphere. As things are, the curves showing the observed variation of temperature with height march well with the adiabatics for saturated air. This is true for Batavia, the British Isles, and Canada, and for Pavlovsk in summer, but not for McMurdo Sound on the coast of the Antarctic Continent. The ascent of a mass of saturated air stops when the air gets cold enough for its environment; in particular, in winter at McMurdo Sound it cannot rise even from the ground, on account of the temperature inversion there.

If the moist air rose to the tropopause, its water falling as rain as it did so, and were adiabatically compressed as it came down again, it would attain a temperature of 350a on the ground. Hence heat must be lost somewhere on the way. With an entropy-temperature diagram the relations of heat to work can be considered; it can be shown that for equatorial air saturated at about 300a, the troposphere, regarded as a heat engine, must have an efficiency of about 25 per cent., for colder or drier air the efficiency is less.

Slides were shown to indicate the distribution of water vapour over the surface of the earth and the general circulation of the atmosphere at different levels. The latter were regarded as illustrating the flywheel of the atmospheric engine, the kinetic energy of which was estimated.

In the discussion, the Chairman insisted on the need for an explanation of the suddenness of the tropopause. Colonel E. Gold considered that a reasonable explanation of the division of the atmosphere into stratosphere and troposphere had been furnished. If radiation permitted convection would go on throughout the whole atmosphere, but radiation set a limit below which the temperature of the air could not fall and this, in time, fixed a limiting height above which convection could not be effective. Mr. W. H. Dines discussed the correlations between pressure and temperature at the same height, and suggested that their explanation is to be sought on dynamical grounds rather than on pure thermodynamics. The negative correlation between pressure and temperature at a height of 10 km. is particularly difficult to account for by purely thermo-dynamical reasoning. Dr. Jeffreys pointed out that the same term "convection" is used to denote two quite different phenomena, the local and irregular convection caused by the lapse-rate becoming too great for stability, and the regular type arising from differences of temperature between points on the same level. He also pointed out that on theoretical grounds regular vertical motion in the atmosphere must be extremely slow: for a steady motion without friction there would be no vertical motion at all.

Royal Meteorological Society.

THE usual monthly meeting was held on May 18th, 1921, in the Society's rooms, Mr. R. H. Hooker, M.A., President, in the chair.

Mr. J. E. Clark presented the Report on the Phenology of the British Isles, December 1919 to November 1920, drawn up by himself and Mr. H. B. Adames.

Returns from 212 stations, more than double the number of the preceding year and 80 above the previous highest, 1914, make the results exceptionally complete. The early months of 1920 were unusually mild and wet and the spring flowers were out a fortnight before their normal times. The succeeding flowers became less and less early until the two of July were just average.

The charts for the year indicate a delay in flowering of six days for every degree to the north. The report also deals with bird migrations and the time of appearance of insects.

At the same meeting Dr. E. J. Salisbury gave a paper on "Phenology and Habitat with special reference to Woodlands." This paper brought out how far the life-processes of plants depend on sunlight as well as on temperature. The lowlier plants of the woodlands can only obtain a reasonable share of sunshine when the great trees are leafless, and it results that these small plants flower much earlier than similar species growing in the open. Moreover, whilst the average date at which woodland herbs which lose their foliage in winter begin to develop new leaves is February 19th, the shrubs begin a month later and the trees towards the end of April. When the trees are in full leaf the diminished light in the wood may be only one per cent. of that in the open.

Meeting at Edinburgh.

It is proposed to hold an ordinary meeting of the Society in Edinburgh on September 7th. The British Association hold their 1921 meeting in Edinburgh from September 7th to 13th, and the occasion offers an opportunity for the Fellows of the Society on either side of the Border to meet their colleagues. A "Meteorological Luncheon," and an excursion of special meteorological interest, are also under consideration. Fuller particulars will be announced later.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

The Highest Aerial Sounding.

In an article published in the *Monthly Weather Review* for November 1920 Mr. W. R. Gregg discusses the note by Mr. Whipple in a recent number of the *Meteorological Magazine*. Mr. Gregg writes:—

> "The sounding-balloon ascensions made in this country show, in practically all cases, an increasing rate of ascent with increasing altitude. In 20 ascensions at Fort Omaha, Nebr. and Huron, S. Dak., the mean rate increased from 180 metres per minute near the surface to 300 at 15 kilometres. In seven ascensions at Avalon, Calif., the mean rate increased from 185 metres per minute near the surface to 295 at 18 kilometres. Objection may be raised to these records as reliable evidence, since the heights were themselves computed from the pressure records. This is true in the cases cited, but in 1914 several balloons were followed by two theodolites at Fort Omaha, Nebr. A base-line 5,088 metres in length was used.

The results indicated close agreement between altitudes determined from triangulation and those from the barograph. Using only those ascensions in which the balloons were followed by two theodolites, we find that the mean rate of ascent increased from 150 metres per minute near the surface to 240 at 17 kilometres. The increase is fairly constant at all altitudes below 15–18 kilometres, and is practically the same in the individual ascensions. It seems certain, therefore, that the height reached by the Pavia balloon was considerably greater than that computed on the basis of a constant rate of ascent. It seems also quite certain that that height was considerably less than 35 kilometres.

Mr. Whipple inquires what sounding is the highest on record, if the Pavia record is to be deprived of that distinction. So far as known, the next highest observation published is that made at Avalon, Calif., on July 30, 1913. As computed from the barograph trace, an altitude of 32,640 metres was reached. The pressure was 7·4 millimetres. The rate of ascent was about 100 metres per minute near the surface, 275 at 16 kilometres, and 520 at the highest altitude."

Mr. W. R. Gregg has also been so good as to communicate the following additional information for publication in this Magazine:—

"Our best balloons were obtained, before the war, from the Russian-American India-Rubber Co., St. Petersburg. They were of extraordinarily fine quality, better than any others ever tried. In fact, since the war, we have been quite unable to procure any balloons at all suitable. These Russian balloons, unstretched, were of two sizes—4 and 5 feet in diameter, weighing 5 and 9 lbs. respectively. The larger balloons were used singly, the smaller in pairs. In the ascent made at Avalon two small balloons were used; in those at Fort Omaha and Huron one large one was used.

"The extra load to be carried, including the meteorograph and the "free lift," was about 3 lbs.; hence, it was necessary to inflate the two small balloons each to a diameter of 5·6 feet. In order to reach a height where the pressure was 7·4 mm., these balloons would have to stretch to a diameter of 26 feet. In other words, the linear stretch of the rubber was about 550 per cent.

"Replying to your question, I regret to say that no actual tests were made on these balloons in this country. Presumably such tests were made by the manufacturers, however, since in their quotation they guaranteed inflation to 4 or 5 diameters (300 to 400 per cent.) Moreover, pieces of one of the burst balloons were submitted to the U.S. Bureau of Standards two years after the balloons were received, and the tests conducted on these pieces showed that on the average the rubber was capable of stretching 900 per cent. In view of these facts it is reasonable to suppose that the balloons used at Avalon actually reached a height where the pressure was 7·4 mm., as recorded.

"The reason for the increasing rate of ascent is difficult to explain. If there were no diffusion of gas through the rubber, the rate of ascent should vary as the 6th root of the density and would therefore, increase, but, as is well known, there *is* such diffusion. Possibly the difference in temperature of the gas and the outside air has some bearing on the problem. Again, the balloons carry a meteorograph which constitutes a material part of the weight of the system, whose cross-section, however, unlike that of the balloon, remains constant. With decreasing air-density the resistance offered becomes less also. The whole question is in an unsettled state, and is, I think, worthy of some study by anyone having the necessary time to devote to it. "W. R. GREGG.

"*Weather Bureau, Washington, March 19th, 1921.*"

Velocity of Vertical Air Currents.

WITH reference to the point raised by Captain Durward, ascending currents of six miles per hour or more are by no means uncommon, but descending currents of a like magnitude are extremely rare. Strong descending currents seldom exceed two or three miles per hour. In the long series of two-theodolite ascents at Shoeburyness, only a few such cases have been noted. I have noted appreciable downward currents on fine days, with detached cumulus, in the gaps between the cumulus clouds, but usually the balloon passes out of these currents in one minute.

Quite a striking case was the ascent at Shoeburyness on April 15th, 1921, at 10 h. 50 m. G.M.T. The balloon was filled to ascend 500 feet per minute, and the wind was north-westerly, 25–30 feet per second. The state of the sky was given as "Detached cumulus."

Time.	Height in Feet.	Ascending Current.
		Ft./sec.
1	386	−1·9
2	696	−3·3
3	1,027	−2·8
4	1,362	−2·9
5	1,678	−2·9

After the first five minutes no appreciable vertical currents were observed. In this case the descending current of 3 feet per second, or 1 metre per second, extended up to about 1,700 feet.

This is the most striking case shown in many hundreds of two-theodolite ascents. Mr. Clarke's results are therefore of considerable interest in that they show quite unusually strong downward currents. I should be inclined to ascribe them to the topography of the country round Aberdeen, *i.e.*, as hydro-dynamical rather than thermal effects.

D. BRUNT.

April 30th, 1921.

The Dry Weather: A Contrast in Rainfall.

THE rainfall from January 1st to May 31st has been the smallest in my recollection, with the single exception of 1911, when it was exactly the same, viz., 7·57 ins. A comparison with last year's is instructive.

Month.	Average for 15 Years.	1920.	1921.
	Ins.	Ins.	Ins.
January	2·69	4·78	3·34
February	2·50	1·01	0·17
March	3·44	4·50	2·36
April	2·35	5·81	0·56
May	2·51	2·72	1·14
Total	13·49	18·82	7·57
Difference from Average	..	+5·33	−5·92

The drought this year has therefore been more pronounced than was the excessive rainfall last year, though it has never been "absolute." The first twenty-three days of February were only broken by two falls of ·01 inch each, and no rain fell after May 14th till the evening of the 29th. A remarkable feature has been that the normally drier Midlands and east (including London) had a heavier fall, at any rate in April and May, than this western district, which has almost entirely escaped the Icelandic depressions moving from north-west to south-east across the country, especially in April. These have given rain to a lower latitude in the east than in the west. We also entirely escaped the depression which spread from France on May 26th across the Midlands and eastern counties. The air throughout May was remarkably dry and harsh. The grass on my lawn was getting brown and burnt in the last week of the month, and a very light hay crop seems now inevitable.

R. P. DANSEY.

Kentchurch Rectory, Hereford, June 2nd, 1921.

Units for Meteorological Work.

HAVING been interested in the recent correspondence in your Magazine regarding Meteorological Units, I venture to add a few words in agreement with Messrs. Hurnard and Cross.

While the new units are doubtless of some use for international comparisons, etc., their advantages seem to be over-balanced by their drawbacks. It appears very desirable that meteorology should be made interesting to the general public, but this will hardly be done when units are used which convey absolutely nothing to them While any educated person will grasp the meaning of the older scales, comparatively few will comprehend the new ones, and consequently tables containing these will probably be thrown aside and thought no more of.

If it is wished to confine meteorology to a few experts, by all means use the new units, but if it is desired to popularise it, surely our old methods of measurement are simpler and better for the purpose. E. W. M. MURPHY.

Ballinamona, Cashel, Co. Tipperary, May 28th, 1921.

I TOO should like to protest against the introduction of the millimetre, in preference for the inch, in British rainfall observation.

My thoughts on the subject are so well expressed by Mr. Samuel F. Hurnard in the May number of the Magazine that all I need add is that I endorse what he says there most heartily. BASIL T. ROWSWELL.

Les Blanches, St. Martin's, Guernsey, June 4th, 1921.

RECENT forms for recording rainfall require the noting not only of the number of falls of ·01 inch and upwards, but also of the number of those of ·04 inch and upwards. If this is intended with a view to comparison with millimetre records, surely the limit should be ·02 instead of ·04 inch. Anything between ·005 inch and ·015 inch is reckoned as ·01, so I presume that anything between ·02 and ·06 inch would be reckoned one millimetre in a metric record.

F. J. WARDALE.

Shrewton, Wilts, May 31st, 1921.

[Mr. Wardale's point would have great force were records of rainfall made in millimetres read only to the nearest whole millimetre. The actual readings are, however, made in tenths, and the precise minimum amount actually counting for a "wet day" is therefore 0·95 mm., equivalent to ·037 inch. On the inch scale the minimum in practice is ·035 inch.—ED. M.M.]

Early Morning Convective Instability.

THE occurrence of violent atmospheric instability in the early morning is rare, and the following instance is interesting.

At 6 h. on May 1st, 1921, the cloud forms observed at Lenton Fields, Nottingham, suggested considerable instability. Small cumulus clouds were forming all over the sky, with protuberances, in some cases long slender columns, projecting from the upper surfaces. In the south-west there were sheets of stratus, which cumulus clouds with curiously ragged and uneven bases penetrated.

In the north and north-east there was some castellated alto-cumulus as well as detached masses of false cirrus, whilst what appeared to be a vast cumulo-nimbus with a fan of false cirrus at the top threatened imminent thunder. This cumulo-nimbus gradually moved from the north-east till it nearly covered the sky, but by 9 h. it had considerably subsided and by 10 h. only a few stratus sheets remained, and by 12 h. 30 m. these had completely evaporated leaving the sky cloudless.

The previous two days had been extremely clear and cloudless with very low humidity, though the wind, a gentle north-easterly breeze, had been cold. At night the stars had been rather hazy, suggesting the presence of a damp layer at a low level, and this is supported by the fact that the minima on April 29th and 30th had been high (40° F. and 45° F. respectively) considering the almost cloudless night skies. The cause of instability would seem to have been the arrival of cold air from the north above the warm air which had been practically stagnant at night and had lost but little of the heat gained during the previous day.

R. F. T. GRANGER.

Lenton Fields, May 8th, 1921.

Simultaneous Halo and Corona.

DR. C. F. BROOKS points out in the letter published in the Magazine for May that super-cooled water-drops were not necessarily involved in the formation of the simultaneous halo and corona on the night of December 25th. In that particular instance it is not certain that the drops were super-cooled, but I think that in all probability they were. The clouds appeared very high. during the day-time, but there was a warm current from beyond the Azores, probably with a temperature above freezing-point up to at least 10,000 feet. The corona was large and brilliant, but the halo was not bright.

Clouds of various forms consisting of super-cooled drops are of almost daily occurrence. On the other hand, I have come across melting ice-crystals such as Dr. Brooks postulates several times, but without seeing a corona. The possibility should not be ruled out, however C. K. M. DOUGLAS.

A Rainbow at Eye-Level?

ON May 8th, 1921, at 15 h. 30 m., Miss L. M. Flannery and Miss G. Grubb were driving up the steep road from Carrick-on-Suir to Seskin; when more than half-way here and about 300 feet above Ordnance datum, they observed in the east to north-east a horizontal band of rainbow colours, the lightest being underneath, stretching across the Suir valley. The north end rested on the "Welsh" mountains in Co. Kilkenny, the south end disappeared behind and east of the hill they were ascending. Rain was falling in the valley but not on the observers. J. ERNEST GRUBB.

Seskin, Carrick-on-Suir, May 24th, 1921.

[The elevation of the sun at the time would have been 40° 12′ at 15 h. 30 m. G.M.T., and, the angular radius of the primary rainbow being 42°, the crown of such a bow would have been seen almost at eye-level.—ED. M.M.]

The Word "Forecast."

WITH reference to the last sentence in Mr. Bilham's note in the January number of the *Meteorological Magazine*, p. 275, you may be interested to know that the U.S. Weather Bureau meteorologists use the word "forecast" almost exclusively in place of "forecasted." Do English meteorologists ever pronounce the verb "forecast" with the accent on the first syllable, as Americans so commonly do (in defiance of the dictionary)? CHARLES F. BROOKS.

Weather Bureau, Washington, D.C., March 25th, 1921.

[The custom in the Meteorological Office is to place a slight accent on the first syllable of the word "forecast," whether used as verb or noun.—ED. M.M.]

Meteorological Observations at Apia, Samoa.

THE Note on the Observatory at Apia, Samoa, on p. 100 of the *Meteorological Magazine* for May, seems rather to suggest that the initiation of weather observations at this station was of German origin, and due to Weichert, its establishment commencing in 1902. This is probably true with regard to the resuscitation of weather observations and the establishment of a first-class station at Apia. Mr. R. H. Scott, when Secretary to the Meteorological Council, contributed to the *Quarterly Journal of the Meteorological Society* for July 1879 a discussion, carried out by myself, of observations made at Apia by Mr. J. C. Williams, British Consul at Samoa, for the years 1862 to 1865, the instruments having been supplied by the Meteorological Office in 1861. CHAS. HARDING.

2, *Bakewell Road, Eastbourne, June 3rd*, 1921.

NOTES AND QUERIES.

Notes on a Solar Halo at Eskdalemuir, April 20th, 1921.

THE morning was calm with a surface visibility of 20 kilometres, tending to decrease. The sky was overcast apparently with cirrus stratus haze, which to the eye appeared stationary; a subsequent nephoscope observation at 8 h. 55 m. showed the cloud to be motionless.

The halo was first observed at 6 h. 45 m. G.M.T. It was then partly obscured by Dumfedling Hill, only the top half with arc of contact being visible.

It increased in brightness until 7 h. 45 m.–7 h. 50 m., when the major portion was visible.

A rough sketch was made and measurements taken during this period of maximum brightness. Measurements were made with a pilot balloon theodolite, but it was only possible to align this by the sights, since the halo was invisible through the telescope. Measurements of the sun's elevation, however, checked later by calculation, were accurate to within 0·4°.

The phenomenon at this time took the form of—

(*a*) A halo of 22° radius with arc of contact whose convex side was towards the sun, and a mock sun ring forming a horizontal diameter* to the circle and protruding for some distance outside the circumference. Inside the circle the ring was distinctly visible although of a lesser brilliance than the extensions on either side.

(*b*) An arc of a halo of approximately 45° radius and apparently concentric with the first.

Sections of brilliant whiteness were observed (i) at the junctions between the halo and parhelia, (ii) on the circumference about 45° below the parhelia. These latter were quite

* The development of the mock sun ring inside the 22° halo, but not far beyond it, is rare.

unmistakable, but do not appear to be mentioned* in any published account of a halo.

The inner edge of the ring assumed a red-brown hue, the remainder being white except at its junction with the arc of contact where the colours were:—Violet on the inside, gradating through Red, Yellow, Green, and Blue to White on the extreme outside edge. These colours were, however, of little brilliance.

As the sun's altitude increased the halo grew fainter, the arc of radius 45° and arc of contact disappearing about 8 h. G.M.T.

At 9 h. 15 m. another arc of contact appeared of a reverse curvature to the first. At this time the mock suns were visible outside the circle only, about 9° from its outer edge. They continued to move away, their distance being 14° at 9 h. 50 m. and 20° at 10 h. 40 m.

About this time Cumuli finally eclipsed the sun.

At 18 h. G.M.T. on the same day a mock sun vertically 22° above the sun was observed, and at 21 h. a lunar halo of the usual type.

A nephoscope observation at 19 h. gave Cirrus from north-east at 0·3 milliradians per second.

The positions found for the parhelia with various altitudes of the sun were in accordance with the accepted theory.

P. F. JARROLD.

A Localised Oscillation of Pressure.

A SOMEWHAT unusual form of kink occurred on the barograph trace at Benson on May 8th, 1921, 8 h. 25 m. It consisted of a fall of pressure amounting to about 1 mb., and then a rise again to the original level, the whole rise and fall lasting about 10 minutes. The other recording instruments showed no noticeable peculiarities, though at 8 h. 30 m. a drop in the wind and a small change in its direction were indicated. There was no rain at the time.

The microbarogram and the Dines mercurial barogram at South Kensington for the same day show irregularities between 5 h. and 7 h., but none after that time. Corresponding records at Kew Observatory also show no irregularity synchronising with that at Benson, though the distance between the stations is only 40 miles.

* These patches may perhaps have been degenerate "arcs of Lowitz." These arcs which have only been recorded about six times join the parhelion to points on the lower half of the 22° halo.

A Solitary Cloud-ridge.

ATTENTION having been called to a remarkable cloud effect which occurred about the time of sunset on Wednesday, May 25th, a request for information as to observations was circulated in the Meteorological Office. Extracts from various reports are given below.

Kingston-on-Thames :—

Looking towards the western horizon at Kingston, at 19 h. 55 m. G.M.T. (May 25th), the sky had a very beautiful appearance. From the horizon to about 15° the sky was of a bright orange colour ; this gradually faded away to a pink tint up to about 25°. Above this height the sky was a dull grey, until about 30° from the zenith, where a narrow band of cloud stretched right across from horizon to horizon (NNE—SSW). The under side of the band was a very bright red, the upper edge was a dull grey. The edges were not straight, but were slightly waved. By 20 h. G.M.T. the band had lost its bright red colour and was now a very dull grey, almost black.

The predominant cloud was alto-stratus, but patches of lower stratus cloud were visible. Mammato-cumulus cloud could also be seen below the band. The sky towards the eastern horizon was almost completely covered with a uniform layer of alto-stratus cloud, with a few streaks of stratus or strato-cumulus near the horizon. From the horizon to about 5° the sky was cloudless, and of a bluish-yellow tint.

The atmosphere was calm during the phenomena. A heavy shower of rain occurred about 21 h. G.M.T. The average height of the cloud, I should say, was about 10,000 to 12,000 feet, although the patches of stratus were perhaps about 4,000 or 5,000 feet high.

C. C. NEWMAN.

East Twickenham :—

The feature of chief interest was an arch of cloud in the north-west, the apex having an elevation of about 45° when first noticed (about 18 h. 30 m. G.M.T.). By 19 h. 30 m. this arch was almost in the zenith. The arch itself on its lower side presented a wavy structure which suggested that it might later develop into mammato-cumulus. It divided the sky into two halves in which the cloud forms were strikingly dissimilar. On the north-west side there were detached patches of ragged nimbus, while on the south-east side the cloud was of a heavy alto-cumulus type. Such movement as could be detected appeared to be parallel with the arch from south-west, but, as previously noted, the arch itself moved very slowly towards south-east.

E. G. BILHAM.

Chiswick.—

At sunset the arc showing colours was bounded by a narrow arch stretching from horizon to horizon. This arch was a brilliant pinkish red, and as seen from Chiswick the crown of the arch was about 40° north-west of the zenith. Such slight motion as there was was in the direction south-west to north-east. The fold, as it might be called, could be detected long after the brilliant colour had faded away.

F. J. W. WHIPPLE.

Golders Green :—

I was walking back from the golf-course at Hampstead when my eye caught sight of a cloud-line towards the north-west. It consisted of a grey line which seemed to stand out like the back-bone of a whale ; above, the cloud was lighter and appeared to recede from the backbone; below, it also receded, but was narrower and was slightly tinged with a reddish colour. I put the direction of the line of the arch as south-south-west to north-north-east. I have never seen anything like this cloud before. E. GOLD.

At 20 h. the sky appeared practically covered with alto-cumulus cloud. Radiating from a point on the horizon a little south of west was a warm pink glow extending to 45° from the horizon, becoming then too diffused to be noticeable. Around this glow was a band of light, some 10° broad, not unlike a rainbow, but of one colour, the same pink as the upper part of the glow. Some 40° only of this arc was visible. W. G. DAVIES.

The cloud-fold was not visible from South Kensington, as will be gathered from Mr. Spencer Russell's report: "19 h. 50 m. Entire sky from west to zenith a sheet of purple crimson, colour fading rapidly, dissappearing almost entirely by 20 h., leaving an intensely black sky to westwards." The line from Kingston to Golders Green is about 12 miles long. S. Kensington is about 2½ miles to the south-east of this line.

The weather map of May 25th was dominated by a ridge of high pressure crossing central England, approximately from south-west to north-east, and therefore parallel to the "fold" in question. The rainfall which occurred later in the evening was associated with the passage of a small depression.

Sunlight and Health.

IN a letter to the *Times*, June 6th, 1921, Dr. Leonard Hill quotes some measurements recently made by Dr. Sonne, of the Finsen Light Institute. Dr. Sonne has compared sunlight with sources of dark heat, each kind of radiation being taken of the same energy value per unit of surface. After deducting the amount of each kind of radiation reflected by the skin surface, he has found that twice as much sunlight as dark heat is required to burn the skin. The difference is due to the fact that the visible rays of the sun penetrate the skin and are absorbed by the blood circulating in the deep skin and subcutaneous tissue, while the dark heat is mostly absorbed by the skin surface and warms it. Dr. Sonne has found that sunlight may warm up the blood under the skin no less than 5° C. above the temperature to which dark heat warms it; that is, when the surface of the skin in either case is heated to a just endurable degree. The visible rays absorbed by the blood are converted into heat, and the heat carried away by the circulation warms up the body. Exposed to the cooling breezes of open air, the body is kept cool as a whole, while locally the blood and deep skin, in exposed parts, are warmed by the sun to a temperature which may even exceed that of high fever.

This local warming, not excluding other possible results of absorption by the flood of the same visible rays, probably has a profound effect on the immunity of the body to disease. We know that children with tuberculosis of bones, joints, glands and skin respond wonderfully well to conservative treatment in sanatoria, where they are exposed to open-air and sunlight. In the Alpine sanatoria they live naked but for a loin-cloth, winter and summer, kept warm by the sun, and at the same time stimulated by the cool air. It is the visible, not the ultra-violet rays, which stimulate health, for the latter are absorbed by the surface layer of the scarf-skin, having the least protective power.

Dr. Hill concludes that "we must use smokeless fuel and keep the sky clean so that we can enjoy all the possible sunlight." "Has not the time come," he asks, "to interdict the vast waste of human energy, happiness, and health caused by the burning of soft coal?"

Sunshine and Visibility in London.

ATTENTION has lately been drawn to the exceptional clearness of the atmosphere, attributed to the absence of smoke during the coal crisis. The records of sunshine and visibility in London for May are therefore of interest.

The sunshine recorded at Westminster for May 1921 amounted to 227·1 hours. Since 1911 only one May has had a higher record, *i.e.*, May 1919, with 228·1 hours. Observations of visibility are taken twice daily (at 9 h. and 15 h.) on the roof of the Meteorological Office, South Kensington. During May, in 31 observations at 9 h., Big Ben (at 2¾ miles) was visible 21 times and St. Paul's Cathedral (at 4¼ miles) 10 times, and in 20 observations at 15 h., Big Ben was visible 16 times and St. Paul's 10 times.

The Recent Magnetic and Electrical Disturbances.

THE magnetic and electrical disturbances associated with the large sun-spot which appeared on May 8th have been remarkable for their intensity and persistence. The magnetic storm continued without any considerable break from about 13 h. G.M.T. on May 13th until about 4 h. on May 17th. A quieter interval followed, and then on May 19th and following days notable disturbances occurred. This storm was less persistent therefore than the one in November 1882, which presented very similar features but continued almost without a break for nine or ten days. During the storm aurora was reported from Cambridge, London, and other stations in southern England, where it is a rare event even at the equinoxes. (An interesting acount of aurora observed at Okehampton has been received from Mr. E. P. Burd.) Large earth currents were observed in the Post Office telegraph system at stations in England, Scotland and Ireland.

The American Meteorological Society.

THE American Meteorological Society was organized on December 29th, 1919, and incorporated in Washington on January 21st, 1920. At the end of the first year of its existence it had 1,035 actual or prospective members. Such rapid progress is, in part, due to the low fees for membership, but, in part undoubtedly, to the great interest in meteorology awakened in America by the war and the development of flying. The first president is Professor R. de C. Ward, a choice which will meet with the approval of meteorologists in all parts of the world, and the secretary is Dr. C. F. Brooks, of the United States Weather Bureau.

While the aims of the American Society are identical with those of the Royal Meteorological Society, the methods by which it is proposed to attain those aims appear to be rather different. Meetings are relatively few, and original papers read at these meetings are to be published in abstract only, not in full. The activities of the Society are intended to be concentrated mainly in the hands of the Committees, of which there are twelve, dealing respectively with Membership, Corporation Membership, Meteorological Instruction, Public Information, Research, and Physiological, Agricultural, Commercial, Business, Marine, Aeronautical and Hydrological Meteorology. It is evident from this list that the Society intends to keep the utilitarian aspects of its science well to the fore. The Committees will be able to meet but rarely, and their business will be transacted mainly by letters and memoranda.

The first annual volume of the monthly publication, termed "*The Bulletin of the American Meteorological Society*," is now complete. The first volume is necessarily largely preparatory, and much of it is occupied by summaries of articles in "*The Monthly Weather Review*," and by paragraphs of the "Notes and News" type, but as the various committees and private members get to work we shall expect the "Bulletin" to contain much useful material.

We cordially welcome the advent of the new Society into the meteorological world, and believe that it will be a powerful agent in stimulating and giving expression to the scientific instincts of American students of meteorology, whose broad outlook and thorough methods of research we have frequently had occasion to admire.

News in Brief.

THE METEOROLOGICAL MAGAZINE for February and March 1920 is out of print. If any readers have copies of these issues which they do not wish to retain it would be a kindness if they would return them to THE DIRECTOR, Meteorological Office, South Kensington, S.W. 7, or to THE SUPERINTENDENT, British Rainfall Organization, 62, Camden Square, N.W.1.

Rousdon Observatory.

IT is announced that the wind-tower and the removable buildings of the astronomical observatory at Rousdon are for sale. The wind-tower has a platform nearly 60 feet above ground. An illustration of the tower was published in the *Quarterly Journal of the Royal Meteorological Society*, January 1902.

For particulars, application should be made to Cecil Baker, Esq., Combe Pyne, near Axminster.

IT is announced that Mr. M. A. Giblett is to act as one of the secretaries of Section A. of the British Association for the Edinburgh meeting. Communications relating to meteorology may be sent to him at the Meteorological Office, Air Ministry, Kingsway.

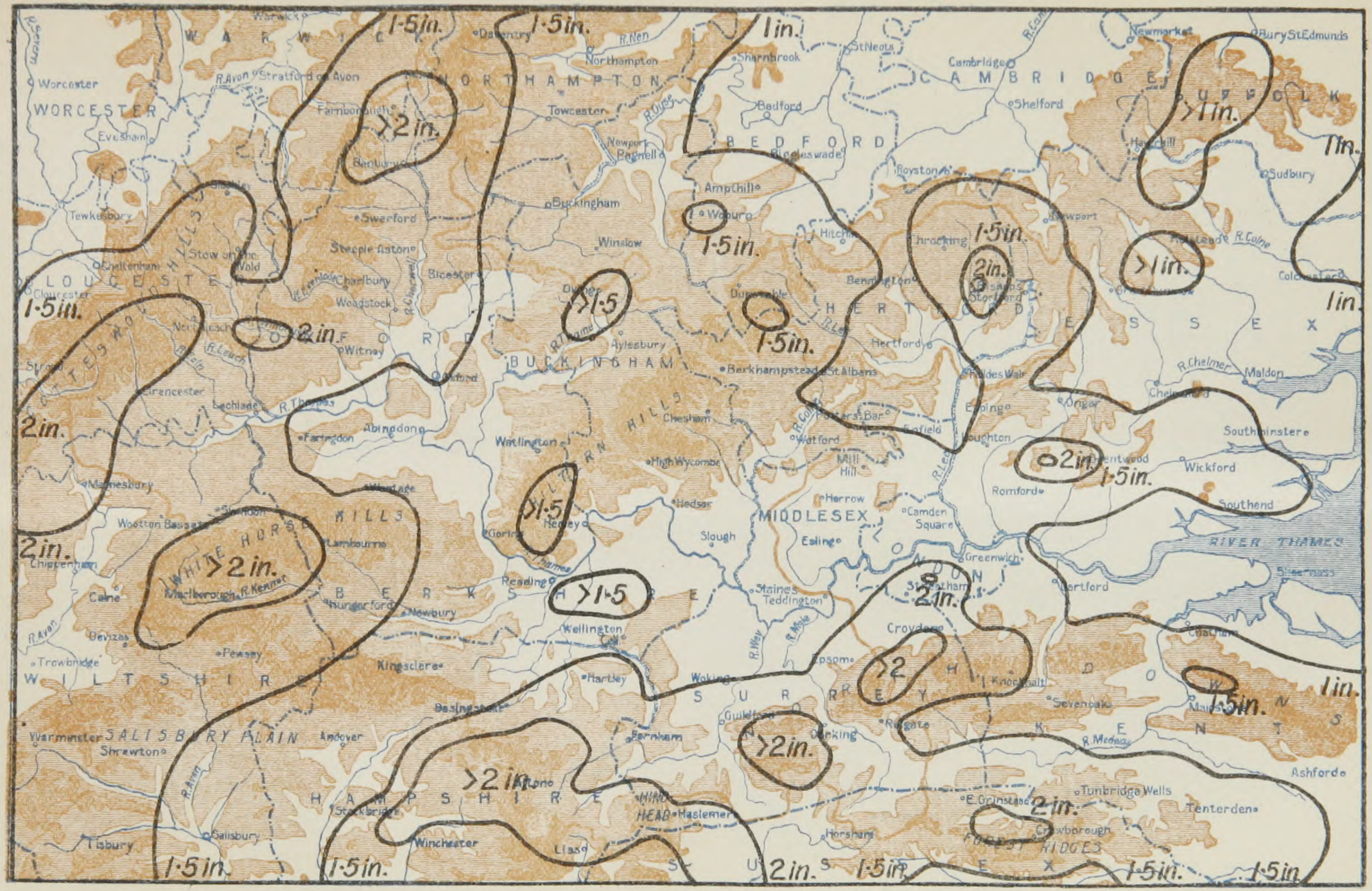
IT is announced that the Cross of the Legion of Honour has been awarded to the Rev. Louis Froc, S.J., Director of the Zi-ka-wei Observatory, Shanghai.

The Weather of May 1921.

THE weather was on the whole fine and dry over the greater part of the country, but unsettled in the extreme north-west. The features which have hitherto characterised the year 1921 were thus maintained. There was continuous fine weather in southern England from the 16th to the 25th.

At the beginning of the month there was a large anticyclone over Iceland and a depression over northern Scandinavia. The weather on the 1st was fine over the British Isles, and warm, except locally on the coast. Temperature was also high in Iceland. A cold northerly current then extended over the British Isles, reaching southern England late in the evening of the 2nd and continuing till the 4th. Cold showery weather was experienced, with snow in the north of Scotland and night-frosts in places. Between the 5th and the 10th a deep depression skirted the north-west coast and caused unsettled but milder weather, with some rain, in all districts, though not in large amounts. This depression filled up near the Shetlands on the 10th, and

THAMES VALLEY RAINFALL —— MAY, 1921.



Meteorological Magazine.

Watershed of River Thames above Teddington and River Lea above Feilde's Weir

Isohyetals.

ALTITUDE SCALE

Below 250 feet	250 to 500 feet	500 to 1000 feet	Above 1000 feet

SCALE OF MILES
0 5 10 15 20

H.M. Stationery Office Press, Kingsway, W.C.2.

PS.3338/343 Wt.26. D.P.15 1250 6/21.

another depression from the Atlantic filled up over England, causing local thunderstorms on the 12th. The next depression appeared over Iceland, and a well-marked secondary skirted the Hebrides on the 14th, causing unsettled weather generally. In southern England the weather was fine until the night of the 14th, when a small secondary brought rain. By the 16th a belt of high pressure was established from the Azores to the Baltic, which persisted till the 25th, causing a spell of brilliantly fine weather over southern England. On the 25th temperature exceeded 75° F. at many stations. The northern and north-western districts were affected at times by depressions to the northward. On the 25th a secondary trough of low pressure developed over England and France, and thunderstorms were experienced in eastern England in a few places on the night of the 25th and more widelv on the 26th. The secondary trough moved east and a cooler current extended over the country from the north-west. On the 25th and 26th there was a northerly gale and snow over Iceland, so that the cold current was drawn from far to the northward, resulting in low upper air temperatures and local hail and thunder over the British Isles. Between the 29th and 31st a deep depression moved north-eastward across the Hebrides, with strong south-west winds over the British Isles, gale force being reached at a few stations. There was heavy rain in the north-west, and smaller amounts elsewhere. On the 31st the depression moved away northward and filled up rapidly, the anticyclonic belt from the Azores to the Baltic becoming re-established on June 1st.

Sea-fog was experienced on the south-west coasts from the 11th to the 13th, and in the English Channel on the 13th and 14th. Otherwise visibility was good, a feature of the month being an unusually large number of observations of exceptional visibility.

In parts of the Continent there was more rain than in England. The cold current about the 3rd extended over a large area, accompanied by secondary depressions, and there was some rain in eastern France and Central Europe, as is usual when polar currents extend over those regions. Belfort had 54 mm. (2·1 inches) on the 2nd and 46 mm. (1·8 inches) on the 4th; while Posen had 60 mm. (2·4 inches) on the 5th. The total for the month at Belfort was 321 mm. (12·6 inches), most of the heavy falls probably being of thunderstorm type. Severe thunderstorms and destructive hail were experienced in southern France between the 18th and 25th, while the weather was fine over England. About the 25th temperature exceeded 80° F. at many Continental stations, reaching 88° F. on that date at Paris. C. K. M. D.

(*Continued on* p. 140.)

Rainfall Table for May 1921.

STATION.	COUNTY.	Aver. 1881–1915. in.	1921. in.	1921. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days
Camden Square	*London*	1·76	1·03	26	59	·18	26	12
Tenterden (Ashenden)	*Kent*	1·57	1·78	45	113	·65	2	11
Arundel (Patching Farm)	*Sussex*	1·85	1·81	46	98	·42	7	13
Fordingbridge (Oaklands)	*Hampshire*	2·08	1·51	38	73	·35	14	18
Oxford (Magdalen College)	*Oxfordshire*	1·79	1·13	29	63	·28	14	18
Wellingborough (Swanspool)	*Northampton*	1·94	1·15	29	59	·19	3, 14	13
Hawkedon Rectory	*Suffolk*	1·85	1·11	28	60	·37	2	13
Norwich (Eaton)	*Norfolk*	1·93	1·27	32	66	·38	27	12
Launceston (Polapit Tamar)	*Devon*	2·02	2·34	59	116	·54	9	16
Sidmouth (Sidmount)	„	1·96	1·81	46	92	·35	9	12
Ross (Chasedale Observatory)	*Herefordshire*	2·13	1·15	29	54	·27	7	13
Church Stretton (Wolstaston)	*Shropshire*	2·58	2·04	52	79	·35	31	17
Boston (Black Sluice)	*Lincoln*	1·76	1·13	29	64	·26	27	16
Worksop (Hodsock Priory)	*Nottingham*	1·99	1·32	34	66	·31	7	13
Mickleover Manor	*Derbyshire*	1·97	1·78	45	90	·29	29	15
Southport (Hesketh Park)	*Lancashire*	2·09	1·45	37	69	·30	14	16
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·14	1·85	47	86	·67	2	13
Hull (Pearson Park)	„ *E. R.*	1·93	2·45	62	127	·47	7	12
Newcastle (Town Moor)	*North'land*	2·03	1·57	40	77	·45	14	10
Borrowdale (Seathwaite)	*Cumberland*	7·37	5·35	136	73	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	2·50	1·95	49	78	·52	29	17
Haverfordwest (Gram. Sch.)	*Pembroke*	2·50	2·18	55	87	·65	29	14
Aberystwyth (Gogerddan)	*Cardigan*	2·64	2·21	56	84	·49	3	8
Llandudno	*Carnarvon*	1·90	1·41	36	74	·35	28	14
Dumfries (Cargen)	*Kirkcudbrt.*	3·01	3·32	84	110	·70	30	20
Marchmont House	*Berwick*	2·47	1·99	51	81	·31	28	16
Girvan (Pinmore)	*Ayr*	2·98	2·55	65	86	·72	30	21
Glasgow (Queen's Park)	*Renfrew*	2·44	..	..	..	..	..	..
Islay (Eallabus)	*Argyll*	2·65	2·72	69	103	·34	30	23
Mull (Quinish)	„	3·06	4·00	102	131	·47	3	22
Loch Dhu	*Perth*	4·49	5·35	136	119	1·15	30	19
Dundee (Eastern Necropolis)	*Forfar*	2·09	1·88	48	90	·30	25	20
Braemar (Bank)	*Aberdeen*	2·39	2·57	65	108	·65	30	16
Aberdeen (Cranford)	„	2·48	1·18	30	48	·19	30	13
Gordon Castle	*Moray*	2·12	2·18	55	103	·41	28	19
Fort William (Atholl Bank)	*Inverness*	3·86	6·03	153	156	1·30	30	27
Alness (Ardross Castle)	*Ross*	2·60	3·26	83	125	1·09	28	20
Loch Torridon (Bendamph)	„	4·56	4·94	125	108	·52	30	21
Stornoway	„	2·56	3·02	77	118	·40	27	23
Wick	*Caithness*	2·07	1·70	43	82	33	5	20
Glanmire (Lota Lodge)	*Cork*	2·45	1·79	45	73	·59	10	18
Killarney (District Asylum)	*Kerry*	3·06	2·27	58	74	·48	30	20
Waterford (Brook Lodge)	*Waterford*	2·32	2·27	58	98	·78	10	16
Nenagh (Castle Lough)	*Tipperary*	2·47	2·09	53	85	·66	30	20
Ennistymon House	*Clare*	2·80	2·78	71	99	·50	30	22
Gorey (Courtown House)	*Wexford*	2·22	1·83	47	82	·30	25	18
Abbey Leix (Blandsfort)	*Queen's Co.*	2·43	2·26	57	93	·42	7	20
Dublin (FitzWilliam Square)	*Dublin*	2·05	1·53	39	75	·23	8	22
Mullingar (Belvedere)	*Westmeath*	2·45	2·26	57	92	·50	30	16
Woodlawn	*Galway*	2·73	2·09	53	77	·27	5	24
Crossmolina (Enniscoe)	*Mayo*	3·25	2·58	65	79	·39	30	23
Collooney (Markree Obsy.)	*Sligo*	2·74	3·12	79	114	·53	8	20
Seaforde	*Down*	2·63	2·67	68	102	·91	30	13
Ballymena (Harryville)	*Antrim*	2·86	3·52	89	123	·79	30	22
Omagh (Edenfel)	*Tyrone*	2·59	2·22	56	86	·46	30	20

Supplementary Rainfall, May 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	·92	23	XII.	Langholm, Drove Rd.	2·71	69
,,	Sevenoaks, Speldhurst	1·36	35	XIII.	Selkirk, Hangingshaw	2·80	71
,,	Hailsham Vicarage	1·31	33	,,	North Berwick Res.	1·17	43
,,	Totland Bay, Aston	1·14	29	,,	Edinburgh, Royal Ob.	1·63	42
,,	Ashley, Old Manor Ho.	1·64	42	XIV.	Biggar	1·57	40
,,	Grayshott	2·45	62	,,	Leadhills	4·11	104
,,	Ufton Nervet	1·26	32	,,	Maybole, Knockdon	2·25	57
III.	Harrow Weald, Hill Ho.	1·29	33	XV.	Dougarie Lodge	3·48	88
,,	Pitsford, Sedgebrook	1·47	37	,,	Inveraray Castle	5·86	149
,,	Chatteris, The Priory.	·70	18	,,	Holy Loch, Ardnadam	..	..
IV.	Elsenham, Gaunts End	1·01	26	XVI.	Loch Venachar	4·55	116
,,	Lexden, Hill House	1·03	26	,,	Glenquey Reservoir	4·40	112
,,	Aylsham, Rippon Hall	1·82	46	,,	Loch Rannoch, Dall	2·68	68
,,	Swaffham	1·12	28	,,	Trinafour	3·80	97
V.	Devizes, Highclere	1·98	51	,,	Coupar Angus	1·82	46
,,	Weymouth	2·27	58	,,	Montrose Asylum	1·66	42
,,	Ashburton, Druid Ho.	3·63	92	XVII.	LogieColdstone,Loanh'd	3·00	76
,,	Cullompton	2·26	57	,,	Fyvie Castle	1·56	40
,,	Hartland Abbey	1·72	44	,,	Grantown-on-Spey	2·12	54
,,	St. Austell, Trevarna	2·65	67	XVIII.	Cluny Castle	3·19	81
,,	North Cadbury Rec.	1·94	49	,,	Loch Quoich, Loan	11·60	295
,,	Cutcombe,Wheddon Cr.	2·69	68	,,	Fortrose	2·34	59
VI.	Clifton, Stoke Bishop.	1·84	47	,,	Glenelg Manse	3·13	79
,,	Ledbury, Underdown.	1·24	31	,,	Skye, Dunvegan	4·76	121
,,	Shifnal,HattonGrange	1·14	29	,,	Glencarron Lodge	4·70	119
,,	Ashbourne, Mayfield	1·74	44	,,	Dunrobin Castle	2·63	67
,,	Barnt Green, Upwood	1·57	40	XIX.	Tongue Manse	3·29	84
,,	Blockley, Upton Wold	1·67	42	,,	Melvich Schoolhouse	2·29	58
VII.	Grantham, Saltersford	1·61	41	,,	Loch More, Achfary	4·77	121
,,	Louth, Westgate	1·64	42	XX.	Dunmanway Rectory	3·01	77
,,	Mansfield, West Bank	1·70	43	,,	Mitchelstown Castle	1·89	48
VIII.	Nantwich, Dorfold Hall	1·36	35	,,	Gearahameen	4·90	125
,,	Bolton, Queen's Park.	2·84	72	,,	Darrynane Abbey	2·89	73
,,	Lancaster, Strathspey.	3·59	91	,,	Clonmel, Bruce Villa	2·60	66
IX.	Rotherham	1·05	27	,,	Cashel, Ballinamona	1·67	42
,,	Bradford, Lister Park.	1·44	37	,,	Roscrea, Timoney Pk.	1·36	35
,,	West Witton	1·29	33	,,	Foynes	2·05	52
,,	Scarborough, Scalby	2·44	62	,,	Broadford, Hurdlesto'n	3·19	81
,,	Middlesbro', Albert Pk.	1·08	27	XXI.	Kilkenny Castle	1·92	49
,,	Mickleton	1·80	46	,,	Rathnew, Clonmannon	2·46	63
X.	Bellingham	1·53	39	,,	Hacketstown Rectory	2·01	51
,,	Ilderton, Lilburn	1·54	39	,,	Balbriggan, Ardgillan	2·36	60
,,	Orton	4·22	107	,,	Drogheda	2·20	56
XI.	Llanfrechfa Grange	1·99	51	,,	Athlone, Twyford	1·80	46
,,	Treherbert,Tyn-y-waun	3·95	100	XXII.	Castle Forbes Gdns.	2·16	55
,,	Llanwrda	2·76	70	,,	Ballynahinch Castle	3·66	93
,,	Fishg'rd,Goodwick Stn.	1·83	47	,,	Galway Grammar Sch.	2·08	53
,,	Lampeter, Falcondale	2·09	53	XXIII.	Westport House	..	..
,,	Cray Station	3·20	81	,,	Enniskillen, Portora	1·90	48
,,	B'ham W.W.,Tyrmynydd	2·73	69	,,	Armagh Observatory	2·06	52
,,	Lake Vyrnwy	3·14	80	,,	Warrenpoint	3·37	86
,,	Llangynhafal, P. Drâw	1·43	36	,,	Belfast, Cave Hill Rd.	2·20	56
,,	Oakley Quarries	5·28	134	,,	Glenarm Castle	2·45	62
,,	Dolgelly, Bryntirion	3·26	83	,,	Londonderry, Creggan.	2·45	62
,,	Snowdon, L. Llydaw.	..	..	,,	Sion Mills	2·02	51
,,	Lligwy	2·44	62	,,	Milford, The Manse	2·20	56
XII.	Stoneykirk,ArdwellHo.	1·93	49	,,	Narin, Kiltoorish	2·58	65
,,	Carsphairn, Shiel	4·06	103	,,	Killybegs, Rockmount	2·79	71

Climatological Table for the

STATIONS	PRESSURE Mean of Day M.S.L. mb.	PRESSURE Diff. from Normal mb.	TEMPERATURE Absolute Max. °F.	Date	Min. °F.	Date	Mean Values Max. °F.	Min. °F.	½ max. and min. °F.	Diff. from Normal °F.
London, Kew Observatory	1016·1	+2·2	56	31	21	13	44·6	37·4	41·0	+0·7
Gibraltar	1019·2	−0·4	71	2	43	16, 21	61·4	48·4	54·9	−1·1
Malta	1015·8	−0·1	67	7	50	26	62·1	54·2	58·1	+1·1
Sierra Leone	1011·6	+0·5	93	23	69	31	89·7	72·7	81·2	−0·3
Lagos, Nigeria	1012·6	+2·1	90	14	68	28	87·9	75·8	81·9	+0·6
Kaduna, Nigeria	1014·3	+4·2	92	21	49	14	86·5	55·0	70·8	−1·6
Zomba, Nyasaland	1008·8	+0·2	89	20	59	31	81·5	64·3	72·9	+0·2
Salisbury, Rhodesia	1009·0	−1·9	95	3	54	5, 15	84·8	59·3	72·1	+2·1
Cape Town	1013·7	−0·6	93	3	50	24	77·3	59·1	68·2	+0·6
Johannesburg	1010·5	0·0	86	5	45	15	78·4	54·1	66·3	+1·2
Mauritius	..	..	...	..	..	..	..	..	..	..
Bloemfontein	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1013·6	−2·1	81	2	50	30	78·2	55·0	66·6	+0·1
Bombay	1010·0	−3·3	90	17	65	26	85·4	69·7	77·5	+0·2
Madras	1013·0	−0·6	87	29	63	3	84·7	68·4	76·5	0·0
Colombo, Ceylon	1010·9	+1·1	88	25, 29	63	5	86·0	71·1	78·5	−1·2
Hong Kong	1017·5	−2·4	77	3	53	14	68·7	61·3	65·0	+2·1
Sydney	1009·9	−2·0	92	22	57	11	76·7	63·5	70·1	+0·1
Melbourne	1011·3	−1·0	106	23	45	17	66.6	58·1	62·3	−2·4
Adelaide	1012·0	−1·2	110	24	48	8	83·5	60·3	71·9	+0·7
Perth, Western Australia	..	..	..	..	..	..	..	..	..	..
Coolgardie	1010·2	−1·0	105	19	45	13	91·6	59·2	75·4	−0·4
Brisbane	..	..	..	..	..	..	..	..	..	..
Hobart, Tasmania	1015·2	+5·5	102	24	40	8	69·8	52·1	60·9	+0·5
Wellington, N.Z.	1011·9	−0·2	75	18	45	24	66·2	54·4	60·3	−0·2
Suva, Fiji	1007·9	−0·7	90	17	71	23	84·6	73·5	79·1	+0·2
Kingston, Jamaica	1013·7	−0·5	91	1	67	12	88·0	70·4	79·2	+1·5
Grenada, W.I.	1012·3	+0·4	88	15	72	7, 12, 15	83·3	73·7	78·5	+0·4
Toronto	1012·9	−4·5	51	14	10	29	36·6	26·4	31·5	+5·3
Winnipeg	1015·4	−2·5	33	1, 31	−22	27	18·7	4·5	11·6	+5·9
St. John, N.B.	1011·4	−2·8	51	2	− 8	26	31·3	20·3	25·8	+1·4
Victoria, B.C.	1010·2	−6·6	51	1, 28	32	14	45·5	39·6	42·6	+1·1

Suva, Fiji.

January 1920	1007·1	−0·6	88	27	69	7	84·7	73·3	79·0	−0·9
February 1920	1004·2	−3·5	89	28	69	22	85·0	74·4	79·7	−0·8
March 1920	1008·7	+0·2	91	4	72	30	85·3	73·9	79·6	−0·5

January, 7 days with thunder heard; February, 11 days with thunder heard; March, 1 day with thunder heard.

LONDON, KEW OBSERVATORY.—Mean speed of wind 8·9 mi/hr; 7 fogs, 6 days with snow.

GIBRALTAR.—2 fogs; 2 days with gale.

MALTA.—Prevailing wind direction NW.; mean speed 8·2 mi/hr.

SIERRA LEONE.—Wind variable, chiefly calm; 2 days with thunder heard.

SALISBURY, RHODESIA.—Prevailing wind direction E.

COLOMBO, CEYLON.—Prevailing wind direction N.; mean speed 5·0 mi/hr; 6 days with thunder heard.

British Empire, December 1920.

TEMPERATURE Absolute Max. in Sun ° F.	TEMPERATURE Absolute Min. on Grass ° F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	PRECIPITATION Amount mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible	STATIONS
89	10	86	8·2	1·94	49	− 9	17	0·9	11	London, Kew Observatory.
120	35	78	4·5	4·79	122	− 18	7	..	..	Gibraltar.
117	..	79	5·6	1·44	37	− 49	10	5·9	61	Malta.
..	..	69	2·9	0·14	4	− 34	2	..	..	Sierra Leone.
156	61	70	6·3	0·04	1	− 20	1	..	..	Lagos, Nigeria.
..	..	37	..	0·00	0	− 3	0	..	..	Kaduna, Nigeria.
..	..	86	6·9	9·89	251	− 40	19	..	..	Zomba, Nyasaland.
151	55	64	4·7	4·93	125	− 29	14	..	..	Salisbury, Rhodesia.
..	..	57	3·6	1·67	42	+ 20	7	..	..	Cape Town.
..	44	57	5·3	3·35	85	− 38	9	9·3	68	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
..	..	..	..	..	..	..	..	..	..	Bloemfontein.
..	41	47	0·1	0·00	0	− 5	0	..	..	Calcutta, Alipore Obsy.
133	55	61	0·3	0·00	0	− 2	0	..	..	Bombay.
..	..	79	2·9	0·01	trace	−158	1	..	..	Madras.
160	55	68	4·4	4·42	112	− 28	11	..	..	Colombo, Ceylon.
..	..	74	7·9	1·81	46	+ 15	8	3·4	32	Hong Kong.
145	47	69	5·0	15·82	402	+335	16	7·8	54	Sydney.
156	41	54	4·9	0·99	25	− 34	8	..	..	Melbourne.
164	38	43	3·1	2·10	53	+ 29	7	..	..	Adelaide.
..	..	..	..	..	..	..	..	..	..	Perth, Western Australia.
165	43	30	1·7	0·02	1	− 17	1	..	..	Coolgardie.
..	..	..	..	..	..	..	..	..	..	Brisbane.
161	34	59	6·9	3·09	78	+ 28	12	7·9	52	Hobart, Tasmania.
152	34	72	6·0	1·67	42	− 40	6	7·1	47	Wellington, N.Z.
..	..	88	5·7	17·62	448	+140	26	..	..	Suva, Fiji.
..	..	71	3·7	0·02	1	− 40	1	..	..	Kingston, Jamaica.
144	..	73	3·8	4·06	103	− 85	14	..	..	Grenada, W.I.
..	..	83	8·8	3·04	77	+ 5	14	..	..	Toronto.
..	..	95	5·8	0·78	20	− 4	3	..	..	Winnipeg.
..	..	82	6·7	4·70	119	+ 13	16	..	..	St. John, N.B.
..	..	89	8·7	4·62	117	− 33	25	..	..	Victoria, B.C.

Suva, Fiji.

..	..	85	5·7	5·22	133	−139	24	..	..	January 1920.
..	..	92	4·9	12·20	310	+ 53	24	..	..	February 1920.
..	..	88	5·1	14·42	366	− 7	26	..	..	March 1920.

HONG KONG.—Prevailing wind direction ENE. ; mean speed 12·0 mi/hr.
SYDNEY.—Heaviest rainfall on record for Sydney.
SUVA, FIJI.—4 days with thunder heard.
GRENADA.—Prevailing wind direction E.
TORONTO.—2 days with fog.
WINNIPEG.—2 days with fog.
ST. JOHN, N.B.—1 day with thunder heard.
VICTORIA, B.C.—1 day with fog.

Violent rain and severe hail produced havoc in the vineyards of the Valley of the Arce, in the Champagne district of France. As this followed the black frost of April 15th–17th in the adjacent Burgundy district, the season promises to be disastrous. There has not been a good year for Burgundies since 1917.

Rainstorms in the Segura basin have caused the flooding of many villages and the destruction of crops in the Spanish province of Murcia. Serious floods are also reported in the Maia district of the province of Douro in Portugal.

In spite of the recent prolonged drought in the Alps, the upper glacier at Grindelwald is still moving downwards more than half an inch hourly; it is feared that it may reach the generating station of the Wetterhorn aerial railway next winter.

A shower of frogs is reported to have fallen on the North Front at Gibraltar during a thunderstorm. The possibility of frogs being carried from some marsh or lake by a whirlwind must be admitted in view of the well-authenticated shower of fish at Sunderland on August 24th, 1918.

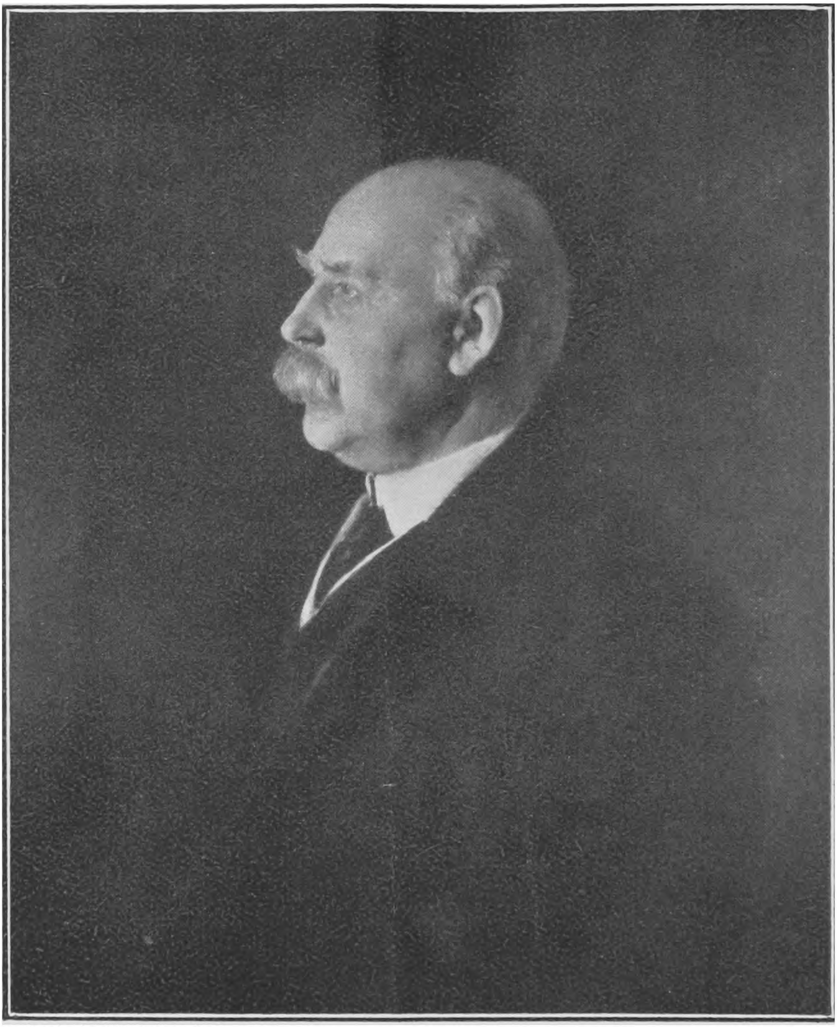
After a long spell of dry weather beneficial rain fell in Victoria, South Australia, and New South Wales, and the outlook for the coming season has considerably brightened.

The rainfall of the month was below the average in England and Wales generally, while a large part of the west of Scotland and isolated areas elsewhere experienced a moderate excess. The general rainfall, expressed as a percentage of the average, was:—England and Wales, 79; Scotland, 108; Ireland, 90; British Isles, 91.

Less than 25 mm. (1 inch) fell during the month over part of the east coast and as much as 50 mm. (2 inches) fell only extremely locally in any part of the east. The fall over the rainy areas of Wales was nearly everywhere below 100 mm. (4 inches), but more than 150 mm. (6 inches) fell in the Central Lake District and over much of the West Highlands. In Ireland the fall was more moderate, varying from rather more than 100 mm. (4 inches) to rather less than (50 mm.) 2 inches in the east.

May was the fourth successive month with general rainfall below the average in England. The area which experienced a defective fall in each of the four months comprised a very broad belt of country extending from Devonshire and Sussex in the south, across England to Haddingtonshire. At Totland Bay, in the Isle of Wight, the total fall was lower than in any previous four spring months except during the great spring drought of 1893.

In London (Camden Square) the month was beautifully fine, sunny and warm, with deficient rainfall. Mean temperature was 57·0° F., or 2·5° F. above the average. Duration of rainfall, 25·3 hours. Evaporation, 3·04 inches.



P. Laib, Photographer.

Sir Napier Shaw, F.R.S.

From the Painting by W. W. Russell, A.R.A.

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Presentation to Sir Napier and Lady Shaw.

THE portrait of Sir Napier Shaw, which has been painted by Mr. W. W. Russell, A.R.A., was presented to Sir Napier and Lady Shaw in the Library of the Meteorological Office at South Kensington on Wednesday, June 22nd. The original portrait is still in the exhibition of the Royal Academy at Burlington House, and a copy painted by Mr. Russell as a gift from the staff to Lady Shaw formed the actual object of presentation.

The Staff of the Office and the members of the Meteorological Committee, as well as other friends who had been brought into relation with the office as observers, or voluntary workers, or who had taken part in the Monday afternoon discussions commenced by Sir Napier in January 1905, were present in large numbers.

Major General Sir Frederick Sykes, Chairman of the Meteorological Committee, presided and invited Sir Arthur Schuster, F.R.S., the senior member of the Committee, to make the presentation on behalf of the subscribers.

In inviting Sir Napier and Lady Shaw to accept the gifts, Sir Arthur referred to Sir Napier's long connection with the Office, which dated back to 1879, when he was invited by the Meteorological Council to undertake an experimental investigation on hygrometry. The work was carried out at the Cavendish Laboratory, Cambridge, and was the means of bringing Lady Shaw also into early contact with the

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Office, for she was at the time a student at the laboratory and assisted in some of the experiments.

Sir Arthur Schuster proceeded to say that there was no need for him to dwell on the distinguished services which Sir Napier had rendered to meteorology, they would be familiar to his hearers as they are to the readers of this magazine, but he emphasized Sir Napier's great power of combining the work of a successful administrator with that of a distinguished scientist. He ended by handing to Sir Napier a book containing the signatures of all associated with the presentation.

Lady Shaw, in returning thanks, recalled the fact that this year marked the coming of age of Sir Napier's directorship of the Office. It was exactly 21 years since he came to London as successor to Dr. Scott.

Dr. Simpson, at the request of the Chairman, accepted the portrait on behalf of the Office.

Sir Napier, in his reply, described the circumstances under which he took charge of the Office and the change which had occurred in the outlook of the Office during the years which had elapsed between his first undertaking work for the Council in 1879 and his becoming its secretary in 1900. Readers of this magazine will remember the interesting account he gave of them in his letter, addressed to Sir Frederick Sykes, which we printed last December. He proceeded to refer to past and present members of the staff who had worked under him by name, and recalled many episodes in the domestic history of the Office that brought back to his audience the remembrance of former days.

After the presentation, tea was served in Room 25—the room designed originally as the Forecast Room, now the home of the British Climatology and Autographic Records Sections.

Mr. Russell's portrait of Sir Napier is reproduced as the frontispiece to this magazine.

On the Design of Rain Gauges.

THE existence of a large body of voluntary and self-equipped observers of rainfall in the British Isles carries with it, among a multitude of advantages, the disadvantage that it is extremely difficult to eliminate the use in many cases of rain gauges of undesirable patterns. Such gauges are not infrequently obtained by persons interested in rainfall observing, but unaware of the errors to which they are likely

Photographs of the portrait of Sir Napier Shaw by Mr. W. W. Russell, A.R.A., can be obtained from Mr. Paul Laib, 3, Thistle Grove, Drayton Gardens, S.W. 10. Prices:—10 in. by 8 in., 5s. 6d., and 7½ in. by 6 in., 2s. 6d. each, plus postage.

to give rise. The collective experience of those who have made rainfall observing a special study is unequivocally in favour of the universal adoption of the now recognised standard patterns of rain gauge and the rejection of certain obsolete patterns.

There are unfortunately price-lists, even amongst those issued by the well-known makers of rain gauges, which include particulars of gauges which have been definitely proved to be unsuitable for accurate measurement of rainfall. It is understood, however, that there is a certain market for obsolete types of rain gauges such as the "Howard" and the "British Association," which are unsatisfactory for measuring heavy rain and snow because of the absence of the deep cylindrical rim above the collecting funnel, and are also open to other objections. In the same way the well-known "Glaisher" gauge is still frequently listed and sold, although it has been clearly proved to be liable to develop serious errors.

It therefore seems desirable that the essential characteristics of a reliable rain gauge should be briefly explained for the guidance of purchasers who may not be aware of the defects inherent in some of the listed instruments. The prototype of the approved gauge is the "Snowdon" rain gauge. The "Meteorological Office" pattern gauge, the "Bradford" gauge and the "Seathwaite" gauge are variants of this type which embody the essential features of the "Snowdon" gauge, and are therefore also satisfactory. Most other gauges are unsatisfactory in that they do not contain the essential features, which may be stated as follows:—

(1) The stout brass turned ring terminating upwards in a knife-edge, exactly 5 or 8 inches in diameter, which forms the rim of the gauge.

(2) The vertical cylinder 4 to 6 inches deep, extending from the rim to the upper edge of the funnel, which is intended to retain snow and hail, to prevent the outsplashing of rain which has fallen upon the funnel, and to reduce to a minimum the risk of loss due to wind eddies.

(3) An inner collecting vessel, which can be removed for measuring the fall without disturbing the body of the gauge. Taps for drawing off water are extremely objectionable.

(4) Provision for a depth of at least 6 inches of the body to be firmly fixed in the ground.

(5) Simplicity of construction and avoidance of the use of rivets.

(6) Strength and durability.

(7) A capacity of not less than 10 inches of rain for a daily gauge. Gauges for monthly readings should be larger according to the district in which they are to be used.

Drawings of some of the gauges referred to will be found in "Rules for Rainfall Observers," a copy of which will be forwarded to any address gratis, on application to the Superintendent of the British Rainfall Organization. "The Observer's Handbook" of the Meteorological Office may also be consulted.

The above conditions, with the exception of that numbered (3), apply generally also to self-recording rain gauges, it being noted, however, that the diameter of the rim of modern British recording gauges is usually either 6, 8, or 11 inches. Condition (5) is most important, and the following further desiderata apply:—

(8) The scale values of the chart must conform accurately with the indications of the instrument.

(9) It is desirable that the hour lines on the chart should be straight and not curved.

(10) It is desirable that the scale value for rainfall should be not less than six times the natural scale, and that the drum should make a complete revolution in 24 hours.

(11) Dial gauges, tipping-bucket, and electrical recording rain gauges are not in general suited to modern requirements.

(12) Should the mechanism of the gauge include an automatic syphon, the design and construction of the syphon require special care; the liability to failure of syphons is a serious drawback.

(13) Space should be available inside the case of the instrument for the insertion of a small oil lamp or a night-light to warm the gauge in frosty weather.

Makers of rain gauges could materially assist in the extermination of undesirable types of rain gauge by refraining, in the interests of science as well as in their own ultimate interests, from making and listing any instrument which is known to be unsuitable for measuring or recording rainfall. As such a step could, no doubt, only be taken gradually, it is suggested that, as a preliminary, makers should issue with their lists of rain gauges a slip stating that ordinary rain gauges of the "Snowdon," "Meteorological Office," "Bradford," and "Seathwaite" gauges are the only kind recommended for use by the Meteorological Office (which includes the British Rainfall Organization). This suggestion is due to one of our leading firms of instrument-makers, which has already decided to issue such a slip in the manner indicated.

Intending rainfall observers, or existing observers who have the intention of re-equipping themselves with new gauges, are advised to insist that goods should be accompanied by certificates of accuracy. These certificates not only ensure the accuracy of the construction, but also give a guarantee that the gauge is of the approved pattern.

No instrument sent to the Meteorological Office for test will be granted the certificate of the British Rainfall Organisation unless it is considered to be of suitable design as well as found to be accurate as regards essential dimensions.

It has been decided that, in the interests of the science of meteorology, no advertisements of instruments will be accepted for publication in this Magazine or in "British Rainfall" when, in the opinion of the Director of the Meteorological Office, the instruments referred to are defective in design.

The Case for the Modern Units in Meteorology.

By F. J. W. Whipple, M.A., Superintendent, Climatology Division, Meteorological Office.

1. Rainfall.

LETTERS which have recently been published in this Magazine expressing the dissatisfaction which is felt in some quarters with regard to the adoption of new units in meteorological publications merit serious consideration, especially by those who are in responsible positions as servants of the public.

The first point which I should like to bring home to our correspondents is that the inconvenience of any change of units is more serious for those who have to handle meteorological statistics every day than for those whose interest in them is only secondary. Such changes would not be made deliberately unless the weight of the arguments in their favour were felt to be very strong.

On the general question of the choice between units of the metric system and the British system there is no room for doubt; the world has decided that wherever uniformity in measurement is required the metric system holds the field. Is such uniformity required in meteorology? That it is desirable no one can deny.

Now consider the case of rainfall. We may be interested in the occurrence of rainfall day by day, or in comparisons between the rainfall of large areas over long periods. In either case we must either have all the readings made in the same units or else ask someone to convert the readings of other people into the unit of our choice.

In the preparation of a publication like the Daily Weather Report, which includes the rainfall of all parts of Europe, it is obviously an economy of time to avoid all unnecessary conversions from one unit to another, as, for example, from millimetres to inches, whilst the elimination of the risk of error is also of prime importance.

Moreover, the figures are not only required for printed reports, they are also to be used in the messages sent out broadcast periodically, and economy of time is again of the first importance. It must be admitted, in fact, that for an official weather service working at high pressure an unnecessary difference between the units in use for rainfall measurement in this country and on the other side of the Channel would be intolerable.

How far the usage of the official weather service should govern the practice of rainfall observers in general is a matter for discussion. As far as the actual measurements go, there is no more difficulty in one system than the other: it is simply a question of the provision of a suitable glass measure. When it comes to visualising what the measurements mean, it is probably easier for most of the younger generation to think of, say, 8 millimetres than to think of the equivalent ·31 inch, but, on the other hand, it is easier to think of 3·1 inches than of 80 millimetres. On such *a priori* grounds there is nothing to choose between the systems. The amateur observer who is setting up a rain gauge is usually interested in comparing his readings with official records, and therefore is wise when he adopts the millimetre measure.

But how about the old established observer with a long series of observations to his credit? He is not asked to change his own system, but he is practically told that if he wishes to maintain his interest in rainfall statistics in general he should educate himself to convert readings from millimetres to inches, and *vice versa*. Undoubtedly this conversion is a nuisance. The only consolation that can be offered is that it is borne with for the sake of the coming generation, a generation which will find the study of meteorology freed from the distraction of confused units.

As to the conversion from millimetres to inches, it is convenient to remember that 25 millimetres being nearly an inch, a measurement in millimetres has only to be multiplied by 4 to give the rainfall in hundredths of an inch. The habit of conversion is not entirely a good one, however. Just as the aim of a student of languages is to learn to think in foreign languages without translating to and from his mother tongue, so it is desirable to get into the habit of appreciating measurements given in a novel unit without converting to the more familiar unit. For this purpose we want certain standards of reference. Such in the case of rainfall are the following:—Really heavy rainfall such as the children call "cats and dogs" is at the rate of one millimetre a minute or more, whereas a slight drizzle may only yield one-tenth of a millimetre per hour. The normal annual rainfall of London is 500 millimetres, and, on the other hand, in the thunderstorm of June 16th, 1917, as much as 120 millimetres fell at Campden Hill in two hours. A fall of one millimetre yields 1,000 metric tons to the square kilometre, nearly four tons to the acre, or one ton to the rood.

Everyone who is in the habit of looking at rainfall statistics carries a few such standard facts in his head, and some, happily, carry a large number. Once these standard facts have been referred to the new unit, there is no difficulty in appreciating how fresh statistics compare with old ones. The transition stage is undoubtedly irksome to most people, but though we may bemoan our misfortune in having to pass through it, perhaps we should rather congratulate ourselves that meteorologists have had the enterprise to take the step of which many other practical people have fought shy.

OFFICIAL NOTICES.

Meteorological Stations.

Dalkeith.

OBSERVATIONS have been discontinued at Dalkeith, Palace Gardens, where the Duke of Buccleuch had maintained a station for many years. The gardens were recently let to a market gardener, who has acted as a voluntary observer for some months, but who now finds it impossible to continue the work.

Cahir.

SINCE 1911 weekly returns of meteorological observations at Cahir in Tipperary have been received at the Meteorological Office from Mr. R. W. Smith, junior. The series has terminated abruptly and tragically owing to the destruction by fire of Mr. Smith's house, "Bengurragh," through the action of Sinn Fein. Voluntary meteorological stations in rural Ireland have always been widely separated, and the closure of Mr. Smith's valuable observations is therefore to be deplored.

Crathes.

It was recently announced that with the exception of the sunshine recorder the instruments at Crathes had been moved from Pinewood to the Schoolhouse. It is now to be noted that the sunshine recorder was installed at the new station on June 30th.

Guernsey.

The station maintained by Mr. A. Collenette at Brooklyn, St. Martin's Road, for the last 18 years has been moved to Grange, St. Peter Port; the thermometer and rain gauge are in their permanent places, but the barometer is at present in a temporary position, while the sunshine recorder will remain at St. Martin's Road until the new building is sufficiently advanced to receive it.

The Royal Meteorological Society.

THE last monthly meeting of the session was held on June 15th, Mr. R. H. Hooker (President) in the chair.

The first paper was by Mr. G. M. B. Dobson on "The Causes of Errors in forecasting Pressure Gradients and Upper Winds." Since meteorologists picture the wind at moderate heights as the flow of air along isobaric lines, the forecasting of wind depends more or less explicitly on the forecasting of the distribution of pressure. The forecaster starts with the map showing the distribution of pressure at a particular time, and from the information at his disposal he has to estimate what changes are likely to take place in so many hours. He has to estimate not only how the well-marked features will move, but also how the minor details of the map will change. If the strength and the direction of the wind is to be foretold with any accuracy, great precision in these details is necessary, and Major Dobson was sceptical as to whether such precision was likely to be obtained, at any rate in the near future. He put forward as a general principle the view that the merit of a forecast was to be judged, not by how near it was to the truth but by how well the changes from day to day were indicated. If it is showery to-day it is generally safe to forecast showers to-morrow: it is a more severe but better test to be asked to say whether showers will be more or less common or more or less heavy to-morrow than to-day.

Taking the case of wind, Major Dobson discussed the vector change in the wind in the course of so many hours. In his own experience the proportion of successes in such forecasts was very low. Hence the despondent tone of his paper.

Colonel Gold, who opened the discussion, was more optimistic. He thought that forecasting in general terms was of great value. A forecast of a gale from a northerly quarter was justified for practical purposes even if a strong wind from north-west followed, though the error in the forecast as estimated by Dobson's method would be serious.

Sir Napier Shaw gave an amusing but instructive analysis of the innate tendency of humanity to make forecasts of other things besides weather. Mr. Richardson mentioned that his attempts to develop a system of forecasting by computation had been frustrated by the fact that the comparatively small details of the weather map were of so much importance.

Mr. R. Francis Granger gave a paper on "The Physical Structure of Cloud Forms in the Lowest Atmosphere." Mr. Granger is a young and enthusiastic amateur whose intimate study of cloud forms should prove of great value. In his paper he gave details of his observations of the lower clouds from which rain is falling. Special emphasis is given to the hypothesis that actual rain-producing cloud is formed by the ascent *en masse* of an eddy-formed damp layer.

Mr. J. Wadsworth gave an account of a paper by himself and Mr. N. A. Comissopulos on the variability of annual mean temperature over Europe and North America. The authors had worked out the standard deviation of annual mean temperature for numerous stations and plotted the results.

In Europe the maxima of variability occur over north-east Russia and over a belt across western Germany, France and Spain, the minima over the Atlantic and Mediterranean. In the discussion Mr. Brooks pointed out the similarity between the distribution of temperature variability and that of clear skies. North-east Russia, where there are possibilities of very cold winters and of very hot summers, was naturally the part of Europe where the annual mean was most likely to be highly variable.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

Units for Meteorological Work.

THE point raised by Mr. E. W. Murphy and others is one of the very greatest importance to meteorological science, and it would be unwise in the extreme to disregard it. Of all the sciences Meteorology and Astronomy owe most to the voluntary efforts of amateur workers. The former in particular would be badly off indeed if they were withdrawn. Moreover, the constant cry of the Meteorological Office and of the British Rainfall Organization is for more observers and more stations (voluntary ones, of course).

This being so, is it not the height of unwisdom to force upon observers a system of units which are Chinese to the very class from whom alone voluntary workers can be drawn, viz., the average educated middle class? I myself, though I now hold a paid professional post, both meteorological and astronomical, worked for 40 years as an amateur. To the present day I do not know what millibars mean, barely can get roughly the hang of degrees absolute, and am not comfortable with millimetres. The vast majority of English-speaking observers must be in the same case, or more so. Is it too much to ask that the Meteorological Office should give us the temperatures in degrees Fahrenheit and the barometer and rainfall in inches in the Weekly and Monthly reports, side by side with the international units? It would be a move which would pay them. The present policy certainly will not pay, if they want to encourage voluntary observers.

The fact is that the English-speaking world as a whole has no use for the Metric System; the British foot and its subdivisions are too convenient and too deeply rooted to be displaced. As far as the Anglo-Saxon race is concerned the millimetre and its multiples will never be anything but the language of the trained savant and the scientific pedant. The same may be said of the Fahrenheit thermometer scale. It has taken root too deeply to be displaced. No doubt it was founded on a mistaken idea, but so was the Metric System. The British Empire, plus the United States, cover too big a slice of the globe for their ideas to be ignored.

WM. F. A. ELLISON.

Armagh Observatory, June 22nd, 1921.

Visibility at Deal.

DEAL has lately experienced a degree of visibility hardly ever remembered by the present generation. The nearest point of the French coast has been clearly visible for an extent of about eight miles, with the Dover Patrol Memorial distinguishable by the naked eye. Also the land beyond to the south, on which is the Cape Griz Nez Lighthouse, has been visible to the extent of about 1½ miles. It is estimated that objects have been distinguished with the naked eye at a distance of over 25 miles.

R. J. DOYLE PARGETER.

Aston Villa, Wellington Road, Deal, June 28th, 1921.

Somerset—Eleven Months of Deficient Rainfall.

THE seriousness of the present shortage of rainfall is much enhanced by the fact that for five months before this year began there had been a great deficiency of rainfall in this district. I give below figures corresponding to those given by Mr. Dansey in the June issue, but for eleven months.

The first six months of 1921 show 8·48 ins. of rain on 68 days, against the previous minima of 9·4 ins. in 1908 and 71 rain-days in 1918.

But it is of far more serious import that the total rainfall of the eleven months August 1920—June 1921 should be only 18·10 ins., against the previous lowest of 23·54 ins. for the corresponding months of 1906–7, or against a previous lowest, for *any* consecutive eleven months, of 20·34 in January–November 1911.

Month.	Average for 24 years.		1919 and 1920 Rainfall.	1920 and 1921.	
	Rainfall.	Rain-days (of ·01).		Rainfall.	Rain-days (of ·01).
	Inches.		Inches.	Inches.	
August	3·29	16·4	3·57	1·60	6
September	2·10	12·5	1·62	1·55	11
October	3·43	18·4	2·01	2·86	12
November	2·53	17·0	2·42	1·37	10
December	4·12	21·2	5·52	2·24	14
January	2·71	16·8	4·48	2·92	22
February	2·40	17·1	1·05	·24	2
March	2·53	17·5	2·19	2·09	19
April	2·27	14·9	4·77	·88	7
May	2·05	13·5	1·55	1·94	16
June	2·42	12·3	2·32	·41	2
	29·85	177·6	31·50 +1·65	18·10 –11·75	121 –55·4

The only rain to speak of during this parching June was ·40, with a little thunder, in about two hours in the late evening of the 25th. H. A. BOYS, F.R.Met.Soc.

North Cadbury Rectory, Somerset, July 4th, 1921.

The long Dry Period—the Totland Bay Record.

IT may be of interest to note that the June rainfall at Totland Bay was only 0·16 inch, the driest June on record. June is the fifth month in succession below average. The total for the last five months is 3·38 ins.; for a similar period in 1893 the fall was 5·78 ins. The driest period of any previous five months was 4·53 inches during May 1st to September 30th, 1893.

The driest half year is still January 1st to June 30th, 1892, with 5·99 ins.; the next is January to June 1893, with 7·62 ins.; and then 1921, with 7·88 ins. JOHN DOVER.

Aston House, Totland Bay, I.O.W., July 1st, 1921.

High Temperature in the Wirral Peninsula.

IT may be of interest to some of your readers to know that here in West Kirby on the banks of the River Dee, as it empties itself out into the Irish Sea, the remarkably high temperature or 92° F. in the shade, was recorded by me in my thermometer screen on Saturday, June 25th, at 13 h. 45 m. G.M.T. The readings during the day were as follows:—

Time G.M.T. -	9 h. 0 m.	11 h. 0 m.	12 h. 0 m.	13 h. 0 m.
Temperature F. -	78	87	89	90

Time G.M.T. -	13 h. 45 m.	14 h. 15 m.	14 h. 30 m.
Temperature F.	92	81	86

The drop of 11° between 13 h. 45 m. and 14 h. 15 m. was due to a shift of the wind from SE. to N. and with another shift of the wind to NE. the temperature again rose. It is interesting to note that no less than three other thermometers in the area registered a shade reading between 91° F. and 94° F. These are said to be the highest readings yet recorded in this neighbourhood, and Bidston Observatory elevated on Bidston Hill also recorded the very high reading of 86° F., so it is only to be expected that sheltered spots like West Kirby with a land breeze blowing should record even higher readings.

E. F. ROBSON.

St. Andrews Vicarage, West Kirby, Cheshire, July 2nd, 1921.

[For June 25th the maximum temperatures reported to the Meteorological Office from the station nearest to West Kirby are Hoylake 81° F., Bidston Observatory 86° F., Blundellsands 88° F., Hawarden Bridge 86° F., Rhyl 81° F., Macclesfield 86° F. No temperatures above 89° F. were registered officially in the British Isles. The contrast between the 92° F. at West Kirby and the 81° F. at Hoylake less than two miles distant may be explained perhaps by the SE. wind reaching the former station across the flats bordering the Dee and the latter station across open sea.—ED. M. M.]

Sunspots and Weather.

IN your last issue, in an article on sunspots and weather, Mr. C. E. P. Brooks remarks "Solar variations undoubtedly cause marked fluctuations of terrestrial magnetism and auroral frequency, but there is no evidence that either of these elements is a factor of weather. . . ."

Now in a paper (*Phil. Mag.*, Vol. XXXV., 1918, p. 234) on *Rain, Wind and Cyclones*, I suggest "that the great heating of the upper surface of the atmosphere over the poles is primarily due to the electrons shot out by the sun, which, being caught by the earth's magnetic field, are directed towards the poles, the air in the neighbourhood of which they heat and probably ionise." On this point I may perhaps be allowed to quote from page 169 of Sir Oliver Lodge's book on Electrons: "These early perceptions have been well elaborated of late by Arrhenius and his explanation of the aurora—by means of the catching and guiding of the rapidly moving electrons by the earth's magnetic lines of force, so as to deflect them away from the tropical sunshine, and to guide them in long spirals, along the lines to the poles—there to reproduce the phenomena of the vacuum tube in the rarified upper regions of the atmosphere—is particularly definite and pleasing."

It is scarcely correct, therefore, to say that solar influence, as regards the weather, acts entirely through slight variations in the heat and light rays emitted by the sun. These would affect the equatorial regions mainly. The great difficulty is to account for the two great polar cyclones, and their variations in intensity. My view is that these cyclones are due to the electrons shot out by the sun and caught by the earth's magnetic field. R. DEELEY.

"*Tintagel*," *Kew Gardens Road, Kew, Surrey, July 5th*, 1921.

[Reference to the paper cited by Mr. Deeley shows that he produces no direct evidence which would controvert Mr. Brooks's statement. It is interesting to notice that the energy of the greatest magnetic storm is insignificant compared with that of a cyclone, so that if the phenomena are associated in any way it must be through some trigger-like action.—ED. M.M.]

NOTES AND QUERIES.

The Problem of Forecasting Periods of Drought.

THE issue to farmers of notifications of expected spells of settled fair weather presents a problem rather different from that of ordinary daily forecasting. The occasions when a forecaster would feel justified in predicting absolutely rainless weather for three days in succession are very rare, and if he were to wait for these occasions the farmer who delays cutting his hay until the receipt of a "spell notification" might miss the most favourable opportunity. The problem for the forecaster is really to find out types of pressure distribution following which the rainfall is generally very much below the average during the next week or so.

As an example, one fair type may be considered, namely, that in which there is an anticyclone nearly due west of Ireland, apparently at no great distance, while the low pressure is all to the east of the British Isles (type X, plate VI, in Geophysical Memoir No. 16), and the weather has become fair over the British Isles. The number of successive days of generally fair weather over southern England (as far north as Nottingham) following such conditions has been tabulated for the months of May and June from 1905 to 1921. No strict definition of a "break" has been made, but a rainfall of about 1 mm. (·04 in.) on one day at a few stations only has not been taken to constitute more than a "temporary break," nor have quite local falls of rather more than this amount due to isolated thunderstorms. The duration of the spell is intended to represent the length of time during which generally favourable weather for haymaking purposes was experienced.

The results are shown in the following table:—

Date of commencement of Fair Spell.	Duration of Spell in Days.	Manner of break up.
May 12th, 1905	18	Slight local breaks 16th and 20th, finally SW. type with thunderstorms.
May 16th, 1907	2	Rain spread westwards from a depression over the Continent.
May 23rd, 1910	6	To westerly type.
May 19th, 1911	7	Col with thunderstorms after fair SW. type. A depression apparently formed over Germany and moved SW.
May 24th, 1912	6	Depression spread westwards from Scandinavia. Thunderstorms.
May 14th, 1914	8	Col with thunderstorms, the result of a secondary to a depression near Iceland, forming over Portugal.
May 28th, 1915	23	Temporary breaks in extreme south-west June 2nd and 10th. Finally wet south-east type.
June 3rd, 1906	12	Depression from Baltic.
June 20th, 1908	13	Thunderstorms spread up from south.
June 8th, 1909	2	Depression from east of the British Isles.
June 9th, 1911	4	Depression formed over the Bay of Biscay.
June 3rd, 1914	2	Depression moved SE. from Iceland.
June 15th, 1916	7	Partial break 20th and 21st. Depression moved east from the Atlantic.
June 2nd, 1919	2	Depression spread back from the Baltic.
June 15th, 1921	10	Temporary break in parts of East Anglia due to thunderstorms, 17th and 20th. Depression spread up from the south, giving thunderstorms, 25th–26th.

It will be seen that the average fair spell lasted about eight days. For individual stations the average would be higher than this.

It is noteworthy that a quick break up under these conditions appears more likely to be caused by the polar current to the east of the British Isles than in any other way. Of the four cases where the fair weather lasted only 2 days, three corresponded with the direct spreading back of this current and one to the fact that a depression moved down from the north and eventually produced the same result. On the other hand, the cases where depressions advanced from the Atlantic gave spells of 18, 6, 23 and 7 days duration.

Generally speaking, the type represents a 2 to 1 chance of at least 6 days fair weather. Extended researches on these lines would almost certainly yield results of practical value. It would be necessary to treat the various districts of the British Isles separately and find out for each the types of weather map on which spell notifications should be issued. It is worth noticing that the best type is not necessarily that which, while it lasts unchanged, gives the driest weather; the possibility of intermediate fair types occurring before a change to unsettled weather takes place is a factor. Thus, the type here considered is especially favourable for the southern Midlands, for the spreading back of wet weather from the North Sea often leaves the inland districts unaffected while giving very bad weather in East Anglia; moreover, thunderstorms sometimes extend up from the Bay of Biscay to the south coast of England without penetrating far inland, and the change to a wet south-westerly type would generally give several days of dry weather in the southern Midlands, lasting perhaps for more than a week if pressure remained high from Spain to Germany. For eastern Scotland one would anticipate that a large anticyclone actually centered over Scotland or somewhat further north would be very favourable for continued fair weather, while one to the west, on the other hand, might not be so effective because of the frequency with which under these conditions depressions form over Scandinavia or arrive there from the Icelandic region, causing rain in Scotland. It is quite possible that for southern England the type considered is better than the case where an anticyclone is actually centered over England, owing to the ease with which a change to a thundery type can take place in the latter case. These and other similar problems can be solved only by careful statistical treatment extended over a period of many years.

E. V. NEWNHAM.

Visibility in London.

LAST month attention was drawn to the exceptional clearness of the atmosphere as shown by the observations of visibility taken from the roof of the Meteorological Office at South Kensington. The records for June are even more striking than those for May. In 30 observations at 9 h. Big Ben (at $2\frac{3}{4}$ miles) was visible 27 times and St. Paul's Cathedral (at $4\frac{1}{4}$ miles) 23 times, and in 22 observations at 15 h. Big Ben was visible 22 times and St. Paul's 20 times.

The Effect of the Coal Crisis upon London Sunshine.

THE scarcity of coal during the past three months might be expected to effect favourably the amount of sunshine enjoyed in large towns. To test the accuracy of such a supposition an analysis has been made of the records from selected stations (*a*) in central London, (*b*) in outer London, and (*c*) near enough to London to be regarded as under the influence of the same general meteorological conditions, but far enough away to be ordinarily free from the effects of London smoke. The results are given in the following table:—

DURATION of SUNSHINE in 1921 expressed as a percentage of the normal for the period 1881–1915.

Station.	April.	May.	June.
(*a*) Westminster - - - -	144	130	125
Bunhill Row - - - - -	138	122	117
(*b*) Greenwich - - - - - -	134	116	110
Kew Observatory - - - -	124	114	113
(*c*) Wisley - - -	126	110	117
Tunbridge Wells - - -	123	105	108

In each month the deviation from the normal is greater in central London than in the outer zone, whereas the difference between outer London and the country districts is comparatively small. During the first weeks of the strike the shortage of coal was probably little felt in many cases, thus the figures for April are more uniform than those for May, when the difference between Westminster (130 per cent.) and Tunbridge Wells (105 per cent.) is at its maximum. The subsequent decrease in June may be due in part to the normal decrease during the summer in consumption for household purposes.

It is, however, improbable that the greater deviations in inner London are wholly due to the strike. The values published in the *Monthly Weather Reports* for the same period in recent years indicate that the atmosphere in London has been tending to become clearer, owing, presumably, to the extended use of gas and perhaps to daylight saving. Such conditions may account for half or even more than half the difference, but scarcely the whole. L. DORIS SAWYER.

Radiation from the Sky.

IN the *Meteorological Magazine* for May 1921 observations on radiation from the sky above Benson for the months of January and February, 1921 were published. The results of observations for March, April and May are given in the following table. It is regretted that owing to the illness of the observer there are not observations enough to give reliable averages for June.

RADIATION MEASURED AT BENSON, OXON., 1921.

Unit : one gramme calorie per square centimetre per day.

		March.	April.	May.
ATMOSPHERIC RADIATION only (dark heat rays). Averages for Readings about time of Sunset.				
Cloudless days :—				
Radiation from sky in zenith	πI	434	450	496
Total radiation from sky	J	467	483	525
Total radiation from horizontal black surface on earth.	X	647	660	690
Net radiation from earth	X-J	180	177	165
DIFFUSE SOLAR RADIATION (luminous rays). Averages for Readings between 9 h. and 15 h. G.M.T.				
Cloudless days :—				
Radiation from sky in zenith	πI_0	31	53	70
Total radiation from sky	J_0	52	58	75
Cloudy days :—				
Radiation from sky in zenith	πI_1	123	130	190
Total radiation from sky	J_1	110	165	183

The notation used is explained on page 99. The references to the times of observations are correct in the present table; the earlier one should be amended.

Abnormal July Temperature.

DURING July the weather has become a subject of absorbing interest. Temperatures over 90° F. have been reported in many parts of England on several days, and records for July have been broken. The continued drought is causing great anxiety; the flow in the Thames is so much reduced that the river can be forded at Teddington. Mirage has become a frequent phenomenon in the London streets.

Problems of Cloud Nomenclature.

THE feeling that cloud nomenclature according to the international classification does not meet the needs of meteorologists is widespread, but the remedies proposed are as numerous as the doctors. It is desirable that the views of the United States Weather Bureau as set out by Dr. C. F. Brooks in his paper read before the American Meteorological Society in April 1920, and printed in the *Monthly Weather Review* for September 1920, should be discussed on this side of the Atlantic. Dr. Brooks decides against classifying clouds according to the processes by which they may be supposed to originate, and against the practice of giving detailed descriptions with epithets such as fibrous, smooth, &c., in routine observations. His conclusions are in favour of retaining the ten types of the international classification whilst modifying slightly some of the definitions. It is to be noted that he has not had his article illustrated, as he considers that observers must decide doubtful cases by reference to definitions rather than to pictures.

The principal changes in definition proposed are as follows :—

INTERNATIONAL DEFINITION.	PROPOSED DEFINITION.
Cirro-cumulus—"Mackerel Sky." Small globular masses or white flakes without shadows, or showing very slight shadows, arranged in groups and often in lines.	**Cirro-cumulus.** Small white flakes or tenuous globular masses which produce no diffraction colours near the sun or moon. The cloud units are usually arranged in groups and often in lines, suggestive of one or more sets of small waves. Cirro-cumuli, being composed of ice particles, are usually bright in spite of their tenuity and do not have the solid appearance characteristic of liquid-droplet, alto-cumulus clouds. At times the tops of cirrus tufts or of cirro-stratus sheets are capped with cirro-cumulus.

Alto-cumulus—"Great Waves."
Largish globular masses, white or greyish, partially shaded, arranged in groups or lines, and often so closely packed that their edges appear confused. The detached masses are generally larger and more compact (resembling strato-cumulus) at the centre of the group, but the thickness of the layer varies. At times the masses spread themselves out and assume the appearance of small waves or thin slightly curved plates. At the margin they form into fine flakes (resembling cirro-cumulus). They often spread themselves out in lines in one or two direction.

Alto-cumulus.
Globular, scaly or wave-like masses, white or greyish, partially shaded, usually arranged in groups or lines, and often so closely packed that their edges appear confused. In the vicinity of the sun or moon diffraction colours are usually visible. At times the tops of large cirrus tufts or of cirro-stratus or alto-stratus masses are capped with rounded domes of alto-cumulus, too large to be called cirro-cumulus.

Alto-stratus.
A thick sheet of grey or bluish colour, sometimes forming a compact mass of dark grey colour and fibrous structure. At other times the sheet is thin, resembling thick cirro-stratus, and through it the sun or the moon may be seen dimly gleaming as through ground glass. This form exhibits all changes peculiar to cirro-stratus, but from measurements its average altitude is about one-half that of cirro-stratus.

Alto-stratus.
A sheet of grey or bluish colour, either generally fibrous or presenting a smooth, undulated, mammato, or frayed-hole appearance. Through the fibrous (snow crystal) alto-stratus the sun or the moon may at times be seen dimly gleaming as through ground glass. On thin parts of the other (water droplet) kind diffraction colours appear in the vicinity of the sun or moon. Steady rain or snow may fall for hours from alto-stratus.

Stratus.
A uniform layer of cloud resembling a fog, but not resting on the ground.

Stratus.
A low layer of cloud. Stratus is distinguishable from alto-stratus only by whether or not it appears to be lower than 1,000 metres above the surface.

In other cases minor alterations are suggested. The definition of strato-cumulus begins "large globular masses or rolls of dark clouds." Dr. Brooks would substitute "disc-like or scaly" for "globular," though it will be noticed that he passes "globular" in the definitions of cirro-cumulus and alto-cumulus. The authoritative French text has *petites balles* for cirro-cumulus, *balles plus grosses* for alto-cumulus, *grosses balles* for strato-cumulus. In the translation in "Cloud Forms" we find "small rounded masses," "larger rounded masses" and "large lumpy masses."

It is for the practised observer to say how far the proposed alterations in the definitions would facilitate his task. It is worth consideration, however, whether some far simpler scheme of instructions should not be practicable. Correspondence on this question would be welcomed.

Oxford University Expedition to Spitzbergen.

THE principal object of the Oxford University Expedition to Spitzbergen is the investigation of biological problems such as the modification of the habits of animals in an Arctic climate. The study of the coal measures is expected to indicate what species of timber flourished formerly in the island, and may throw light on the climatic changes that have taken place. The meteorologist of the expedition is Mr. R. A. Fraser, of the National Physical Laboratory.

Owing chiefly to the work of the Norwegian Meteorological Institute, we are well supplied with statistics for low-level stations in the islands, and there are valuable series of upper air observations, but there is scope for pioneer work on the climate of the uplands.

Transmission of Mercurial Barometers by Rail.

BAROMETERS are no longer accepted by the English railway companies for transmission at company's risk, and in order to overcome the difficulty thus created the Meteorological Office now forwards barometers in "doolies," or light wooden frames after the style of sedan chairs, which are arranged to take either two or four barometers each. The instruments are placed in their own boxes, which are secured in vertical pockets provided in the centre of the dooly in such a way that the barometer cisterns are upwards. The whole is sent by passenger train at owner's risk. Many instruments have already been forwarded in this manner and no breakages of tubes have occurred.

This method was adopted in India many years ago, and is still in regular use there.

Further particulars will be sent to anyone interested.

Review.

Amount and Composition of Rain Falling at Rothamsted. By E. J. Russell and E. H. Richards. The Journal of Agricultural Science, London, Oct. 1919, Vol. 9, pp. 309–337.

THIS paper, although of particular interest to the agricultural chemist, contains much of importance for the meteorologist. Estimations of the proportions of nitrogen and of chlorine in rain which have been made at Rothamsted since 1888 and 1877 respectively are dealt with. The annual rainfall of Rothamsted has been increasing, on the whole since 1908. It is found that over the whole period the amount of nitrogen fixed as nitrate increased, but the amount fixed as ammonia decreased, the sum remaining fairly constant. The

THAMES VALLEY RAINFALL —— JUNE, 1921.

Isohyetals.

Meteorological Magazine.

ALTITUDE SCALE: Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES: 0 5 10 15 20

H.M.S.O. Press, Kingsway, W.C.2.

chlorine in the rainwater increased from 2–2½ parts to 2½–3 parts per million by weight.

The average values for the constituents mentioned amounted, in lb. per acre per year, to—ammoniacal nitrogen 2·64, nitric nitrogen 1·33, organic nitrogen 1·35, chlorine 16, whilst the corresponding figure for the dissolved oxygen is 66·4. In the winter the rain was richer in chlorine and oxygen and poorer in ammoniacal and nitric nitrogen than in the summer months.

The main sources of the nitrogen are three, viz., the sea, the city smoke, and the soil; it is thought that the soil supplies the major part. Experiments have shown that the ammoniacal nitrogen existing as such at any time in the top 9 inches of soil amounts to at least 5 lb. per acre, and its rate of diffusion into the atmosphere must be fairly rapid. If the rate were greater in wet weather it would account for the renewal of the amount in the air and give an increased quantity with increased rainfall. It is further argued that the greater amount in the summer months is due to the increased biochemical action in the soil which is certainly greatest at that time of the year.

The chlorine is usually attributed mainly to the sea spray blown over the land, which view is consistent with the facts here. The winter gales give high chlorine values in the winter months, and the chlorine from fires is also most in evidence at this season.

The cause of the lower proportion of oxygen in the summer months (about 95 per cent. of saturation compared with 99 per cent. in the winter) is thought to be that in the summer the rain is formed higher up at pressures below that at ground level and in falling has not time to become saturated.

The marked difference in the amounts of the constituents falling in the summer and winter suggests a different origin for the rain.

The winter rain at Rothamsted resembles that collected at Valencia Observatory on the Atlantic coast in its high chlorine and low ammonia contents. The high proportion of chlorine at Rothamsted in winter is probably due in part to the fact that the air in which rain is formed in SE. England has usually been over the Atlantic a few hours previously but also to the fact that the stronger winds of the season carry more spray into the air; the evaporated spray leaves in the air nuclei of salt on which some of the moisture will condense when the air eddies up into cooler regions.

On the other hand, in summer the air has been for longer periods over the land and has had time to become charged with ammonia before the occurrence of the rainfall of the convectional type for which the ammonia and ammonium salts may serve as nuclei of condensation.

A Correction.

THE radius of the halo described by Mr. R. E. Watson in the *Meteorological Magazine*, April 1921, p. 70, should be given as 23°, not 33°.

The Geophysical Observatory at Lerwick.

THE Geophysical Observatory at Lerwick was opened on June 7th, 1921. It has long been recognised that the establishment of an observatory in the Shetlands was desirable so as to secure observations of aurora under favourable conditions as well as records of magnetic force in the most disturbed region of the British Isles. The invitation of the Norwegian Government to co-operation in geophysical work during the period of Amundsen's Arctic expedition gave a further stimulus for the founding of a northern observatory.

The Lerwick Observatory occupies the premises of the Admiralty Wireless Station, which has been handed over to the Air Ministry for the purposes of the Meteorological Office.

The work of the Observatory will include meteorology, terrestrial magnetism, auroral parallax and atmospheric electricity; and when permanency is ensured further geophysical work will be undertaken. For the present the observations telegraphed for the daily weather service are to be contributed as hitherto by H.M. Coastguard. It should be noted, however, that the telegraphic reporting station which had been at Fort Charlotte since 1911 except for a few months in 1918 and 1919, was transferred to The Nab on April 14th, 1921. The station on this new site has a very free exposure—in fact, there is not sufficient shelter for satisfactory observations of rainfall. The Nab is ¾ mile from Fort Charlotte, whilst the Observatory is 1¾ miles from the Fort.

News in Brief.

WE regret to learn that Capt. Roald Amundsen has suffered a further delay in his Arctic expedition. His vessel, the *Maud*, lost a propeller off Cape Serge, on the Behring Strait, and is to be towed to Seattle for repairs.

SEÑOR JUAN CRUZ CONDE has been appointed Director of the Spanish Meteorological Service in succession to Señor Jose Galbis. Señor Galbis, who held the directorship from 1900, has been made a member of the Council of the Geographical Service.

Dr. Julius von Hann has retired from the editorship of the *Meteorologische Zeitschrift* after 55 years in that capacity. He edited the first number of the Zeitschrift in 1866, and since then has been joint editor with Jelinek, Köppen, Hellmann, and Süring. Drs. F. H. Exner and R. Süring are the present editors. At the meeting of the Austrian Meteorological Society on March 7th, 1921, Dr. Hann was presented with an address in which he was thanked for his services rendered through the medium of the Zeitschrift to the Society and to the science of Meteorology.

The publication of the twelfth volume of the *Zeitschrift für Gletscherkunde* (Berlin, 1921) is announced. The price is £1 in this country, and the editors appeal for subscriptions in order that the publication of this work, much hindered during the war years, may be continued. A descriptive leaflet and a specimen section of the volume may be obtained post free on application to

Verlagsbuchhandlung Gebrüder Borntraeger,
Berlin, W. 35,
Deutsches Reich. Schoneberger Ufer 12a.

The Meteorological Office staff at Croydon aerodrome are to be congratulated on the organization of a cricket team, and on a victory in their first match with the score 118 for 5 (Budd, 50 not out).

The Weather of June 1921.

The weather of June over a considerable part of western and south-western Europe was notable for the exceptional scarcity of rain, due to the predominating effect of the anticyclone over the eastern Atlantic.

At the beginning of the month the Azores anticyclone extended to Scandinavia, while cyclonic conditions prevailed in the extreme north-west, and relatively low pressure over southern Europe and the Mediterranean. The weather was fair or fine in the anticyclonic region, but there was heavy rain in parts of central Europe.

On the 3rd and 4th a shallow depression over France caused rain in the north of France and south-east of England, with local thunderstorms in the Netherlands, whilst the Atlantic anticyclone moved north until it was situated between Iceland and the Hebrides.

A new depression which began to form over Scandinavia, giving strong northerly winds and rain on the Norwegian

(*Continued on* p. 170.)

Rainfall Table for June 1921.

STATION.	COUNTY.	Aver. 1881—1915. in.	1921. in.	1921. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days
Camden Square	*London*	2·02	·37	9	18	·23	3	5
Tenterden (Ashenden)	*Kent*	1·91	·00	0	0	·00	..	0
Arundel (Patching Farm)	*Sussex*	2·02	·05	1	2	·04	19	2
Fordingbridge (Oaklands)	*Hampshire*	1·85	·26	7	14	·16	25	3
Oxford (Magdalen College)	*Oxfordshire*	2·13	·35	..	16	·18	26	6
Wellingborough (Swanspool)	*Northampton*	2·10	·37	9	18	·20	26	5
Hawkedon Rectory	*Suffolk*	2·07	·29	7	14	·16	3	3
Norwich (Eaton)	*Norfolk*	1·93	·55	14	28	·38	17	7
Launceston (Polapit Tamar)	*Devon*	2·15	·02	1	1	·02	25	1
Sidmouth (Sidmount)	,,	2·10	·80	20	38	·69	25	2
Ross (Chasedale Observatory)	*Herefordshire*	2·15	·41	11	19	·30	25	6
Church Stretton (Wolstaston)	*Shropshire*	2·42	·64	16	26	·27	4	6
Boston (Black Sluice)	*Lincoln*	1·82	·55	14	20	·22	26	6
Worksop (Hodsock Priory)	*Nottingham*	1·98	·44	11	22	·14	20	6
Mickleover Manor	*Derbyshire*	2·39	·51	13	21	·32	4	5
Southport (Hesketh Park)	*Lancashire*	2·17	·46	12	21	·25	25	9
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·39	·17	4	7	·07	4	4
Hull (Pearson Park)	,, *E. R.*	2·06	·26	7	13	·10	4	6
Newcastle (Town Moor)	*North'land*	2·17	·88	22	41	·17	8	8
Borrowdale (Seathwaite)	*Cumberland*	6·52	1·76	45	27	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	2·49	·06	2	2	·03	12	3
Haverfordwest (Gram. Sch.)	*Pembroke*	2·70	·01	0	0	·01	26	1
Aberystwyth (Gogerddan)	*Cardigan*	3·11	·44	11	14	·34	27	3
Llandudno	*Carnarvon*	2·39	·21	5	9	·07	25	8
Dumfries (Cargen)	*Kirkcudbrt.*	3·24	·45	11	14	·21	8	7
Marchmont House	*Berwick*	3·05	·75	19	25	·30	9	8
Girvan (Pinmore)	*Ayr*	2·89	·93	24	32	·39	22	12
Glasgow (Queen's Park)	*Renfrew*	2·31	·50	13	22	·14	12	9
Islay (Eallabus)	*Argyll*	2·62	1·41	36	54	·26	12	13
Mull (Quinish)	,,	2·97	1·64	42	55	·48	22	16
Loch Dhu	*Perth*	4·17	·50	13	12	·10	9,12*	7
Dundee (Eastern Necropolis)	*Forfar*	1·80	·62	16	34	·15	8	11
Braemar (Bank)	*Aberdeen*	1·91	·74	19	39	·16	20	5
Aberdeen (Cranford)	,,	1·80	1·12	28	62	·35	8, 21	14
Gordon Castle	*Moray*	2·04	1·79	45	88	·36	9	15
Fort William (Atholl Bank)	*Inverness*	3·50	1·25	32	36	·29	22	14
Alness (Ardross Castle)	*Ross*	2·26	·84	21	37	·31	21	13
Loch Torridon (Bendamph)	,,	4·08	..	..	..	..	..	..
Stornoway	,,	2·32	1·76	45	76	·42	21	14
Wick	*Caithness*	1·80	1·12	28	62	·16	9	20
Glanmire (Lota Lodge)	*Cork*	2·70	·04	1	1	·04	25	1
Killarney (District Asylum)	*Kerry*	2·91	·06	1	2	·06	27	1
Waterford (Brook Lodge)	*Waterford*	2·69	·08	2	3	·08	27	1
Nenagh (Castle Lough)	*Tipperary*	2·45	·76	19	31	·57	26	4
Ennistymon House	*Clare*	3·05	·64	16	21	·21	12	9
Gorey (Courtown House)	*Wexford*	2·43	·74	19	30	·63	25	5
Abbey Leix (Blandsfort)	*Queen's Co.*	2·59	3·69	94	142	3·10	26	8
Dublin (FitzWilliam Square)	*Dublin*	1·95	·19	5	10	·06	26	7
Mullingar (Belvedere)	*Westmeath*	2·60	·20	5	8	·11	11	4
Woodlawn	*Galway*	2·79	·39	10	14	·13	12	8
Crossmolina (Enniscoe)	*Mayo*	3·00	·64	16	21	·18	11	7
Collooney (Markree Obsy.)	*Sligo*	2·94	·49	12	17	·12	11	8
Seaforde	*Down*	2·76	·44	11	16	·13	11	5
Ballymena (Harryville)	*Antrim*	2·91	·67	17	23	·19	11	10
Omagh (Edenfel)	*Tyrone*	2·82	·58	15	21	·16	20	7

* and 19.

Supplementary Rainfall, June 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	·19	5
"	Sevenoaks, Speldhurst	·12	3
"	Hailsham Vicarage	·00	0
"	Totland Bay, Aston	·16	4
"	Ashley, Old Manor Ho.	·11	3
"	Grayshott	·13	3
"	Ufton Nervet	·31	8
III.	Harrow Weald, Hill Ho.	·17	4
"	Pitsford, Sedgebrook	·38	10
"	Chatteris, The Priory	·41	10
IV.	Elsenham, Gaunts End	·90	23
"	Lexden, Hill House	·10	3
"	Aylsham, Rippon Hall	·38	10
"	Swaffham	·51	13
V.	Devizes, Highclere	·26	7
"	Weymouth	·30	7
"	Ashburton, Druid Ho.	·11	3
"	Cullompton	1·02	26
"	Hartland Abbey	·04	1
"	St. Austell, Trevarna	·10	3
"	North Cadbury Rec.	·41	10
"	Cutcombe, Wheddon Cr.	·56	14
VI.	Clifton, Stoke Bishop	·20	5
"	Ledbury, Underdown	·72	18
"	Shifnal, Hatton Grange	·50	13
"	Ashbourne, Mayfield	·30	8
"	Barnt Green, Upwood	·55	14
"	Blockley, Upton Wold	·46	12
VII.	Grantham, Saltersford	·89	23
"	Louth, Westgate	·42	11
"	Mansfield, West Bank	·80	20
VIII.	Nantwich, Dorfold Hall	·44	11
"	Bolton, Queen's Park	·43	11
"	Lancaster, Strathspey	·61	15
IX.	Rotherham	·36	9
"	Bradford, Lister Park	·05	1
"	West Witton	·36	9
"	Scarborough, Scalby	·31	8
"	Middlesbro', Albert Pk.	·36	9
"	Mickleton	·20	5
X.	Bellingham	·86	22
"	Ilderton, Lilburn	·53	13
"	Orton	·26	7
XI.	Llanfrechfa Grange	·20	5
"	Treherbert, Tyn-y-waun	1·13	29
"	Carmarthen Friary	·03	1
"	Fishg'rd, Goodwick Stn.	·05	1
"	Lampeter, Falcondale	·27	7
"	Cray Station	1·00	25
"	B'ham W.W., Tyrmynydd	·77	20
"	Lake Vyrnwy	·31	8
"	Llangynhafal, P. Drâw	·50	13
"	Oakley Quarries	·96	24
"	Dolgelly, Bryntirion	·54	14
"	Lligwy	·10	3
XII.	Stoneykirk, Ardwell Ho.	·28	7
"	Carsphairn, Shiel	1·19	30
XII.	Langholm, Drove Rd.	·73	19
XIII.	Ettrick Manse	·52	13
"	North Berwick Res	·57	15
"	Edinburgh, Royal Ob.	·35	9
XIV.	Biggar	·50	13
"	Leadhills	1·10	28
"	Maybole, Knockdon	·78	20
XV.	Dougarie Lodge	·69	17
"	Inveraray Castle	2·00	51
"	Holy Loch, Ardnadam	·59	15
XVI.	Loch Venachar	·30	8
"	Glenquey Reservoir	·20	5
"	Loch Rannoch, Dall	·50	13
"	Trinafour	·35	9
"	Blair Athol	·61	15
"	Coupar Angus	·63	16
"	Montrose Asylum	1·00	25
XVII.	LogieColdstone, Loanh'd	1·21	31
"	Fyvie Castle	1·51	38
"	Grantown-on-Spey	1·29	33
XVIII.	Cluny Castle	·97	25
"	Loch Quoich, Loan	5·00	127
"	Fortrose	·75	19
"	Faire-na Squir	2·12	54
"	Skye, Dunvegan	2·29	58
"	Glencarron Lodge	2·46	63
"	Dunrobin Castle	1·08	27
XIX.	Tongue Manse	1·77	45
"	Melvich Schoolhouse	1·62	43
"	Loch More, Achfary	4·29	109
XX.	Dunmanway Rectory	·08	2
"	Mitchelstown Castle	·32	8
"	Gearahameen	·00*	0
"	Darrynane Abbey	·13	3
"	Clonmel, Bruce Villa	1·07	27
"	Cashel, Ballinamona	·22	6
"	Roscrea, Timoney Pk.	1·03	26
"	Foynes	·60	15
"	Broadford, Hurdlesto'n	·45	11
XXI.	Kilkenny Castle	·26	7
"	Rathnew, Clonmannon	·55	14
"	Hacketstown Rectory	1·01	26
"	Balbriggan, Ardgillan	·11	3
"	Drogheda	·05	1
"	Athlone, Twyford	·94	24
XXII.	Castle Forbes Gdns.	·31	8
"	Ballynahinch Castle	·83	21
"	Galway Grammar Sch.	·44	11
XXIII.	Westport House	·68	17
"	Enniskillen, Portora	·35	9
"	Armagh Observatory	·28	7
"	Warrenpoint	·20	5
"	Belfast, Cave Hill Rd.	·41	10
"	Glenarm Castle	·29	7
"	Londonderry, Creggan	·75	19
"	Sion Mills	·30	8
"	Milford, The Manse	·57	15
"	Narin, Kiltoorish	·52	13
"	Killybegs, Rockmount	1·23	21

* Read to nearest ·1 inch.

Climatological Table for the

STATIONS	PRESSURE: Mean of Day M.S.L. mb.	PRESSURE: Diff. from Normal mb.	TEMPERATURE Absolute: Max. °F.	Date	Min. °F.	Date	Mean Values: Max. °F.	Min. °F.	½ max. and min. °F.	Diff. from Normal °F.
London, Kew Obsy.	1016·2	+1·0	79	May 25	21	Dec. 13	57·4	44·0	50·7	+1·0
Gibraltar	1018·2	+1·7	95	Aug. 6	37	Mar. 11	70·4	57·6	64·0	−0·1
*Malta	1015·7	+0·9	97	Aug. 24	47	Jan. 21	..	..	66·3	+1·1
Sierra Leone	1012·6	+0·8	99	Feb. 24 Mar. 7	65	May 22	87·1	72·8	79·9	−1·0
Lagos, Nigeria	1012·9	+1·5	99	Mar. 24	68	Dec. 28	85·8	74·9	80·4	+0·2
Kaduna, Nigeria	1014·2	+4·1	100	Mar. 19, 20	49	Dec. 14	86·7	64·3	75·5	−1·3
Zomba, Nyasaland	1012·5	+0·4	97	Oct. 7	42	June 3	79·6	60·4	70·0	+0·9
Salisbury, Rhodesia	1013·0	−1·6	95	Nov. 25, 26	35	June 4	79·9	53·6	66·8	+1·7
Cape Town	1016·7	−0·3	96	Mar. 19 Apr. 14	38	June 23	71·8	54·6	63·2	+1·2
Johannesburg	..	..	90	Jan. 5	25	June 24	71·3	49·7	60·5	+1·0
Mauritius	..	..	..	..	..	..	..	..	..	..
‡Bloemfontein	..	..	97	Jan. 23	18	June 14	..	..	61·2	−0·2
Calcutta, Alipore Obsy.	1006·9	−0·6	105	June 1	50	Dec. 30	87·7	71·7	79·7	+1·0
Bombay	..	..	94	June 7	62	Feb. 7	87·2	76·1	81·7	+1·2
Madras	..	..	109	May 6	63	Dec. 3	92·0	76·0	84·0	+1·1
Colombo, Ceylon	1010·3	+0·9	93	Mar. 26	63	Dec. 5	86·2	74·8	80·5	−0·7
Hong Kong	1011·6	−1·0	93	July 25	45	Jan. 5	76·2	68·6	72·4	+0·1
Sydney	1016·0	+0·1	98	Nov. 24	38	June 5	71·0	55·5	63·2	+0·2
†Melbourne	1015·7	−0·4	106	Dec. 23	34	July 17	..	..	58·2	−0·2
Adelaide	1016·6	−0·4	110	Dec. 24	37	June 5	72·5	53·2	62·8	−0·2
‡Perth, W. Australia	1015·5	−0·9	107	Jan. 27	35	June 30	..	..	65·1	+1·1
Coolgardie	1015·1	−0·9	108	Jan. 13	29	July 1	77·0	51·3	64·2	−0·3
‡Brisbane	1016·0	+0·3	93	Feb. 24	41	July 13	..	..	68·5	−0·4
Hobart, Tasmania	1013·2	+0·7	102	Dec. 24	33	June 15	62·6	47·0	54·8	+0·5
Wellington, N.Z.	1014·9	+0·8	80	Feb. 9	29	July 25	60·3	48·7	54·5	−0·9
Suva, Fiji	1010·5	−0·9	91	Mar. 4	55	July 3	81·1	70·7	75·9	−1·1
Kingston, Jamaica	1013·8	−0·1	95	July 15	64	Feb. 7	88·6	71·7	80·1	+0·8
§Grenada, W.I.	1012·8	+0·4	90	Nov. 27	69	sev.	..	..	78·8	+0·1
Toronto	1016·3	−0·1	93	June 10	−18	Jan. 31	54·6	37·1	45·9	+1·5
Winnipeg	..	..	..	..	..	..	..	..	..	..
St. John, N.B.	1014·1	−0·6	83	July 9	−20	Jan. 31	48·4	33·5	40·9	−0·3
Victoria, B.C.	1016·7	+0·3	91	July 7	25	Jan. 22	55·0	43·2	49·1	−0·4

Mauritius.

September 1920	1019·6	−0·6	80	28	56	5	77·2	61·0	69·1	−1·0
October 1920	1018·2	0·0	84	31	61	4 & 11	79·9	64·9	72·4	−0·8

September, 1 day with thunder heard.

* March and April missing ; normal values for these months used for pressure and temperature.
† April and Nov. " " " " " " " "

LONDON, KEW OBSERVATORY.—Mean speed of wind 7·7 mi/hr. ; 8 days with snow, 13 with thunder heard, 66 with fog. 1 thunder in September previously unrecorded.

GIBRALTAR.—6 days with thunder heard, 16 with fog, 21 with gale.

MALTA.—Prevailing wind direction NW. ; mean speed of wind 7·3 mi/hr.

SIERRA LEONE.—Prevailing wind direction SW. ; 41 days with thunder heard, 9 with gale

SALISBURY, RHODESIA.—Prevailing wind direction easterly ; 2 days with thunder heard.

British Empire, Year 1920.

TEMPERATURE Absolute Max. in Sun °F.	TEMPERATURE Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	PRECIPITATION Amount mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible	STATIONS
140	10	78	6·9	23·62	601	– 5	160	3·5	29	London, Kew Obsy.
153	32	76	3·9	27·20	691	– 219	71	..	..	Gibraltar.
153	..	77	4·1	..	..	..	..	7·6	61	Malta.*
..	..	73	5·1	106·85	2714	– 1227	138	..	..	Sierra Leone.
165	42	74	6·6	53·10	1349	– 471	120	..	..	Lagos, Nigeria.
..	..	68	..	54·81	1392	+ 46	121	..	..	Kaduna, Nigeria.
..	..	82	5·5	65·77	1671	+ 260	129	..	..	Zomba, Nyasaland.
153	29	58	4·0	28·40	721	– 124	83	..	..	Salisbury, Rhodesia.
..	..	70	4·4	26·98	685	+ 36	104	..	..	Cape Town.
..	22	61	3·8	27·96	710	– 90	91	8·6	72	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
..	..	59	3·3	..	..	..	..	..	..	Bloemfontein.‡
..	41	60	4·6	63·75	1619	+ 51	71	..	..	Calcutta, Alipore Obsy.
139	53	73	3·5	41·05	1043	– 783	98	..	..	Bombay.
..	..	72	4·7	63·89	1623	+ 368	80	..	..	Madras.
163	55	75	6·9	90·73	2305	+ 149	189	..	..	Colombo, Ceylon.
..	..	78	7·4	107·88	2740	+ 627	161	4·7	39	Hong Kong.
148	33	67	4·8	43·42	1103	– 116	159	..	..	Sydney.
156	30	67	5·6	..	..	..	..	..	..	Melbourne.†
164	26	57	4·5	26·70	678	+ 143	119	..	..	Adelaide.
172	25	61	4·6	..	..	..	..	..	..	Perth, W. Australia.‡
169	25	43	3·8	7·63	194	– 64	60	..	..	Coolgardie.
155	34	64	4·7	..	..	..	..	..	..	Brisbane.‡
161	27	67	6·2	18·00	457	– 145	182	..	..	Hobart, Tasmania.
152	18	77	6·5	49·28	1252	+ 20	150	5·2	43	Wellington, N.Z.
..	..	87	5·9	109·14	2772	– 82	263	..	..	Suva Fiji.
..	..	74	4·5	9·11	231	– 630	55	..	..	Kingston, Jamaica.
144	..	75	4·8	..	..	..	..	..	..	Grenada, W.I.§
147	? – 20	73	5·3	29·91	760	– 90	145	..	..	Toronto.
..	..	..	..	..	..	..	..	..	..	Winnipeg.
139	? – 21	80	5·9	51·58	1310	+ 90	148	..	..	St. John, N.B.
145	? 19	83	5·8	30·29	769	– 58	155	..	..	Victoria. B.C.

Mauritius.

..	50	76	5·2	1·93	49	+ 16	22	7·8	65	September 1920.
..	54	71	5·2	1·87	48	+ 13	15	9·1	73	October 1920.

‡ December missing; normal values for these months used for pressure and temperature.
§ October " " " " " " " "

COLOMBO, CEYLON.—Prevailing wind direction SW.; mean speed 5·0 mi/hr.; 52 days with thunder heard.

HONG KONG.—Prevailing wind direction E.; mean speed 12·0 mi/hr.; 31 days with thunder heard, 32 with fog.

WELLINGTON.—1 day with thunder heard, 2 days of fog.

SUVA, FIJI.—41 days with thunder heard.

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean of Day M.S.L. mb.	Diff. from Normal mb.	Max. °F.	Date	Min. °F.	Date	Max. °F.	Min. °F.	½ max. and min. °F.	Diff. from Normal °F.
London, Kew Observatory	1015·7	−1·6	56	9	26	16	50·4	41·5	46·0	+7·1
Gibraltar	1026·8	+7·3	71	4	42	15, 16	61·5	47·5	54·5	−0·2
Malta	1019·2	+3·0	64	2	45	20	59·5	51·9	55·7	+1·4
Sierra Leone	1011·8	+0·7	93	12, 20, 23	65	4	89·7	70·5	80·1	−1·3
Lagos, Nigeria	1013·1	+3·2	90	16	65	29	88·0	71·5	79·7	−1·3
Kaduna, Nigeria	1014·4	+4·6	94	12	54	3, 24, 31	87·0	57·7	72·4	−1·9
Zomba, Nyasaland	1007·7	−0·2	90	5, 6	62	9, 19, 29	81·2	65·3	73·3	+0·9
Salisbury, Rhodesia	1007·4	−3·3	92	3	55	19	81·8	60·7	71·3	+1·8
Cape Town	1013·4	0·0	98	31	53	10	77·2	58·8	68·0	−1·8
Johannesburg	1011·0	−0·1	89	21	50	17	77·3	56·0	66·7	+0·5
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	95	26	49	16	88·2	58·7	73·5	+0·3
Calcutta, Alipore Obsy.	1014·9	−0·3	86	19	49	4	78·0	58·1	68·1	+1·7
Bombay	1012·4	−0·8	91	4	61	22	83·9	67·9	75·9	+0·7
Madras	1013·0	−0·9	88	2	65	31	84·4	71·4	77·9	+1·8
Colombo, Ceylon	1010·7	−0·1	92	26	69	6	86·1	73·4	79·7	−0·1
Hong Kong	1021·2	+1·8	76	26	45	14	64·2	54·1	59·1	−1·2
Sydney	1016·4	+3·9	89	2	57	13	77·0	64·0	70·5	−1·2
Melbourne	1015·6	+2·9	107	24	49	4	80·8	59·9	70·3	+2·9
Adelaide	1015·1	+2·1	110	23	53	4	88·3	64·7	76·5	+2·4
Perth, Western Australia	1012·8	+0·3	108	28	50	1	86·3	64·0	75·1	+1·4
Coolgardie	1011·7	+0·3	112	21	48	2	93·4	62·1	77·7	+0·3
Brisbane	1013·4	+2·1	89	11, 12	64	18	82·5	68·1	75·3	−2·0
Hobart, Tasmania	1015·6	+5·3	96	1	45	3	72·9	54·0	63·5	+1·2
Wellington, N.Z.	1017·2	+4·4	82	2	45	17	69·8	54·7	62·3	−0·4
Suva, Fiji	1005·5	−2·2	90	5	71	2	86·5	73·2	79·9	0·0
Kingston, Jamaica	1015·4	+0·1	89	29	66	25	85·9	69·5	77·7	+0·9
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..
Toronto	1020·2	+2·8	53	20	−5	18	35·4	20·2	27·8	+5·7
Winnipeg	1018·6	−1·2	33	6	−33	17	16·5	−2·2	7·1	+11·5
St. John, N.B.	1015·7	0·0	47	15	−5	19	29·4	12·6	21·0	+1·8
Victoria, B.C.	1013·4	−1·9	52	14	29	10	43·9	36·4	40·1	0·0

London, Kew Observatory.—Mean speed of wind 10·2 mi/hr ; 4 days with fog.
Gibraltar.—1 day with thunder heard, 3 days with fog.
Malta.—Prevailing wind direction NW. ; mean speed 7·9 mi/hr.
Sierra Leone.—Prevailing wind direction NE.
Colombo, Ceylon.—Prevailing wind direction NNE. ; mean speed 5·3 mi/hr ; 7 days with thunder heard.

British Empire, January 1921.

TEMPERATURE Absolute Max. in Sun °F.	TEMPERATURE Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	PRECIPITATION Amount mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible	STATIONS
84	21	85	8·3	2·04	52	+ 7	19	0·9	11	London, Kew Observatory.
126	35	78	3·8	1·17	30	−100	8	..	..	Gibraltar.
116	..	83	6·2	2·73	69	− 6	13	5·5	56	Malta.
..	..	66	2·2	0·00	0	− 11	0	..	..	Sierra Leone.
145	52	73	6·6	0·31	8	− 20	2	..	..	Lagos, Nigeria.
..	..	38	..	0·00	0	0	0	..	..	Kaduna, Nigeria.
..	..	87	7·4	10·16	258	− 27	16	..	..	Zomba, Nyasaland.
158	50	73	6·5	6·41	163	− 38	15	..	..	Salisbury, Rhodesia.
..	..	59	4·0	0·77	20	+ 3	5	..	..	Cape Town.
..	49	66	5·7	4·77	121	− 38	11	8·5	63	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
..	..	45	2·5	1·08	27	− 75	7	..	..	Bloemfontein.
..	39	54	3·3	2·09	53	+ 43	3	..	..	Calcutta, Alipore Obsy.
133	49	61	0·7	0·00	0	− 2	0	..	..	Bombay.
..	..	85	50	5·46	139	+116	9	..	..	Madras.
166	63	73	7·2	7·55	192	+101	18	..	..	Colombo, Ceylon.
..	..	66	5·3	0·19	5	− 32	5	5·9	54	Hong Kong.
146	51	69	4·9	3·15	80	− 7	14	7·5	53	Sydney.
159	43	55	4·7	4·49	114	+ 67	11	..	..	Melbourne.
163	38	38	3·0	1·59	40	+ 22	1	10·9	77	Adelaide.
169	40	48	3·1	0·04	1	− 8	3	..	..	Perth, Western Australia.
173	44	31	3·1	1·22	31	+ 19	4	..	..	Coolgardie.
155	60	67	6·7	4·04	103	− 62	21	..	..	Brisbane.
158	39	57	6·5	2·18	55	+ 9	11	8·9	59	Hobart, Tasmania.
145	33	70	6·0	3·14	80	− 6	11	7·7	52	Wellington, N.Z.
..	..	87	6·2	20·49	520	+248	23	..	..	Suva, Fiji.
..	..	73	5·4	1·40	36	+ 12	11	..	..	Kingston, Jamaica.
..	..	..	..	..	..	..	..	..	..	Grenada, W.I.
90	−9	58	5·5	0·67	17	− 56	11	..	..	Toronto.
..	..	92	4·1	1·15	29	+ 10	6	..	..	Winnipeg.
103	−6	56	5·8	3·16	80	− 42	9	..	..	St. John, N.B.
101	26	89	8·1	5·55	141	+ 26	22	..	...	Victoria, B.C.

HONG KONG.—Prevailing wind direction ENE. ; mean speed 9·1 mi/hr.

PERTH.—Absolute max. the highest ever recorded at Perth, and absolute min. the lowest on record for January.

SUVA, FIJI.—15 days with thunder heard.

coast, moved to central Europe, causing dull weather with slight rain in many parts and heavy rain at Zürich, but by the 6th the large anticyclone over the eastern Atlantic extended across Denmark to Russia, and fair weather prevailed over a large part of Europe.

On the 8th there was a depression near Iceland with a shallow trough extending over the British Isles. The depression moved north-eastward and a shallow low moved north over France and the Netherlands, causing rain in parts of the British Isles, France, Germany, Denmark and Switzerland.

For some days depressions over Iceland and southern Scandinavia maintained unsettled conditions in north and north-west Europe, 44 mm. of rain being recorded at Saerna in Sweden on the 10th, while in the south of the British Isles and south-west Europe generally fair weather prevailed, pressure meanwhile continuing low over the eastern Mediterranean with rather unsettled weather in Italy and central Europe.

On the 17th a depression near Spitzbergen spread southward over Scandinavia, and by the 18th it was over the Baltic, giving strong northerly winds and causing a considerable fall of temperature over the British Isles and the more northerly parts of Europe; the maximum temperatures on the 17th in south England exceeded 80° F. at several stations, while on the 18th temperatures in the same district only reached about 60° F. The maximum temperatures at Ross-on-Wye were 87° F. on the 17th, 64° F. on the 18th. Local thunderstorms, although accompanied by only slight rain, were experienced at Gorleston and at Croydon during the night of the 17th–18th. The next night screen temperatures fell below 40° F. at several stations in England. At Benson the screen minimum was 34° F. and at South Farnborough 35° F., and ground frosts were recorded at some stations, the grass minimum being as low as 22° F. at Greenwich, at Benson 26° F., at Howden 28° F., and at Kew Observatory 29° F.

The Baltic depression persisted and secondaries stretched from it to Iceland, causing cloudy weather and rain in north-west Europe. Although the rainfall was mostly slight, it was heavy in parts of Sweden and locally elsewhere. On the 18th, 19th, and 20th Stockholm reported 23 mm., 19 mm., and 10 mm. of rain respectively, while on the 20th Berlin had 26 mm. and Kronstadt 22 mm.

On the same date a depression over Italy caused a fall of 53 mm. at Rome.

The Atlantic anticyclone moved slowly across the southern part of the British Isles on the 23rd and 24th, and temperature became very high, reaching the maximum at most places on the 25th.

On that day, Nottingham recorded a screen temperature of 88° F., Ross 86° F., Kew 83° F. and Aberbeen 80° F. The anticyclone was now over the Netherlands, moving slowly east and a trough of low pressure extended over the British Isles. Thunderstorms occurred at night over the South and Midlands of England, with particularly brilliant displays of lightning. The amount of rainfall was, however, generally small, although Jersey had 15 mm. and Bournemouth 11 mm.

On the 26th another anticyclone spread down from Iceland, and, after extending over the British Isles, took up its position to the westward of these Islands, where it still remained at the end of the month. Fair settled weather set in again over the British Isles and most of western Europe, although an area of low pressure over the Bay of Biscay caused local thunderstorms and rain in western France, while the Scandinavian depression maintained unsettled weather in northern Europe. On the night of the 27th–28th ground frosts were experienced at some English stations, Howden recording a grass minimum of 24° F.

Visibility was good throughout the month over the British Isles, apart from a few cases of local fog on the west and north-west coasts, and a large number of cases were reported where the range of visibility exceeded eighteen miles.

W. C. K.

THE prolonged dry spell in France, following an unusually dry winter, is causing anxiety as to crops and cattle. Switzerland has also experienced a hot, dry month, the rivers being six feet lower than usual, but falls of snow at altitudes above 4,500 feet have been reported. The Atlantic Ice Patrol reports that ice conditions in the North Atlantic are worse than they have been for many years, large numbers of icebergs being scattered over a wide area.

Serious floods following heavy rainfall have affected the cotton and wheat crops in the north-eastern part of the Egyptian delta, and similar floods have resulted in grave damage in the Fukuoka district of Kinshin, Japan.

The Indian monsoon broke later than usual this year, but by the 22nd of the month it was extending normally, with excess of rain in some regions. Early in the month heavy rain was reported at many stations in Queensland and New South Wales.

Timely rainfalls have occurred in Northern Alberta, Manitoba and Saskatchewan, and throughout the dominion of Canada crop prospects are exceptionally favourable.

A violent storm on June 3rd at Pueblo, Colorado, caused extensive damage to life and property. The subsequent bursting of the neighbouring dams caused reflooding of the city, wholesale destruction of crops and the wasting of the irrigation supply for the summer.

The Belize district of British Honduras was suffering from severe drought, but floods following a heavy storm were reported from San Salvador on the 11th.

The month was again one of widespread deficiency of rainfall, less than half the average falling everywhere except in the north and west of Scotland and in Queen's County. In the last mentioned a local fall of 3·10 inches fell on the 26th at Blandsfort, bringing the total to 42 per cent. above the average. The areas in which the deficiency was most marked were the north-east and south of Ireland, the west and south of Wales, and the south of England. In all these districts less than 10 per cent. of the average rainfall was observed. In parts of Sussex no rain fell during the month, and an extremely large area had less than ·25 inch. More than 1 inch fell to the north of Banbury, in Central Wales, in the Lake District, and in the north and north-west of Scotland generally, as well as in small isolated patches in Ireland. Following on the exceptional dryness of the preceding four months, which was most marked in the Midlands and south of England, the dryness of June has created a widespread deficiency which has now reached serious proportions. The rainfall of the five months was less than half the average over most of England, and fell to less than 40 per cent. of the average in Northamptonshire. The amount increased towards the north-west, and the West Highlands experienced no general shortage, March and May having been wet in these districts. So far as it is possible to ascertain, the deficiency of rainfall has been at least as severe as that observed in the notably dry springs of 1893, 1895, and 1896. There was almost certainly no drier period of five months in 1887, the driest year known to have occurred in the British Isles.

The general rainfall for June, expressed as a percentage of the average, was:—England and Wales, 17; Scotland, 40; Ireland, 24; British Isles, 26.

In London (Camden Square) the month was remarkably fine, sunny, and dry. The total rainfall was the least recorded in June since 1895, when only ·30 inch fell. In the five months February to June the total was 4·06 inches. Only once in 64 years' record has a smaller total been recorded in five consecutive months, viz., February to June 1895, when the total only reached 3·52 inches. Mean temperature, 61·8° F., or 1·6° above the average. Duration of rainfall, 7·9 hours. Evaporation, 3·66 inches.

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The Shape of the Sky.

By HAROLD JEFFREYS, M.A., D.Sc.

IT is well known that if we attempt to estimate the angular altitude of a celestial object by eye, and afterwards determine it by means of an instrument, the former estimate is always the greater. The current explanation of this fact is that when we think we are estimating the angular distance between two points we are really carrying out a much more complex process. We suppose the points projected by perspective on some real or imagined physical object, and instead of estimating the angular distance between them, we really estimate the linear distance along the surface of this object. The sky, even in the absence of clouds, appears to many people to be a somewhat flattened vault. The projections upon it of two points with a given angular separation are further apart when the points are low down than when they are high up, and therefore, according to the theory, their angular distance is estimated to be greater when they are low down than when they are high up.

Gauss suggested that this flattening of the sky was caused by our mechanism of vision, the distances from us of all objects, real or imagined, and in particular of parts of the sky, being systematically under-estimated when we have to turn our eyes upwards to see them. This theory is followed by Pernter. Humphreys, on the other hand, holds that the apparent distances of different parts of the sky are determined by the "clearness" of those parts. In three recent papers*

* Anuario del Observatorio Central Meteorologico, Madrid. Supplemento al Tomo III., pp. 157-163, 175-210.

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H. Dember and M. Uibe advocate a further hypothesis, which has a considerable amount of experimental support. Their suggestion is that the distance of any part of the sky is determined by its luminosity; whereas in Humphreys's theory the determining cause appears to be the amount by which the colour departs from a certain standard blue, the specification of which requires investigation. Their observations decide definitely against the theory of Gauss and Pernter, but that of Humphreys is not considered.

It is clear that the issue between the theory of Gauss and the other two is capable of experimental test. If the discrepancies are due to purely physiological or psychological causes, the same observer, observing objects at equal measured altitudes, should always make the same, or nearly the same, estimate of the altitude. Different observers observing under the same conditions, however, may make different estimates. On the other hand, if an external physical cause enters into the estimate, the appearance of the sky will influence the estimates of any one observer; different observers, however, may be affected equally, and therefore make the same estimate. This test has been carried out by Dember and Uibe. The sight of a quadrant was pointed to the part of the sky whose angular elevation was estimated at 45°. The actual altitude was then read off. It was found at Teneriffe to range from 25·2° to 42·9° for the same observer. Reimann, in Germany, had previously found a considerable range in the determinations. Accordingly there must be some other cause involved than the purely physiological one.

Dember and Uibe had, up to this point, made no assumption about the form of the vault. They next tried a segment of a sphere as an approximation. In the following table ϕ is the mean of the measured altitudes of points, on different occasions, whose altitudes were estimated at 45°; k is the ratio of the distance of the sky beyond the horizon to its height in the zenith.

Illumination.	Germany.		Teneriffe.	
	ϕ	k	ϕ	k
Moonlight nights - - -	26·5°	2·90	36·7°	1·73
Starry, moonless nights - -	29·9°	2·36	40·1°	1·40
Clear days - - - -	22·0°	3·55	32·0°	2·14
Cloudy days - - - -	?	?	29·0°	2·54

On the assumption that the sky is a segment of a sphere, the ratio k can be determined when ϕ is known.

It will be noticed that the flattening of the sky is less on moonless nights than on moonlight nights, on clear than on cloudy days, by night than by day, and at Teneriffe than in Germany. This summary is confirmed by an inspection of the individual observations, which shows that these differences are systematic and not accidental. The lowest value of k found at Teneriffe was 1·12, corresponding to $\phi = 43°$. The influence of optical and atmospheric conditions is plain.

As a test of the accuracy of the segment of a sphere as an approximation, the authors have found the measured altitudes of points in the sky at other estimated altitudes than 45°; this hypothesis about the form of the sky makes these calculable from ϕ, and the observed and calculated values usually agree within 1° or 2°, the greatest individual discrepancy being 7°. The agreement is quite satisfactory, and indicates that the approximation is very close.

The suggested explanation of this form is that we estimate the distance of the sky in any direction as proportional to the distance to which a body of specified size with the same surface luminosity as that part of the sky would have to be removed in order to be just visible. The apparent distance should then be proportional to the square root of the luminosity. The distribution of luminosity being determinable by observation, the form of the sky to be expected on this theory is capable of quantitative determination, and it is found to agree with that determined from ϕ to within about 4 °/₀ in the radius vector. On some occasions, however, the sky becomes markedly flatter near the horizon, though retaining the spherical form at measured altitudes of 30° and more.

The explanation, however, seems very artificial. Even if variation of luminosity is the fundamental cause of the discrepancies between measured and estimated angular distances, the assumption of a background of a definite size and shape is an extraneous hypothesis. Dember and Uibe's observations are sufficient to show that the ratio of the estimated angular distance between two objects to the measured angular distance is proportional to the square root of the luminosity of the background in the neighbourhood. This result is purely empirical, and involves no special assumption whatever. The reference to the shape of the sky, with the estimates of distances between non-existent objects on a non-existent background, involves several purely psychological assumptions, and can be tested, if at all, only by the methods of experimental psychology. It is worth while calling attention to this, in view of Dember and Uibe's insistence on the physical, not psychological, nature of their theory.

It is not improbable, indeed, that the true cause may be some other factor than the luminosity of the background, but ordinarily so closely correlated with luminosity that a correlation between the other factor and apparent size implies one between luminosity and apparent size. The colour of the clear sky, for instance, usually varies steadily from deep blue in the zenith to a bluish white near the horizon, while luminosity also steadily increases towards the horizon. The correlation between the colour of the surrounding sky and the ratio of the measured and estimated angular distances is not examined in the papers. This is unfortunate, since it renders impossible a comparison between Dember and Uibe's theory and that of Humphreys.

In Dember and Uibe's last paper the variations with altitude of the apparent sizes of the sun and moon are discussed. It is pointed out that the apparent magnification of the setting sun persists when it is looked at in an inclined mirror, which shows that the phenomenon is not affected by the direction of gaze. The authors had two discs of diameters 30 cm. and 40 cm. These were placed on the ground at the same level as the observer, and their distances adjusted till their angular diameters were estimated as equal to that of the sun. When the sun was near the horizon the measured angular diameters would naturally agree with that of the sun, but when the sun was high the discs had to be placed further away. In each case the distances necessary remained closely proportional to the actual diameters of the discs. This provided a useful check, for the discs, being of different sizes, had to be set independently, so that neither could influence the setting of the other. It was found that the ratio of the estimated angular diameters of the sun when high up and low down agreed closely with that of the projections of the horizontal diameter on the hypothetical vault.

One may doubt, however, whether this confirms the theory in the form in which the experimenters present it. The surface of the vault is not normal to the radius vector from the observer, except in the zenith. Hence the projection on the vault of the diameter of the sun in a plane passing through the zenith should be longer than that of the horizontal diameter. On this theory, therefore, the sun should almost always appear elliptical, with the long axis vertical. This is a serious objection to the assumption of a background of reference. On the other hand, if there is merely an apparent magnification or reduction of angular diameter owing to variation in the luminosity of the sky, there is no reason why the estimate of one diameter should be more in excess or defect than that of any other, and the sun should appear circular; as it actually does except when near the horizon, when it appears flattened, but in the opposite way to that required by the former theory.

To an observer at a considerable height above the earth's surface the sky appears less luminous than to another observer at the surface, but the effect of dust and water particles is practically removed. These are an important factor in causing the whiteness of the sky near the horizon, and it is not unlikely that observations from balloons and aeroplanes may be valuable in comparing the importance of luminosity and clearness.

The Deficient Rainfall.

SINCE the extremely wet July of 1920 the rainfall in the British Isles has been so generally deficient as to call for widespread comment, and the markedly small rainfall of the present year, particularly in England and Wales, has greatly accentuated the effect of the dry period as a whole.

It is not possible as yet to examine the records of the year in comparison with those of previous dry years in complete detail, but the results of a preliminary investigation are probably of sufficient interest to put on record.

Speaking generally, January and March were the only months since July 1920 with an excessive rainfall, and even during these months parts of the south-east of England failed to record their average fall; but up to and including January the general deficiency was not in any way remarkable, and we propose to confine attention to the six months February to July, inclusive. In February the rainfall reached as much as half the average only in the west of Ireland and in parts of the west coast fringe of Scotland. Over by far the greater part of Great Britain less than a quarter of the average fell, and in some districts, the most conspicuous of which comprised the counties contiguous to the Bristol Channel, less than one-tenth of the average fell. March was wet in the west, especially in Scotland, where more than twice the average fell widely, but nearly all parts of England continued dry, and less than half the average fell over part of the eastern counties. In April the deficiency was again widespread, but it was least marked in the east of England, where part of East Anglia just exceeded its average. In the south of Ireland and of Scotland, and in the south-west of England

and Wales, less than half the average fell. May was distinctly less dry, most of Scotland having a slight excess, but nearly all parts of England, Wales and Ireland had little relief from the shortage of rain, and an extremely dry June in all districts set the seal upon what had already threatened to become a very serious drought, using the term in its popular significance rather than in its technical sense. In June less than half the average was practically universal, and less than a quarter of the average fell everywhere in England, Wales and Ireland except a few very local patches affected by a thunderstorm on the 26th. The district chiefly affected by this storm was the south Midlands of Ireland, where 3·10 in. fell at Abbey Leix, in Queen's Co. The deficiency was greatest on the south coast, where less than one-tenth of the average fell, no rain at all being reported from some stations in Pembrokeshire and Sussex.

With July came relief in the west, but nearly the whole of England and about half of Wales again failed to record as much as half the average rainfall, and all parts of the south-east from the Humber to Dorset less than one quarter. In the south-east Midlands less than one-tenth of the average again fell.

In considering the period of six months as a whole it is necessary to confine attention to England and Wales, since the deficient rainfall, although remarkable elsewhere, was not sufficiently so to warrant the expenditure of time necessary to carry out a detailed comparison with previous years.

The total rainfall from February to July, inclusive, exceeded 60 per cent. of the average in England and Wales only in the extreme west and north-west. Less than half the average, representing a deficiency of an almost unprecedented nature over so protracted a period, occurred over a roughly circular area bounded by a line passing from the mouth of the Humber through the north Midlands to South Wales and Devonshire, and in the east, possibly cutting off eastern Kent. This may be regarded as defining the field over which the drought of 1921 has been extremely severe, and the district most severely affected lay in the centre, where less than 40 per cent. of the average rainfall occurred over some 15,000 square miles extending from Monmouthshire on the west to Lincolnshire on the north, and Suffolk and Sussex on the east and south. The lowest values of which any record has been received are 33 per cent., or 67 per cent. deficiency, at Wellingborough, and 34 per cent., or 66 per cent. deficiency, at Ross-on-Wye. In London there was a deficiency of 63 per cent.

In comparing the above with the records of previous long dry spells, an examination was made of the monthly rainfall at a large number of stations for the past 50 years. There have been a considerable number of instances of short periods, from one to three months, which would bear comparison with the most severe phases of the dry spell of 1921, but taking the period as a whole there appears no doubt that the only six-monthly periods worth considering as comparable with 1921 were those of the spring and early summer of 1887 and 1893. The conditions during these two years were discussed fully by Mr. Symons in the appropriate volumes of *British Rainfall* and also in *Symons's Meteorological Magazine*, and the reader is referred to these publications for fuller details.

In 1887, as in 1921, the driest months were February and July, whilst May was only moderately dry. During the whole period the deficiency of rainfall was greatest in two separate areas, the north of England and the extreme south-west. The latter was the only district in which less than 40 per cent. of the average fell, and no part was so dry as the south Midlands in 1921.

In 1893 the dry period lasted from March to August, the driest months being March and April. These two months together, over England and Wales as a whole, were far drier than any two consecutive months in 1921. The latter part of the period was, however, far less remarkable, and July, though clearly falling into the dry spell as a whole, had more than its average fall. The total fall was nowhere less than half the average, but exceeded this limit by only a narrow margin over a large area extending from Pembrokeshire to Kent.

In the following summary are compared the general values of rainfall over England and Wales expressed as percentages of the average :—

GENERAL RAINFALL as Percentage of Average, 1881–1915.

ENGLAND AND WALES.

—	Feb.	Mar.	April.	May.	June.	July.	Aug.	Six Dry Months.
1887 -	36	70	70	86	31	51	—	57
1893 -	—	24	17	72	58	132	67	65
1921 -	17	81	66	79	16	35	—	49

It is inadvisable to make too hasty a judgment, but we have little hesitation in expressing the opinion that, even when a fuller examination of past records has been possible, it will prove that the six months just completed will, so far as England and Wales are concerned, have been unprecedented for widespread deficiency of rainfall for at least half a century.

The Case for the Modern Units in Meteorology.

By F. J. W. Whipple, M.A., Superintendent, Climatology Division, Meteorological Office.

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2. Pressure.

IN the case of rainfall the new unit adopted in the British meteorological service is merely one which has been used as a matter of course on the Continent for a century. For pressure a unit has been chosen which is entirely a novelty in practical meteorology, and the underlying ideas are not so simple. It seems so straightforward to regard pressure as merely the reading of a mercury barometer that most people who have not had occasion to consider the matter closely are not aware of the difficulty of giving precision to the interpretation of such readings and of bringing them into connection with other physical measurements. With a mercury barometer we balance the pressure of the mercury against the pressure of the atmosphere. It is not sufficient, however, to say that the pressure is equivalent to a head of so many inches of mercury; we must know the temperature of the mercury, for two barometers in adjacent rooms and at different temperatures will give appreciably different readings on account of the fact that warming mercury makes it lighter. The practice has been to take mercury at the freezing point of water as the standard, and to apply corrections to "reduce" the readings to this standard. It will be agreed that this practice is rather artificial, especially as barometers are very seldom used in rooms at such a temperature as 32° F. With Fortin barometers graduated to read in inches there is another anomaly to allow for. The standard British yard being the length of a certain brass rod when at 62° F., it is customary to graduate barometers so that the scales read true inches at this temperature. Accordingly the specification of the conditions under which barometers would give readings requiring no corrections implies that the brass scale is to be at 62° F., whilst the mercury is at 32° F. It should be noticed, however, that in the routine of a meteorological station this curious rule of the instrument maker does not introduce any additional complication. The correction tables allow for the peculiarity in the graduation. The important point is that the corrections for temperature are large enough to matter seriously. A barometer reading of 30·000 inches, with the thermometer standing at 80° F., corresponds with only 29·861 true inches on the ideal barometer, with mercury at 32° F.

A further difficulty was introduced into the subject when it was realised that since the same "head" of mercury would not support the same pressure in different latitudes, it was not legitimate to treat barometric readings as if latitude were of no account. The gravitational attraction of the earth is greater at the poles than at the Equator, so the pressure which could be balanced by 30·000 inches of mercury at the North Pole is greater than that balanced by 30·000 inches at the same temperature at the Equator. The difference is considerable; it is about equivalent to a head of 0·156 inch of mercury. The difficulty can be met by "reducing" the readings of the barometer to latitude 45°, the meaning being that the pressure at a particular place is not expressed in terms of the head of mercury which can be supported there, but in terms of the head of mercury which could be supported by an equal pressure at a place in latitude 45° and at sea-level.

The student of meteorological literature will find that all important pressure observations he has to deal with have been reduced to 32° F., but that even close scrutiny will not always show whether the reduction to latitude 45° has been carried through. The latter correction was not introduced into the publications of the Meteorological Office until 1911. On maps drawn before that date the lines which were supposed to be isobars, *i.e.*, isopleths of pressure, were merely isopleths of head of mercury.

Enough has been said to indicate that the British unit of pressure, one inch of mercury at 32° F. in latitude 45° at sea-level, is not a very handy unit. The Continental unit, the millimetre of mercury at 32° F. in latitude 45° at sea-level, suffers from most of the same defects.

When we attempt to make a fresh start we realise that we have been slaves to our tools: mercury happened to be available as the best liquid for making pressure gauges, and so pressure was measured in terms of the weight of mercury. On the other hand, the more instructive way is to regard pressure as giving so much force over a specified area. The engineer is content to deal with so many pounds to the square inch, so many kilograms to the square centimetre, but the meteorologist wants precise and universal units, and the weight or—as I prefer to call it—gravitance of a pound is not a universal unit, since even on the earth's surface it depends on latitude. The universal unit of force on the C.G.S. system is the dyne, the force which produces an acceleration of one centimetre per second per second in a mass of one gramme. The corresponding unit of pressure is one dyne per square centimetre. To this pressure the name microbar has been given. The microbar is small compared with the pressure dealt with in ordinary meteorology. The pressure of the very rare gas in an electric-light bulb may be as low as one microbar, however. The "bar," one million microbars, is known sometimes as the C.G.S. atmosphere, since it happens that it is not far from the average atmospheric pressure at sea-level. The unit which has come into practical use is the millibar, the thousandth of a bar and one thousand times the microbar.

There are happy accidents which make the use of the millibar very convenient. The fact which has been mentioned that one bar or 1,000 millibars is fairly close to the average pressure of the atmosphere at sea-level may rank first. It results that in balloon ascents, when pressure is 900 mb., one-tenth of the atmosphere is below the aviator, nine-tenths above, and similarly for other pressure readings. The range of sea-level pressure all over the world is almost confined between the limits 1,050 millibars and 950 millibars, so that a barograph chart may conveniently have 1,000 millibars for its middle line. To avoid misconception it should be mentioned, however, that in no part of the world is the average sea-level pressure as low as 1,000 millibars. For Greenwich the average is approximately 1,015 millibars. The standard atmosphere of the chemist, 760 millimetres of mercury at 0° C. at sea-level in latitude 45°, is 1,013·23 millibars.

Mercury barometers can be graduated to give readings in millibars, and these readings require corrections for temperature and for latitude, but on account of the difference between the ways in which the idea of measuring pressure is approached the theory of these corrections is on rather a different footing from that of the corrections to the inch barometer. The difference is that one can hardly realise the significance of the unit "one inch of mercury at 32° F. and 45 degrees of latitude" without considering the nature of barometer corrections, whilst the definition of the millibar makes no reference to mercury and the corrections of the millibar barometer are mere technical detail.

On the practical side the advantage of using a unit of pressure selected in accordance with the principles of dynamics is great. With systematised units the pressure due to the weight of a column of homogeneous liquid may be determined at once by the formula

$$p = \rho g h,$$

where p is the pressure, ρ the density, g the acceleration due to gravity and the earth's rotation, h the height of the column. For example, the pressure due to a column of water 30 feet, *i.e.*, 914·4 cms., high at 50° F. in latitude 51° is found in centimetre-gramme-second units by writing $\rho = 0{\cdot}9991$, $g = 981{\cdot}2$, $h = 914{\cdot}4$. On substitution in the formula we get $p = 896000$ nearly. So that the pressure is 896000 microbars, or 896 millibars.

Similarly with the fundamental formula of aerodynamics, $p = \frac{1}{2}\rho v^2$, which gives the extra pressure on a surface due to a stream impinging directly on it with speed v, with the fundamental formula of the theory of gases, $p = \frac{1}{3} \rho \times$ average (V^2), which connects the pressure of a gas and the speeds of the molecules, and with the fundamental formula of dynamical meteorology, $\frac{\delta p}{\delta n} = 2\, \omega \rho \sin \lambda$, by which the speed of a steady atmospheric current can be computed from the pressure gradient, in every case the use of the absolute unit of pressure makes it possible to approach special problems without reference to such irrelevant details as the density of mercury and the local value of "*g*." In fact, to the student who is trying to master the more theoretical aspects of meteorology, the use of a unit of pressure which is frankly nothing else is a decided advantage.

It is a welcome sign of the times that the instrument makers report a steadily increasing demand for barometers with the millibar graduation. Such barometers can be obtained from all the makers advertising in the *Meteorological Magazine*. On the other hand, the possessor of an old favourite aneroid can easily bring himself abreast of the times by pasting a scale of millibars on the glass of the instrument. With the barograph the change-over is even simpler, as all that is necessary is to order charts with the appropriate ruling.

Official Publications.

Professional Notes.—No. 18. Lizard Balloons for Signalling the Ratio of Pressure to Temperature. No. 19. Cracker Balloons for Signalling Temperature. By Lewis F. Richardson, F.Inst.P. *Price* 1s. net each.

DURING the year 1920 Mr. Richardson was working at Benson Observatory and found opportunity to develop new methods of upper-air research. The present notes are devoted to two of these methods.

The first note, No. 18, describes the "Lizard Balloon" and gives some account of its manufacture, the tests applied to its several parts and the theories relating to its calibration and expansion. A report of the first ascent made at Benson on April 30th, 1920, is also given.

The "Lizard Balloon" is an ordinary india-rubber balloon inflated with hydrogen within an inextensible case of chiffon. A trigger of bronze wire with an india-rubber spring is sewn to the chiffon case and the balloon drags after it a thread ending in an inverted parachute made of a small square of nainsook. The balloon is prevented by the chiffon case from expanding horizontally, so it expands vertically, ultimately pressing the trigger and releasing the tail. Hence the name "Lizard" from the habit of some of these animals to drop their tails when disturbed. The observer follows the balloon with a theodolite and the height is determined by the "tail method."

The initial and final volumes of the balloon are compared just before the ascent by weighing the corresponding total lifts. During the ascent the balloon acts as a hydrogen thermometer, expanding between known volumes; it therefore measures the ratio of pressure to temperature at the level where the tail is released, and except for the small effect of water vapour it may be said to measure density. Mr. W. H. Dines has shown that the standard deviation of density at heights between 1,000 and 5,000 metres is only 1 to 2 per cent. of its mean so that if the present instrument is to be of value it must have a standard error decidedly less than 1 per cent. Mr. Richardson aspires to attaining an accuracy of 1 in 1,000. The most serious difficulty is due to the warming of the gas in the balloon by direct sunshine; it is thought that this effect, which invalidates the assumption that the temperature of the balloon is the same as that of the free air, may introduce an error of $\frac{1}{2}$ per cent. in the computed density. With a sky either uniformly clear or uniformly overcast, the greater accuracy might be obtained.

The second note, No. 19, is similar in content to the first—it describes the "cracker-balloon" and its various parts and gives accounts of two ascents made at Benson in 1920, one with a single thermometer, the other with two thermometers.

The "cracker-balloon" carries a thermometer capable of closing an electric circuit when the temperature falls to a pre-arranged value. The electric current heats a fine wire, which in turn ignites a small charge of explosive, the cracker. This balloon, like the "lizard," has a tail of thread ending in a nainsook parachute. A larger square of nainsook is used, however, in order to prevent the falling cell from injuring anyone. As with the "lizard" balloon the height is determined by the "tail method"; the explosion of the cracker is seen through the theodolite. In case the balloon should burst and fall to the ground before the cracker has exploded, a warning label is attached, telling the finder how to dispose of the cracker harmlessly.

Mr. Richardson states that his original design was to arrange for an explosion that would be audible from the ground. Then, if the time of the explosion were noted and the rate of ascent known, the height could be obtained. Also observations would not be hindered by thick weather. But up to the present he has only used small charges of powder and their explosion has only just been audible at a direct distance of 2,200 metres, which is not sufficient. If more powerful crackers were used, further precautions to protect the finder of an unexploded cracker would be necessary. A short-lived cell is suggested as a safe device and the possibility of making a whistle or siren blown by burning cordite is also considered.

British Meteorological and Magnetic Year Book, 1910, *Part V. Réseau Mondial Charts.* Price 8s. 6*d*. net.

THIS volume contains charts illustrating the tables of the *Réseau Mondial* for 1910, which were issued last year. The charts show deviations of pressure and temperature from the normal for each month and for the year, and are in all respects similar to those of the volume for 1911, which was published in 1916.

Réseau Mondial Tables have been published for the years 1911, 1912 and 1913, but owing to the difficulty experienced during the war in obtaining the necessary data for the later years, it was decided, after the tables for 1913 had been prepared, to proceed with the volume for 1910. When the issue of charts was again taken up, this year, being the earliest of the series, was the first to be dealt with. It is hoped that the charts for 1912 and 1913 will be published in due course.

Correspondence.

To the *Editors*, "*Meteorological Magazine*."

Aerial Photography of Industrial Towns during the Coal Strike.

Might I enquire if any aerial photographs were taken of the large industrial cities during the coal strike, when the dark canopy which usually enshrouds them was removed for some weeks, revealing their features with exemplary and probably unprecedented clearness?

From my point of view in Sheffield, which is some 600 ft. above sea level, I saw the details of the valley through which the Don passes, and where all the large works are situated, entirely free from smoke throughout its entire length, even so far eastwards as Rotherham, where the church spire could be distinctly discerned. It was a sight that has never been previously opened to my view, although I have occupied the same habitation for more than a quarter of a century, and it occurred to me it would be of interest generally, if we could have had some photographs from an aeroplane. This was suggested to the Corporation, but difficulties were felt in the way of doing it which could not easily be overcome, so nothing was done. Possibly some airman flying over the country may have taken a photograph of Sheffield, and if so I should be very glad to hear from him.

Our smoke canopy is confined, in the mass, to the valley of the Don, and in that district I have had for some years a sunshine recorder in the thick of the smoke. A quarter of a mile away, in the same district, but on a hill at High Hazels about 150 feet higher than the valley, I have another. The difference between the two for one year is about 30 per cent. under ordinary circumstances, Attercliffe having the smaller number of hours. During the coal strike, when all the works were down, the difference was practically nil, in fact at the three stations, Weston Park, 450 feet above sea, and about two miles away from the heavy industrial parts, High Hazels, 300 feet above sea, and Attercliffe, 141 feet above sea, the readings were practically the same, and on some days Attercliffe got more sunshine than the other two, although, being in the valley, the actual possible amount was always less.

E. Howarth.

Museum and Art Gallery, Sheffield, July 29th, 1921.

Descending Currents associated with Sea Breezes.

An instance of the apparent descent of air from one level to another was observed at Calshot on July 6th. A pilot balloon ascent was made at 10 h. 10 m. G.M.T., the height of the balloon at each minute being obtained by means of the "tail method." Two white balloons were used, one being inflated with hydrogen to give a rate of ascent of 500 feet per minute, while a smaller balloon was inflated with air until its diameter was approximately one half that of the other. Readings of the altitude and azimuth were made at even minutes, and micrometer readings were made at alternate half-minutes. Both balloons were observed for 23 minutes.

At the end of 8 minutes the balloons had reached a height of 3,100 feet, the mean rate of ascent being 390 feet per minute. For the next 3 minutes the rate of ascent decreased to 250 feet per minute. From the 11th to the 13th minutes the balloons rose only 40 feet, but afterwards the rate of ascent increased, the mean rate for the remaining 10 minutes being 450 feet per minute.

The weather conditions at the time were as follows :—

> Anticyclone to the SW of England; wind at surface SW by S, 18 feet per second; gradient wind WNW, 20 feet per second; cloud cirrus 7; humidity 57 °/₀ decreasing; surface temperature 70·3° F.; approximate sea temperature (derived from D.W.R.) 58° F.

The track of the balloons was almost wholly over the sea, and during the 9th to 15th minutes a loop was described the speed of the wind being very light, less than 5 feet per second.

Assuming that the resistance of the smaller balloon would decrease the rate of ascent by approximately one-fifth, *i.e.*, that the rate of ascent of the system of two balloons was 400 feet per minute, it appears that between the 11th and 13th minutes descending currents of 6·3 feet per second were encountered. The descending currents were undoubtedly real, as the micrometer readings for the 12th and 13th minutes were exceptionally low compared with the neighbouring readings.

Another ascent, made at 15 h. 15 m. G.M.T. on the same day exhibited no signs of descending currents of more than 1 foot per second.

R. P. Batty.

Calshot, July 18th, 1921.

[This report is of special interest as showing a descending current of air over the sea (between Hampshire and the Isle of Wight) synchronising with a sea-breeze at the observing station.—Ed. M.M.]

The Magnetic Storm of May 13th–16th: Samoa Magnetograms.

I HAVE recently received a reduced copy of the Samoa magnetograms for May 13th – 16th, 1921, showing the remarkable character of the magnetic storm then experienced. The "sudden commencement" at about 13h. 10m. G.M.T. on the 13th, with sharp rises in horizontal force and vertical force and small easterly movement in declination, was followed about six hours later by a substantial fall in horizontal force. But the disturbance on the 13th and earlier part of the 14th was overshadowed, as in Europe, by the disturbance from 22h. on the 14th to 11h. on the 15th. There was also very active disturbance during the early hours of the 16th.

The total range during the three days was only about 18′ in declination (equivalent to 180γ in the component of horizontal force perpendicular to the magnetic meridian) and 160γ in vertical force, but in horizontal force it was nearly 1,000γ. For an observatory only 14° from the Equator the disturbance is probably unprecedented. The Samoa record would be of altogether exceptional value for a complete study of the great storm.

It is sincerely to be hoped that the continuance at Samoa of an observatory capable of producing such satisfactory records will be secured. C. CHREE.

July 22nd, 1921.

Thermometer Exposure at Kew Observatory, Richmond.

I NOTICE from page 138 of the *Meteorological Magazine* for June that the minimum temperature at Kew Observatory for December last is given as 21° F.

On the night of December 12th–13th last a frost of exceptional severity was experienced over the south-east of England and low readings were recorded in the screen, even in the London District, Croydon reporting a minimum of 10° F., Camden Square 12° F., Greenwich and even Kensington Palace 16° F. It would seem, therefore, that the figure of 21° F. recorded at Kew was exceptionally high and not in accordance with the readings registered in surrounding districts. The fact that a minimum reading of 10° F. was registered at Kew on the same night on the surface of the snow would indicate that the sky was as clear as elsewhere, and therefore there is no apparent reason for this divergent screen reading.

In this connection I have very frequently noted relatively high minima recorded at Kew Observatory on cold nights compared with the other London stations, but have never before noticed such a great divergence as on the occasion mentioned, and I am unable to account for this.

Another peculiarity about Kew which I have frequently observed is not only the fact that the maxima recorded there in hot weather are often lower than at other London stations (either central or outlying), but that they are reached later in the day, in clear, hot weather the 6 p.m. (G.M.T.) reading often approaching the highest reading for the day.

HAROLD FREIR.

Bylock Hall, Ponders End, Middlesex, July 2nd, 1921.

[The use of different methods for exposing thermometers makes the comparison of observations difficult. At Kew Observatory the thermometers used for all the official reports are exposed in the large thermograph screen on the north wall of the building, and 10 feet above ground. There is a Stevenson screen (double size) on the lawn.

For the night in question, December 12th–13th, 1920, the lowest temperatures recorded were :—

North wall screen ordinary minimum thermometer	20° F.
„ „ „ photo-thermograph - - -	20° F.
Stevenson screen - - - . - -	15° F.
Grass minimum thermometer - - - -	10° F.

For the first ten days of December 1920 the minimum by the Stevenson screen averaged 1·0° F. lower than that in the north wall screen, whilst the maximum in the Stevenson was the higher by 0·5° F., so that the difference of range was about 1·5° F. According to a comparison made at Kew Observatory in the years 1879–81 (Q.W.R. 1880, App. II.) the average differences in winter were :—

Maximum	Stevenson	higher than north wall by	0·42° F.
Minimum	„	lower „ „ „ „	1·80° F.

The use of the more modern pattern of Stevenson screen provided with a double roof and a nearly closed bottom has presumably made the present Stevenson screen readings more nearly represent the temperature of the free air.

It should be mentioned that the comparability of London observations is also affected by the use at Greenwich Observatory and at Camden Square of Glaisher stands instead of Stevenson screens. On the Glaisher stand the thermometer is sheltered from direct radiation from the sun, but it can exchange radiation with the ground, &c. These exceptional methods of thermometer exposure have been maintained for historical reasons.—ED. M.M.]

Cloud Nomenclature.

My experience is that seven of the principal types of cloud are readily recognised from their definition, according to the international classification. The difficulty arises when alto-stratus, stratus or nimbus clouds prevail. The distinction between stratus and nimbus clouds is not very clear to most observers, unless rain is falling, when the clouds are called nimbus. According to the *Meteorological Glossary*, p. 65, " it should be noted that rain, hail or snow only fall from nimbus or cumulo-nimbus clouds, except the slighest and most transient showers, which may sometimes fall from alto-cumulus or strato-cumulus clouds." This statement is either incorrect, or otherwise on quite 40 per cent. of the occasions when rain is reported, the cloud type is wrong. Observers frequently report "continuous moderate rain," "heavy showers," etc., with a cloud-type stratus.

The only means of distinguishing stratus from alto-stratus by the definitions proposed by Dr. Brooks is "by whether or not it appears to be lower than 1,000 metres above the surface," but with this distinction only, greater confusion between the two types of cloud is certain to arise. Estimating the height of a cloud is very difficult and deceiving, as people with flying experience will testify.

The question of precipitation from various types of clouds other than nimbus arises in Dr. Brooks's definition of alto-stratus where he says "steady rain or snow may fall for hours from alto-stratus."

To bring about a better uniformity among cloud observations, some clear statement about precipitation from various types of clouds should be added to the definitions in the international classification. C. C. Newman.

Kingston-on-Thames, July 27th, 1921.

The Design of Rain Gauges.

I have read with great interest the article in the *Meteorological Magazine* for July, entitled "The Design of Rain Gauges," and it would be an excellent thing if all rain gauges conformed to the specification given. I would suggest an amplification of essential feature No. 5 something like this, "Simplicity of construction and avoidance of the use of unsoldered joints in any place where a leak may cause loss of collected rainfall."

There are many ways, other than rivetting, of making a leaky joint, such as screwing, bolting or folding without soldering, and Dr. Mill many times impressed on me the importance of having solder over any joint however it might be held together mechanically. F. L. Halliwell.

17, Brockenhurst Gardens, Mill Hill, July 22nd, 1921.

Somerset—A Year of Drought.

A VERY hot and dry July has greatly aggravated a situation which was bad enough before, and completed a very dry twelve months.

July yielded ·71 in. of rain on 7 days, against an average of 2·47 in. on 13·2 days.

The aggregate fall for 1921 thus far is 9·19 in. on 75 days, against a previous lowest 10·94 in. in 1911, and against 85 days in 1899 and in 1911. The averages for 24 years are 16·84 in. on 107 days.

For the 12 months now ended we have 18·81 in., against a previous lowest of 25·43 in the corresponding months of 1904–5, and against a 24 years' average of 32·32 in., that is 74 per cent. of the previous least and 55 per cent. of the average. H. A. BOYS, F.R.Met.Soc.

North Cadbury Rectory, Somerset, August 2nd, 1921.

The Rainfall of June 26th at Limerick.

A FEW facts connected with the abnormal rainfall here on June 26th may be of interest.

Sunday morning and afternoon were bright and hot; about 4 p.m. clouds began to roll up from the north-west. There was at first distant thunder, it came nearer, and about 4.45 p.m. a perfect "cloud burst" occurred, the rain coming down in sheets. On measuring the rain at 6.45 p.m., I found slightly over 1·50 ins. in the gauge. The rain had ceased slightly although it was still raining hard. It continued practically all night, but its great strength was over. The gauge at 9 a.m. on the 27th registered for the 24 hours 1·88 ins. which, as far as I know, was a record in this district.

My records have been carefully kept since 1890 inclusive.

Another gauge at my factory, Upper William Street, Limerick (on the opposite side of the River Shannon), only read 1·06 for the 27th. Of course a cloud-burst causes an unequal distribution of rainfall, and I have reason to think that within 20 miles of Derravoher there were places in which the rainfall was not one-third of what we had. In fact, I have heard, but I cannot verify it, that there were places that afternoon in which there was no rain at all.

A. W. SHAW.

Mulgrave Street, Limerick, July 13th, 1921.

NOTES AND QUERIES.

Optical Phenomena at Aberdeen, June 13th, 1921.

Simultaneous Halo and Corona.

A REMARKABLE display of various optical phenomena occurred at Aberdeen between 15 h. and 18 h. G.M.T. on June 13th, 1921.

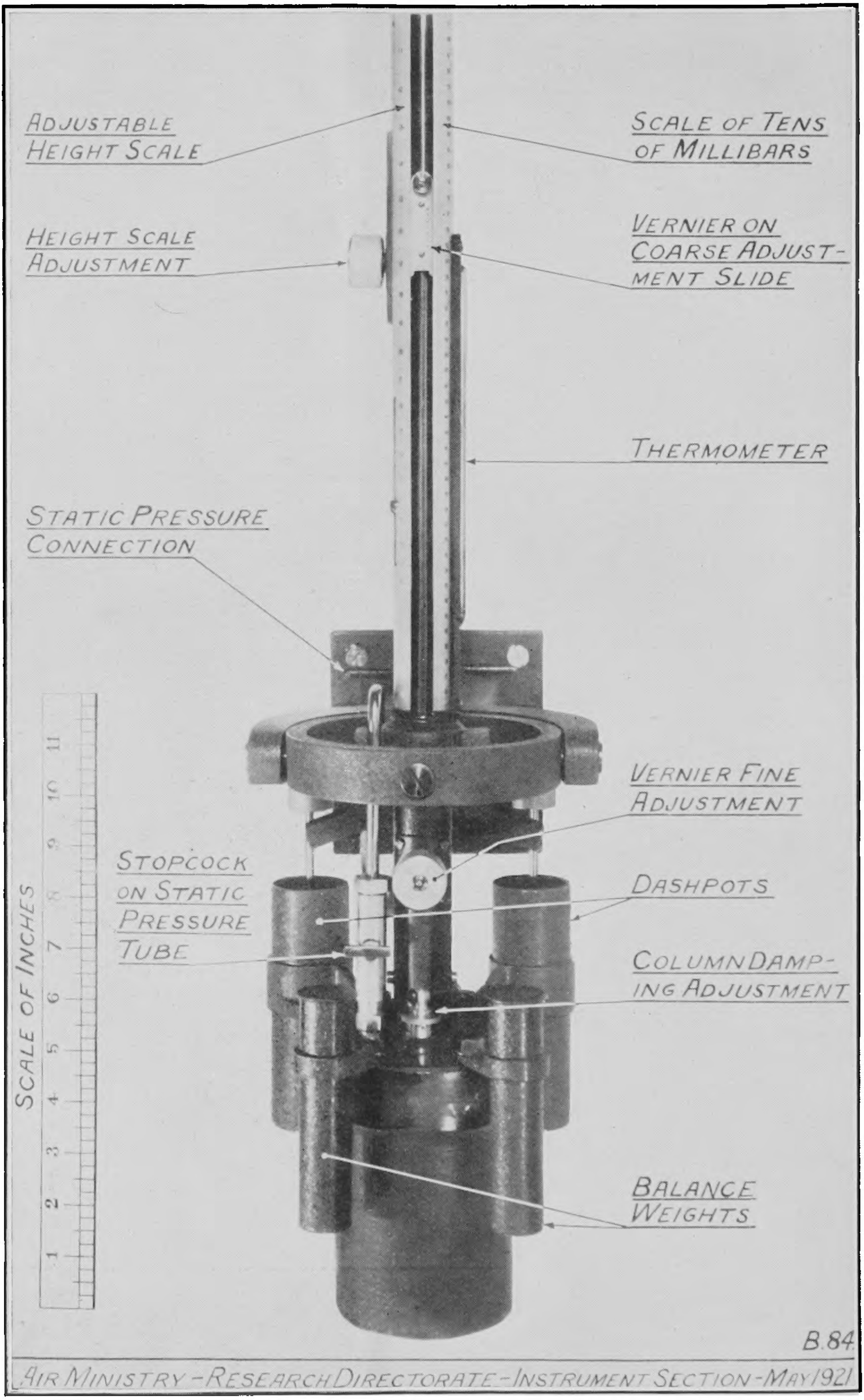
At 15 h. the sky was covered with a film of cirro-nebula, which was structureless and scarcely sufficed to dim the blue colour of the sky. A very fine halo of 22° was visible, showing the reddish-orange very strongly, and the yellowish-green quite plainly, though not intensely. Beyond the green the colour was a white, or bluish-white, merging into, and probably tinted by, the bluish-white of the sky. The halo-ring seemed somewhat narrower than usual.

Shortly after 15 h. some sheets of very thin cirro-cumulus exhibiting double undulation formed very rapidly and went through a series of rapid changes of form and also of internal structure. Trains of waves were seen to form and to be obliterated by other trains crossing them at angles of 60° or 70°. One of these sheets was situated between the sun and the observer, and in it there formed a magnificent triple corona, approximately 16° in radius to the outermost red. The phenomenon did not last more than two or three minutes at most, and as the cloud thickened the corona rapidly deteriorated into an ordinary one with radius smaller than that of the innermost of the original three rings. During its short duration the triple corona was carefully examined, and the estimation of its radius was made possible by the fact that the cloud sheet in which it was formed was not extensive enough completely to cover the halo.

On a rough approximation the angular radii of the three red rings were about 6°, 10°, and 16° respectively. There was a strong bluish-white aureole edged with brown between the sun and the first violet. The first ring colours were in the normal sequence from the violet to the red, but in the second ring the colours seemed impure, a pinkish-red and a bluish-green, while those of the third and outermost ring were simply the emerald-green and rose-pink so often seen in the phenomena of iridescence. In fact, the lower edge of the outer ring almost reached the margin of the cloud-sheet and the rose colour of the corona merged with and spread into a very fine iridescent area along the edge and contours of the cloud. The iridescent colours were confined to rose-pink and emerald-green in the neighbourhood of the ring, but further along the edge of the sheet some violet and

Simultaneous Halo and Triple Corona.

Observed by Mr. G. A. Clarke, at Aberdeen, June 13th, 1921.



A MERCURY BAROMETER FOR AIRSHIPS.

yellowish-green was seen. This irisation lasted for some time after the triple corona had disappeared. The irisation seemed also to show up the tiny ripples and waves in the cloud sheet, at the extreme edge of which there might be seen groups of very small crossed ripples, the groups being alternately emerald and rose-colour.

During the afternoon these cloud sheets kept forming and evaporating in rapid succession, and were succeeded by heavier sheets of alto-cumulus at 18 h. By 16 h. 30 m. the halo of 22° had faded to a much paler tint, showing little colour, but its upper portion now showed a bright colourless arc of contact. At 18 h. the halo of 22° was still faintly visible, and a brilliantly coloured arc of contact to the halo of 46° was also seen, no trace of the halo itself being visible.

G. A. Clarke.

[Mr. Clarke follows Pernter in calling the last-mentioned arc the arc of contact of the halo of 46°. The arc is frequently seen without the halo of 46°, and the generally accepted theory as given, for example, by Humphreys (Physics of the Air, p. 511) requires that the distance from the sun for the various colours should be greater than in the halo. Moreover, a photograph showing the arc and the 46° halo with a distinct gap between them is reproduced by Benson. (*Ann. Obs. Montsouris.* Paris, 1910. P. 478.) The arc being part of a circle round the zenith, the name "circumzenithal arc" is appropriate. Examinations of this arc with the aid of a theodolite are desirable.—Ed. M.M.]

A Mercury Barometer for Airships.

To meet the needs of the large rigid airships a mercury aerial barometer has recently been designed by the Instrument Department, Air Ministry, and constructed by Messrs. Negretti and Zambra. A general view of the lower part of this instrument is shown in the accompanying figure.

The barometer is of the Kew type and is supported on gimbal bearings from a bracket attached to the framework of the airship in such a way that the column may remain vertical with the supporting bracket inclined at 20° to the vertical in any direction. Two dashpots are provided to damp out any swinging of the instrument. These consist of cylinders which are attached to the back of the mercury cistern and carry loosely fitting pistons suspended by ball joints from the supporting bracket; the cylinders are filled with a mixture of glycerine and water.

The mercury column is of large diameter, 0·5 inch, to eliminate the necessity for any correction for capillarity, while to avoid any inaccuracies due to the fact that the pressure in the control car is very rarely static,* the mercury cistern is not directly open to the atmosphere, but is connected to the static tube of a hanging head slung some 30 feet below the ship, and therefore clear of any disturbance due to the passage of the ship through the air. The nipple to which the static head is connected is fixed to the supporting bracket, and a rubber tube leads therefrom to a stopcock on the cistern, thus avoiding any restraint on the swinging of the barometer.

The end of the barometer tube which dips into the mercury in the cistern is nearly closed by a conical plug, the exact position of which may be adjusted by a screw. By use of this device any oscillations of the mercury column may be damped out, or again the column may be restrained in any one position at will for a reading to be made at leisure. Moreover, to facilitate transport of the instrument the column may be pumped down and the plug closed.

The right-hand side of the barometer carries a pressure scale graduated in millibars; the vernier has a coarse adjustment by sliding and a fine adjustment by rack and pinion operated from the knurled knob seen just beneath the gimbal ring.

The left-hand side of the column carries a movable scale showing heights in feet. This scale is graduated according to the usual convention to be correct for all heights when the air pressure is 1013·2 mb. at the zero height and the air temperature is uniformly 50° F. For convenience of use in landing and in other operations the height scale may be adjusted by means of the knurled knob on the left of the column to place its zero opposite any desired pressure. This height scale is intended as a rough guide when quick readings are called for; for accurate estimates of height it is necessary to use the pressure readings in conjunction with temperature observations.

A MEETING of the International Commission for the Exploration of the Upper Air was held at Bergen, on the invitation of Prof. V. Bjerknes, president of the commission, in the week ending July 30th An account of the proceedings will be given in this Magazine next month.

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* The static pressure is the pressure in the free atmosphere at the same level. If a tube with holes in its sides is set in such a way that the air can stream past it without being obstructed, the pressure inside the tube is equal to the static pressure.

Royal Meteorological Society.

It has been arranged to hold a meeting of the Royal Meteorological Society in Edinburgh on Wednesday afternoon, September 7th. Upon the incorporation of the Scottish Meteorological Society with the Royal Meteorological Society early in the present year, it was decided to hold periodical meetings north of the Border in addition to those held regularly in London. The meeting in September is the first of those to be held in Scotland, and the date has been chosen to coincide with that of the British Association Meeting in Edinburgh during the week September 7th–14th. The Meteorological Luncheon which has been held during the British Association Meeting for a number of years past, will this year be open to Fellows of the Royal Meteorological Society as well as to members of the British Association. It has been fixed for Thursday, September 8th. An excursion to Eskdalemuir open to Fellows of the Society has been arranged for Tuesday, September 6th.

British Association Meeting, September 7th–14th 1921.

It is hoped that, during the meeting of the British Association, a Daily Weather Report will be produced in Edinburgh, by the Meteorological Office, on the lines of that at present issued from "Local Centres," and that copies will not only be exhibited to members of the Association, but also distributed to other addresses in Edinburgh.

In this connection, too, it is hoped that it may be possible to arrange for practical demonstrations to be given, showing how anyone equipped with a small wireless receiving set may pick up the synoptic data issued daily at fixed hours by the Meteorological Offices of this and other countries, and so be in a position to construct synoptic charts of the weather over a wide area, shortly after the observations are taken. A number of papers of meteorological interest will be read before section A of the British Association. The collection of meteorological diagrams and photographs arranged for the meeting of the Royal Meteorological Society will be on view throughout the week.

Ball Lighting seen at St. John's Wood.

The following details concerning a "fireball" which she observed during the thunderstorm of June 26th have kindly been given by Mrs. D——, of Circus Road, St. John's Wood.

It will be remembered that the thunderstorm was remarkable for its long duration and for the large area which it covered as well as for light rainfall and slow movement. Mrs. D—— had been watching the storm from her window, which faces south-east, for a long while when, about 2 a.m. (Summer time) she suddenly noticed the fireball. It appeared as an incandescent mass floating in the atmosphere below the clouds. It was pear-shaped, the greatest width being equivalent to three moons, the height to four or five. No estimate of the distance was made; the elevation seems to have been about 35°, the bearing about south-east. The phenomenon lasted for at least two minutes, for Mrs. D—— had time to go to a friend's room and rouse her to see it set before it vanished. The fireball had a slight "to and fro" movement, but did not travel far, whilst it was under observation. There was continuous rumbling of distant thunder at the time, but no special noise which was associated by the observer with the vanishing of the fireball.

Several newspapers have been so good as to insert a notice to the effect that persons who had observed such a phenomenon were requested to communicate with the Meteorological Office. A summary of the reports which have been received will be published in the next issue of this Magazine.

F. J. W. W.

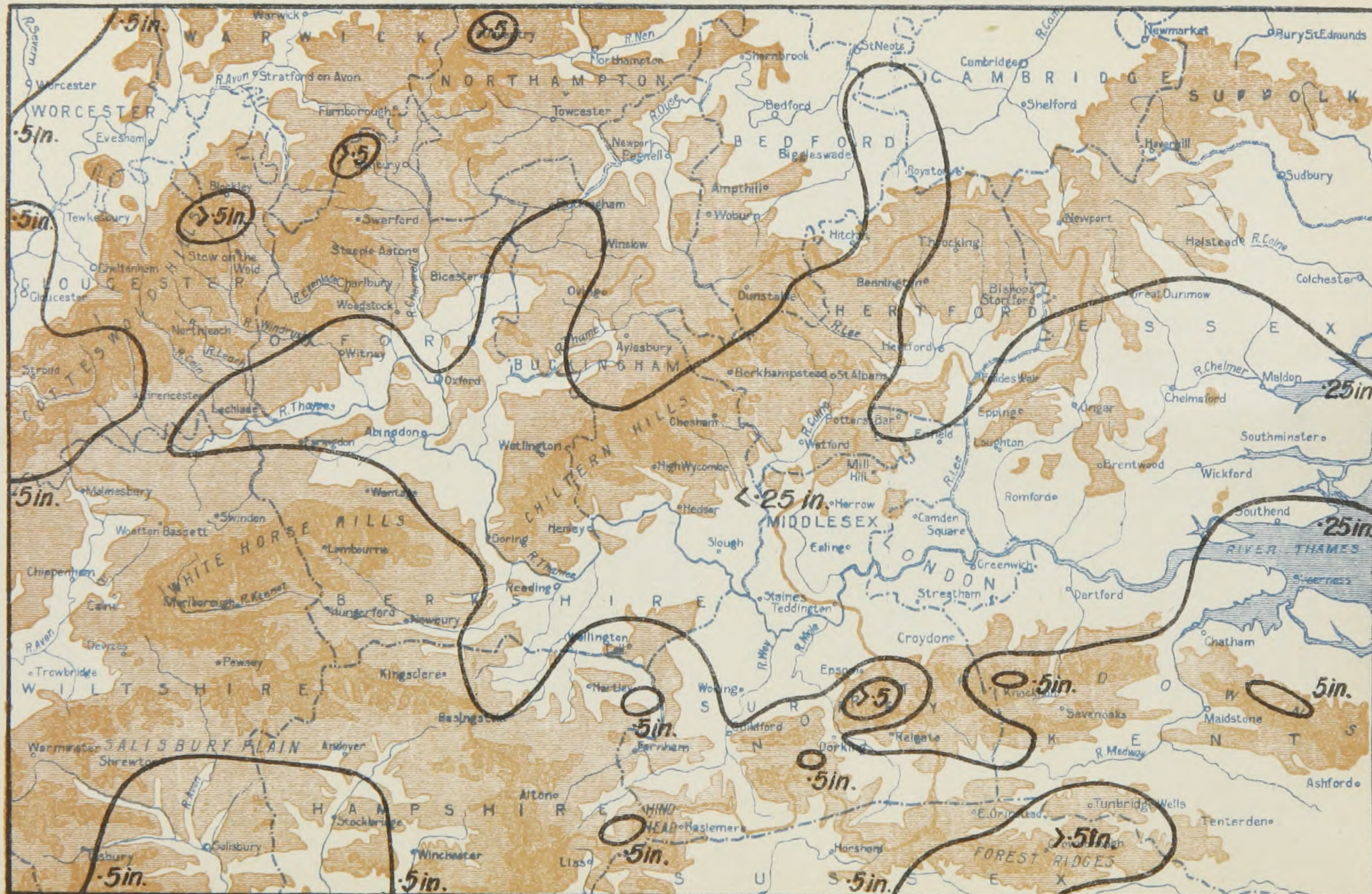
Artificial Rain-making.

During the prolonged drought of the past weeks the question as to the possibility of the production of rain by artificial methods has received considerable attention. On July 13th a question was asked in the House of Commons as to whether the Government would be prepared to initiate experiments for the purpose of inducing rainfall. The reply given was to the effect that from past experiments meteorologists were of opinion that explosions would not induce a fall of rain. Unless an explosion could produce a cold current or cause sufficient disturbance in the atmosphere to bring about the thorough mixing of cold and warm layers of air no rainfall could be induced.

On July 12th and shortly after the *Daily Express* conducted various experiments; on two occasions rockets were fired into the air, and on another occasion the clouds were sprayed with liquid air from an aeroplane. No meteorological results could be traced.

Accounts have also been published in the press of rain-making as practised by a Mr. Hatfield in Canada. Mr. Hatfield attempts to "overturn the atmosphere" by chemical fumes, the nature of which are, at present, a secret. It is said that his efforts have been followed by rain, and that he has been paid about £600 for one month's rain-making.

THAMES VALLEY RAINFALL —— JULY, 1921.



ALTITUDE SCALE: Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES: 0 5 10 15 20

Watershed of River Thames above Teddington and River Lee above Feildes Weir.

Isohyetals

H.M. Stationery Office Press, Kingsway W.C.2.
Ps.3334/945. Wt. 26. D.P.16. 1250. 8/21.

News in Brief.

At the end of June 1921 Professor F. H. Bigelow retired from the Argentine Meteorological Office after 15 years service. Professor Bigelow made his reputation as a meteorologist in the United States, and during his residence in Argentina he has elaborated a theory designed to unify the sciences of Meteorology, Magnetism and Solar Physics.

It was reported in the press that on July 17th Thetford experienced a fall of 1·50 in. of rain in 20 minutes. Rainfall of this intensity is very unusual. It is now stated, however, that an error had insinuated itself into the report circulated by a news agency.

The actual record was ·80 in. in 30 minutes, the heaviest fall in so short a period recorded at Thetford during 22 years.

The Rede Lecture on "The Air and its Ways," given by Sir Napier Shaw at Cambridge on June 9th, is published in a slightly abridged form in *Nature* of July 21st, 1921.

The Weather of July 1921.

The distribution of pressure over western Europe was anticyclonic for the first three weeks, with dry weather generally. Towards the end of the month Atlantic depressions brought rain to the west and north of the British Isles, and to Scandinavia, but over south-east England, France and Central Europe there was no real break in the drought, in spite of the passage of a deep depression across England on the 29th. Great heat prevailed for the most of the month in England and in west and south-west Europe generally, but in Scotland and in the Scandinavian and Baltic areas conditions were much cooler, though there were a few hot days.

At the beginning of the month the anticyclone was situated between Scotland and Iceland, with north-east winds and dry weather over the British Isles. There was some warm days inland, but the nights were cool, with ground frost locally. Pressure was relatively low over the Baltic and Central Europe, with some local rain. The anticyclone moved south on the 4th, and on the next day lay directly over England, where it persisted without much change of position till the 12th. The weather was fine and became very hot, temperatures reaching 90° F. in parts of England on the 10th and 11th, and reaching 84° F. as far west as Cahirciveen on the 12th. Temperature also reached 84° F. at Aberdeen on the 10th, but

(*Continued on* p. 202.)

Rainfall Table for July 1921.

STATION.	COUNTY.	Aver. 1881—1915. in.	1921. in.	1921. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days
Camden Square	*London*	2·38	·13	3	5	·06	29	3
Tenterden (View Town)	*Kent*	2·09	·29	7	14	·23	28	4
Arundel (Patching Farm)	*Sussex*	2·40	·33	8	14	·19	28	4
Fordingbridge (Oaklands)	*Hampshire*	2·00	·58	15	29	·13	17	8
Oxford (Magdalen College)	*Oxfordshire*	2·27	·26	5	8	·08	23	4
Wellingborough (Swanspool)	*Northampton*	2·29	·20	5	9	·10	28	4
Hawkedon Rectory	*Suffolk*	2·44	·40	10	16	·22	6	6
Norwich (Eaton)	*Norfolk*	2·59	·50	13	19	·16	6, 28	5
Launceston (Polapit Tamar)	*Devon*	2·69	1·41	36	52	·97	28	11
Sidmouth (Sidmount)	„	2·51	·48	12	19	·17	28	7
Ross (Chasedale Observatory)	*Herefordshire*	2·25	·49	13	22	·28	25	4
Church Stretton (Wolstaston)	*Shropshire*	2·45	1·15	29	47	·57	25	7
Boston (Black Sluice)	*Lincoln*	2·20	·42	11	19	·14	6	7
Worksop (Hodsock Priory)	*Nottingham*	2·27	·49	12	22	·22	25	7
Mickleover Manor	*Derbyshire*	2·45	·68	17	28	·33	25	6
Southport (Hesketh Park)	*Lancashire*	2·86	1·72	44	60	·52	23	13
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·69	1·42	36	53	·39	23	11
Hull (Pearson Park)	„ *E. R.*	2·34	·59	15	25	·18	25	9
Newcastle (Town Moor)	*North'land*	2·65	1·65	42	62	·44	23	13
Borrowdale (Seathwaite)	*Cumberland*	8·46	6·85	174	81	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	3·11	1·00	25	32	·35	25	10
Haverfordwest (Gram. Sch.)	*Pembroke*	3·20	2·29	58	72	1·03	28	9
Aberystwyth (Gogerddan)	*Cardigan*	3·86	1·83	47	47	·67	25	7
Llandudno	*Carnarvon*	2·39	1·51	38	63	·48	28	12
Dumfries (Cargen)	*Kirkcudbt.*	3·24	6·27	159	193	2·27	28	17
Marchmont House	*Berwick*	3·05	2·84	72	93	·65	25	14
Girvan (Pinmore)	*Ayr*	3·65	4·70	119	129	1·09	28	19
Glasgow (Queen's Park)	*Renfrew*	2·92	3·34	85	114	·56	30	15
Islay (Eallabus)	*Argyll*	3·41	3·84	97	113	·72	24	21
Mull (Quinish)	„	4·05	3·99	101	99	·60	24	21
Loch Dhu	*Perth*	4·83	6·00	152	124	2·05	30	14
Dundee (Eastern Necropolis)	*Forfar*	2·74	2·14	54	78	·62	28	12
Braemar (Bank)	*Aberdeen*	2·56	2·29	58	89	·88	28	8
Aberdeen (Cranford)	„	2·96	1·69	43	57	·43	28	11
Gordon Castle	*Moray*	3·20	2·27	58	71	1·22	28	10
Fort William (Atholl Bank)	*Inverness*	4·85	5·71	145	118	·95	21	20
Alness (Ardross Castle)	*Ross*	3·03	2·94	75	97	·95	28	14
Loch Torridon (Bendamph)	„	5·42	4·92	125	91	1·05	21	19
Stornoway	„	3·03	3·21	81	106	·68	27	20
Wick	*Caithness*	2·63	2·42	61	92	·44	21	19
Glanmire (Lota Lodge)	*Cork*	2·90	3·83	67	132	·87	28	10
Killarney (District Asylum)	*Kerry*	3·32	3·80	97	114	1·10	27	15
Waterford (Brook Lodge)	*Waterford*	3·24	4·62	117	143	2·36	28	9
Nenagh (Castle Lough)	*Tipperary*	3·14	3·78	96	120	1·27	28	14
Ennistymon House	*Clare*	3·75	3·72	95	99	·57	22	15
Gorey (Courtown House)	*Wexford*	2·94	3·97	101	135	1·67	27	13
Abbey Leix (Blandsfort)	*Queen's Co.*	3·13	5·41	137	173	2·25	28	13
Dublin (FitzWilliam Square)	*Dublin*	2·56	4·24	108	166	1·50	27	13
Mullingar (Belvedere)	*Westmeath*	3·18	3·78	96	119	·96	28	13
Woodlawn	*Galway*	3·48	4·00	102	115	·90	28	16
Crossmolina (Enniscoe)	*Mayo*	3·64	3·48	88	96	·68	24	16
Collooney (Markree Obsy.)	*Sligo*	3·44	5·13	130	149	1·10	30	19
Seaforde	*Down*	3·19	4·78	121	150	1·97	28	16
Ballymena (Harryville)	*Antrim*	3·43	4·63	118	135	·79	30	17
Omagh (Edenfel)	*Tyrone*	3·40	4·28	109	126	·80	24	15

Supplementary Rainfall, July 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	·12	3
,,	Sevenoaks, Speldhurst	·29	7
,,	Hailsham Vicarage	·43	11
,,	Totland Bay, Aston	·47	12
,,	Ashley, Old Manor Ho.	·68	17
,,	Grayshott	·51	13
,,	Ufton Nervet	·18	5
III.	Harrow Weald, Hill Ho.	·15	4
,,	Pitsford, Sedgebrook	·27	7
,,	Chatteris, The Priory	·16	4
IV.	Elsenham, Gaunts End	·26	7
,,	Lexden, Hill House	·26	7
,,	Aylsham, Rippon Hall	·40	10
,,	Swaffham	1·75	44
V.	Devizes, Highclere	·42	11
,,	Weymouth	·28	7
,,	Ashburton, Druid Ho.	·92	23
,,	Cullompton	·74	19
,,	Hartland Abbey	·89	23
,,	St. Austell, Trevarna	1·45	37
,,	North Cadbury Rec.	·71	18
,,	Cutcombe, Wheddon Cr.	1·47	37
VI.	Clifton, Stoke Bishop	·87	22
,,	Ledbury, Underdown	·40	10
,,	Shifnal, Hatton Grange	·78	20
,,	Ashbourne, Mayfield	·94	24
,,	Barnt Green, Upwood	·55	14
,,	Blockley, Upton Wold	·56	14
VII.	Grantham, Saltersford	·29	7
,,	Louth, Westgate	·30	8
,,	Mansfield, West Bank	·60	15
VIII.	Nantwich, Dorfold Hall	·64	16
,,	Bolton, Queen's Park	1·59	41
,,	Lancaster, Strathspey	1·52	39
IX.	Rotherham		
,,	Bradford, Lister Park	1·49	38
,,	West Witton	3·06	78
,,	Scarborough, Scalby	1·63	41
,,	Middlesbro', Albert Pk.	1·66	42
,,	Mickleton	1·40	36
X.	Bellingham	2·61	66
,,	Ilderton, Lilburn	2·65	67
,,	Orton	3·71	94
XI.	Llanfrechfa Grange	·97	25
,,	Treherbert, Tyn-y-waun	5·14	131
,,	Carmarthen Friary	2·94	75
,,	Llanwrda, Dolaucothy	3·52	89
,,	Lampeter, Falcondale	2·43	62
,,	Cray Station	5·80	147
,,	B'ham W.W., Tyrmyndd	2·33	59
,,	Lake Vyrnwy	3·25	83
,,	Llangynhafal, P. Drâw	2·10	53
,,	Oakley Quarries	7·71	196
,,	Dolgelly, Bryntirion	2·59	66
,,	Lligwy	2·08	53
XII.	Stoneykirk, Ardwell Ho.	4·20	107
,,	Carsphairn, Shiel	6·38	162
XII.	Langholm, Drove Rd.	4·97	126
XIII.	Ettrick Manse	4·62	117
,,	North Berwick Res.	2·19	56
,,	Edinburgh, Royal Ob.	2·21	56
XIV.	Biggar	3·17	81
,,	Leadhills	6·42	163
,,	Maybole, Knockdon	4·74	120
XV.	Dougarie Lodge	3·93	100
,,	Inveraray Castle	4·19	106
,,	Holy Loch, Ardnadam	7·31	186
XVI.	Loch Venachar	4·60	117
,,	Glenquey Reservoir	4·20	107
,,	Loch Rannoch, Dall	2·46	63
,,	Trinafour	3·05	77
,,	Blair Atholl	2·68	68
,,	Coupar Angus	2·18	55
,,	Montrose Asylum	1·83	47
XVII.	Logie Coldstone, Loanh'd	1·91	49
,,	Fyvie Castle	1·69	43
,,	Grantown-on-Spey	2·25	57
XVIII.	Cluny Castle	2·67	68
,,	Loch Quoich, Loan	..	..
,,	Fortrose	2·37	60
,,	Faire-na Squir	4·30	109
,,	Skye, Dunvegan	3·39	86
,,	Glencarron Lodge	..	..
,,	Dunrobin Castle	2·38	61
XIX.	Tongue Manse	2·55	65
,,	Melvich Schoolhouse	2·15	55
,,	Loch More, Achfary	6·43	163
XX.	Dunmanway Rectory	5·36	136
,,	Mitchelstown Castle	3·86	98
,,	Gearahameen	6·90	175
,,	Darrynane Abbey	3·96	101
,,	Clonmel, Bruce Villa	4·85	123
,,	Cashel, Ballinamona	5·26	134
,,	Roscrea, Timoney Pk.	4·91	125
,,	Foynes	4·31	109
,,	Broadford, Hurdlesto'n	4·32	110
XXI.	Kilkenny Castle	3·60	91
,,	Rathnew, Clonmannon	4·79	122
,,	Hacketstown Rectory	2·93	74
,,	Balbriggan, Ardgillan	4·05	103
,,	Drogheda	4·03	102
,,	Athlone, Twyford	3·71	94
XXII.	Castle Forbes Gdns.	3·87	98
,,	Ballynahinch Castle	4·00	102
,,	Galway Grammar Sch.	3·93	100
XXIII.	Westport House	2·51	64
,,	Enniskillen, Portora	4·83	123
,,	Armagh Observatory	3·64	93
,,	Warrenpoint	3·79	96
,,	Belfast, Cave Hill Rd.	3·64	93
,,	Glenarm Castle	3·26	83
,,	Londonderry, Creggan	3·55	90
,,	Sion Mills	3·78	96
,,	Milford, The Manse	2·59	66
,,	Narin, Kiltoorish	3·41	87
,,	Killybegs, Rockmount	4·34	110

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean of Day M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	° F.		° F.		° F.	° F.	° F.	° F.
London, Kew Observatory	1026·0	+10·3	59	23, 24	28	3	47·1	36·1	41·6	+1·5
Gibraltar	1017·9	−0·9	65	24	42	8	59·1	50·0	54·6	−1·3
Malta	1017·9	+2·9	64	7	44	2	58·7	51·4	55·1	+0·8
Sierra Leone	1011·1	+0·1	97	17	70	14	91·1	73·0	82·1	−0·2
Lagos, Nigeria	1010·9	+0·8	91	25	68	4	82·8	77·3	80·1	−2·0
Kaduna, Nigeria	1013·2	+4·0	98	24	56	4	93·7	60·0	76·9	−1·3
Zomba, Nyasaland	1007·4	−0·4	85	5, 20	62	13	81·9	65·5	73·7	+2·0
Salisbury, Rhodesia	1007·4	−2·5	88	4	57	1, 22	81·4	61·6	71·5	+2·6
Cape Town	1011·4	−2·0	100	24	52	5	82·5	63·1	72·8	+2·8
Johannesburg	1011·6	+0·4	83	6	47	24	74·9	55·4	65·1	−0·3
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	90	2	49	5	80·4	59·6	70·0	−1·9
Calcutta, Alipore Obsy.	1011·8	−1·5	92	28	52	11	83·3	61·3	72·3	+1·3
Bombay	1011·4	−1·2	96	16	64	6	84·4	68·8	76·6	+1·0
Madras	1011·9	−0·9	94	28	63	11	86·3	66·7	76·5	−1·2
Colombo, Ceylon	1010·8	+0·2	93	11	66	22	87·2	69·9	78·5	−2·1
Hong Kong	1018·2	−0·6	78	28	44	4	64·8	55·9	60·3	+1·2
Sydney	1017·9	+3·9	90	26	60	5	78·7	65·1	71·9	+0·8
Melbourne	1017·7	+3·4	102	1	53	8	81·2	61·3	71·3	+3·9
Adelaide	1016·2	+1·9	108	12	54	4, 18	89·0	65·4	77·2	+3·1
Perth, Western Australia	1010·7	−2·3	106	6, 8	56	1	92·7	70·1	81·4	+7·4
Coolgardie	1011·5	−1·0	108	10	58	2	95·7	65·8	80·7	+4·7
Brisbane	1016·6	+4·5	93	5	65	10	84·1	67·6	75·9	−0·6
Hobart, Tasmania	1019·3	+6·0	84	12	47	7	71·0	55·3	63·1	+0·8
Wellington, N.Z.	1018·1	+2·8	77	16	42	13	69·5	54·5	62·0	−0·4
Suva, Fiji	1009·3	+1·6	90	9, 11	70	23	87·0	74·4	80·7	+0·2
Kingston, Jamaica	1015·3	−0·4	90	26	67	sev.	86·4	68·5	77·5	+1·0
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..
Toronto	1018·2	+0·2	53	16	7	24	35·4	21·6	28·5	+6·8
Winnipeg	1015·9	−5·9	40	27	26	19	19·8	2·2	11·0	+11·6
St. John, N.B.	1017·0	+2·9	46	17	−5	1	29·8	12·3	21·1	+1·2
Victoria, B.C.	1018·1	+2·2	55	10	27	16	45·6	37·3	41·5	+1·2

LONDON, KEW OBSERVATORY.—Mean speed of wind 6·5 mi/hr ; 10 days of fog.
GIBRALTAR.—4 days with hail, 4 days with thunder heard, 6 days with gale.
MALTA.—Prevailing wind direction NWly ; mean speed 9·3 mi/hr.
SIERRA LEONE.—Prevailing wind direction SW.

British Empire, February 1921.

Temperature Absolute Max. in Sun ° F.	Temperature Absolute Min. on Grass ° F.	Relative Humidity %	Mean Cloud Am'nt 0–10	Precipitation Amount in.	Precipitation Amount mm.	Precipitation Diff. from Normal mm.	Precipitation Days	Bright Sunshine Hours per day	Bright Sunshine Percentage of possible	STATIONS
102	19	80	7·3	0·19	5	– 34	2	1·9	20	London, Kew Observatory.
117	33	81	6·8	15·08	383	+276	19	..	..	Gibraltar.
124	..	84	6·0	1·13	29	– 22	11	4·5	42	Malta.
..	..	67	3·3	0·00	0	– 7	0	..	..	Sierra Leone.
158	64	86	7·3	0·02	1	– 50	1	..	..	Lagos, Nigeria.
..	..	30	..	0·00	0	– 5	0	..	..	Kaduna, Nigeria.
..	..	92	8·2	12·26	311	+ 35	21	..	..	Zomba, Nyasaland.
154	56	73	7·5	10·60	269	+ 87	15	..	..	Salisbury, Rhodesia.
..	..	64	4·8	1·36	35	+ 20	8	..	..	Cape Town.
..	46	77	6·3	2·63	67	– 63	12	7·7	59	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
..	..	64	4·6	6·62	168	+ 80	10	..	..	Bloemfontein.
..	43	47	0·9	0·49	12	– 17	2	..	..	Calcutta, Alipore Obsy.
138	57	62	0·5	0·00	0	– 1	0	..	..	Bombay.
..	..	82	1·6	0·00	0	– 8	0	..	..	Madras.
165	56	63	4·4	0·19	5	– 48	1	..	..	Colombo, Ceylon.
..	..	68	4·6	1·04	26	– 17	1	7·7	68	Hong Kong.
145	53	68	5·2	0·93	24	– 91	9	8·0	60	Sydney.
153	45	85	4·7	1·50	38	– 5	9	..	..	Melbourne.
169	41	42	3·4	0·55	14	– 2	5	9·0	68	Adelaide.
166	51	47	3·4	1·55	39	+ 28	2	..	..	Perth, Western Australia.
175	..	31	3·6	0·00	0	– 19	0	..	..	Coolgardie.
155	61	63	5·5	1·07	27	–141	10	..	..	Brisbane.
153	40	66	5·9	1·08	27	– 10	11	8·0	58	Hobart, Tasmania.
144	27	69	5·4	0·72	18	– 65	4	8·2	60	Wellington, N.Z.
..	..	83	5·1	11·38	289	+ 32	23	..	..	Suva, Fiji.
..	..	74	6·0	0·56	14	– 1	6	..	..	Kingston, Jamaica.
..	..	..	..	..	..	..	..	..	..	Grenada, W.I.
102	5	66	1·2	1·35	34	– 32	10	..	..	Toronto.
..	..	93	6·0	2·52	64	+ 44	9	..	..	Winnipeg.
123	5	56	5·7	3·08	78	– 21	13	..	..	St. John, N.B.
105	23	87	7·6	4·28	109	+ 19	19	..	..	Victoria, B.C.

COLOMBO, CEYLON.—Prevailing wind direction N.; mean speed 5·0 mi/hr.
HONG KONG.—Prevailing wind direction ENE.; mean speed 13·0 mi/hr.
MELBOURNE.—Highest pressure for February for 64 years.
SUVA, FIJI.—10 days with thunder heard.

a cooler current then spread over Scotland from the north-west. Temperature exceeded 90° F. at many Continental stations, reaching 99° F. at Dijon and Strasbourg on the 12th. Scandinavia was affected by depressions, and there were 35 mm. of rain at Stockholm on the 12th.

After the 12th the anticyclone moved away slowly north-eastward, and a large depression on the Atlantic moved slowly east, so that a south-easterly type of weather set in over the British Isles. Temperature remained high in the south, but with an increase of cloud the heat was less intense. Scotland and the east coast of England were under the influence of a cool current which came round the anticyclone.

Between the 14th and 17th rain fell at a number of stations in the west and north of the British Isles, mostly in small amounts, and thunder occurred locally. During a thunderstorm at Holyhead on the 15th there were 16 mm. of rain in 18 minutes. There were also local thunderstorms at a very few stations in the east and south-east of England. Thunderstorms were rather numerous and severe in France at about this time, Biarritz having 31 mm. of rain on the 15th, and Belfort 15 mm. on this date and 65 mm. on the 17th.

The depression over the Atlantic dispersed on the 17th, and the anticyclone spread back from Scandinavia over the British Isles. The weather became fine and very hot again over England, the thermometer touching 90° F. locally on the 19th and not falling below 69° F. on the following night at Kensington Palace, or below 67° at Portland Bill.

A new anticyclone spread up from the Azores to south-west Ireland on the 20th, and then moved south to the Bay of Biscay region, a westerly type of weather being established. Depressions moving east or north-east on the Atlantic brought rain and strong winds to the west and north of the British Isles and Scandinavia, but in the south of England the weather remained dry and warm, while in France intense heat continued, culminating on the 27th and 28th. On the first of these dates temperature reached 102° F. at Strasbourg and 101° F. at Toulouse, and on the following day it reached 104° F. at Strasbourg, 102° F. at Belfort, and 101° F. at Paris. Temperature also reached 101° F. at Breslau and Prague on the 29th. At some stations in the south of France the thermometer remained above 70° F. for several successive nights.

During the night of the 28th and morning of the 29th a deep depression moved north-eastward over England and caused a gale in the English Channel. There was little rain in south-east England, and practically none in France, but there was a considerable fall over a large area in the west and north of the British Isles. Holyhead had 47 mm. during the night of the 28th, and Baldonnel (Dublin) had 63 mm. during the 36 hours ending 7 a.m. on the 29th. Another depression followed, but moved north-east outside the Hebrides, the rain being again limited to the west and north.

After a cooler day on the 29th, temperature became high again over France at the end of the month, and over Central Europe the heat continued without interruption.

Fog was experienced rather frequently on our western coasts, but otherwise visibility was good over the British Isles. C. K. M. D.

At the beginning of the month thunderstorms, with violent rain, occurred in central and southern France, Toulouse being partially flooded. There was a temporary break in the drought in northern France and Belgium a fortnight later, but hot weather quickly reasserted itself. Forest fires were numerous in the Fontainebleau and other districts, and on the 28th a strong hot wind blew over Paris for several hours, with a cloudless sky.

Extensive forest and moorland fires have also occurred in Norway, Denmark, and Germany, where dry hot weather has been of long standing. The shade temperature at Geneva on the 28th was the highest recorded since 1870, and is said to have exceeded 100° F. The second half of the month was extremely hot in Rome. The whole of central and southern Russia can produce no appreciable harvest on account of the very severe drought, so that a famine of unparalleled severity threatens the entire country this winter.

A message to the *Times*, dated July 22nd, states that the heat in Irak has surpassed all previous experience since the British landing in 1914. A shade temperature of 128·9° F. is said to have been reached on the 16th, with an average maximum shade temperature for a fortnight of over 124° F. Authenticated records will be awaited with interest. Conditions have been almost unendurable in the Persian Gulf.

Periodical heat spells have been occurring in New York and in the whole middle section of the United States east of the Rocky Mountains. They are accompanied by high humidity of an almost unprecedented character. The cotton-growing districts, however, have had too much rain, and require hot dry weather to ensure even a small crop.

Excessive heat was being experienced in eastern Canada at the beginning of the month. There has been no such long period of intense hot weather in the history of Ontario. Enough rain fell later to reduce the forest fires considerably and to improve the crops, but more rain is needed.

Early in the month complete drought prevailed in northern Bombay, Rajputana, and north-west India, but fears of possible famine were subsequently dispelled by good rainfall lasting for a week.

Heavy gales and fierce rainstorms have swept New South Wales from Sydney northwards to the Queensland border, followed by disastrous floods in the coastal rivers. Much damage has been caused over a wide area. In southern Australia the winter has been dry and unusually mild.

The remarkable deficiency in the rainfall of the spring months continued throughout July over England and Wales. Extensive areas in the midland and southern counties had less than 20 per cent. of the average fall. Scotland had less than the average in the east and in some western districts, but there was an excess in the Highlands and in some southern counties. Rather more than the average fell over Ireland generally. The total amount was less than 1·00 in. to the east of a line from Plymouth to Hull and less than ·25 inch fell over a large part of the Thames Valley and Estuary. The fall increased to about 7·00 in. in the wettest parts of the Welsh mountains and the English Lake District. In Scotland it ranged from less than 2·00 in. along the east coast and rather more in the north and west to 8·00 in. at mountain stations in Perthshire and Inverness-shire. More than 2·00 in. fell everywhere in Ireland, and 5·00 was exceeded in parts of Leinster and Munster, where heavy thunderstorms occurred towards the close of the month. In a storm on the 28th more than 2·00 in. fell at several stations, and at Tramore (Co. Waterford) 3·97 in. was measured.

The general rainfall for July, expressed as a percentage of the average, was :—England and Wales, 40; Scotland, 105; Ireland, 130; British Isles, 86.

In London (Camden Square) the month was remarkable for brilliant sunshine, excessive warmth and deficient rainfall. The mean temperature, 69·4° F., was 6·0° above the average and the highest for any month in the 64 years' record. The rainfall was the least for any July in the same period, the nearest approach being ·45 inch in July 1868. Duration of rainfall, 3·3 hours. Evaporation, 4·17 in.

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The Diurnal Variation in Atmospheric Pollution and in Electrical Potential Gradient.

By C. CHREE, Sc.D., F.R.S.

THIS short note is primarily due to a suggestion made by Mr. R. E. Watson, professional assistant at Kew Observatory. In selecting curves of atmospheric electricity potential gradient for a recent exhibition, I came across a case where the drop from the high potential, which is characteristic of thick fog, was exceptionally rapid. Discussing the subject with Mr. Watson, I expressed a belief that the rapid fall of potential gradient had synchronised with a rapid clearing of the fog. Mr. Watson, who has been taking an active interest in Dr. Owens's air pollution apparatus recently installed at Kew Observatory, at once suggested that my explanation might be tested by reference to the air pollution records, as the quantity of dirt in the atmosphere tended to be high during fog. The pollution records on being consulted were found to show an exceedingly rapid diminution in the dirt contents of the atmosphere during the rapid fall of potential gradient. This suggested that it would be of interest to compare the diurnal variations of pollution, electrical potential gradient and barometric pressure, the diurnal changes of the two latter elements being already known to resemble one another. The comparison is made graphically in the accompanying figure, which shows the diurnal inequalities of the three elements for the months of January, February and March combined For pollution, data were available for 1921 only. For the other elements normal values based on a number of years were employed.

By a diurnal inequality is meant the departure from the mean value for the day, a non-cyclic correction having been applied to bring the values for the first and second midnights into accord. To obtain the mean absolute value at any hour, one adds to the inequality figure for the hour the mean value of the element for the day. These mean daily values in the present case were—

for pollution, 0·92 shade number (0·29 milligrams per cubic metre);
for potential gradient, 383 volts per metre;
for barometric pressure, 1014·31 millibars.

The highest and lowest mean hourly values for the day were: for pollution, 1·56 shade number (at 10 h.) and 0·40 shade number (at 3 h.); for potential gradient, 455 and 290 volts per metre; for barometric pressure, 1014·76 and 1013·86 millibars.

Undue weight must not be attached to three months' observations, but it is obvious that the resemblance between the pollution and potential gradient curves in the figure is fully as close as the resemblance between the latter and the pressure curve. The pollution and potential gradient curves appear closely in phase throughout the day, whereas the pressure curve shows a distinct lag, especially in the afternoon, as compared with the potential gradient curve.* The pollution curve agrees with the pressure curve in having the principal maximum in the forenoon, while it agrees with the potential gradient curve in having the principal minimum in the morning.

A resemblance between the pollution and the potential gradient curves was not exactly a surprise in view of the connection described some years ago between potential gradient at Kew and atmospheric opacity.† It was found that an increase of opacity was accompanied by an increase of potential gradient, and it is natural to suppose that the opacity of the atmosphere increases, *ceteris paribus*, with the amount of dirt present.

The potential gradient is proportional to the charge—normally negative—on the earth's surface. As the vertical

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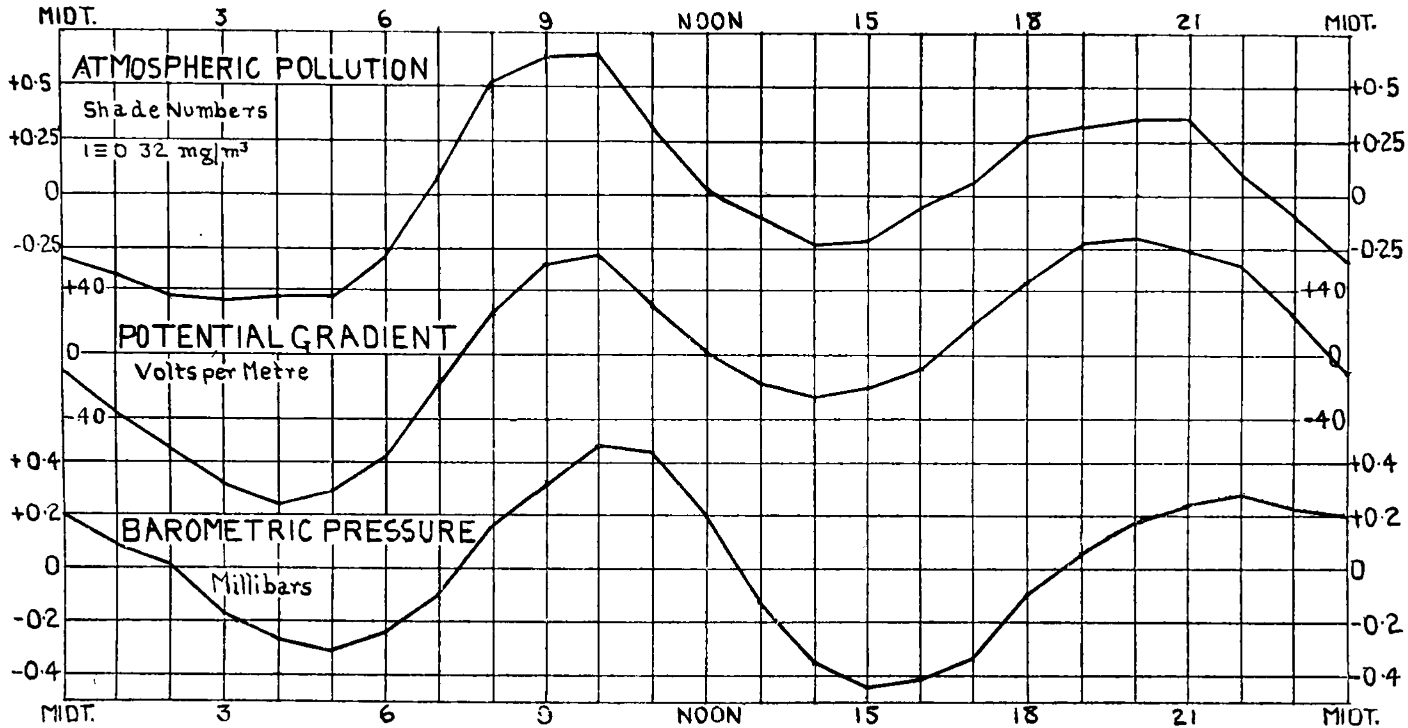
* The resemblance between the variations of potential-gradient and of barometric pressure is said by Gockel (Luft Elektrizität, p. 114) to have been first noted by Hann (Met. Zeit., 1889, Vol. 6, p. 95). It was, however, pointed out by J. D. Everett (Roy. Soc. Phil. Trans., 1868, pp. 347–361).

† Roy. Soc. Proc. A., Vol. 95, p. 210.



Diurnal inequalities of atmospheric pollution, potential gradient and barometric pressure at Kew Observatory for January, February and March.

electrical current in the atmosphere is usually downwards, implying a descent of positive ions or ascent of negative ions, the existence of a negative charge on the earth's surface suggests that somehow or other a continual supply of negative electricity comes from the interior and escapes into the atmosphere. The resemblance between the potential gradient and atmospheric pressure curve has been interpreted as showing that the escape of a negative emanation from the soil is influenced by the change of pressure, but the varying lag in the barometric pressure curve as compared with the potential gradient curve is, as I have pointed out before,* a difficulty which awaits explanation.

The escape of a negative charge from the earth's surface into the atmosphere would naturally depend on the mobility of the ions. If these were loaded up with dirt or aqueous vapour, their mobility, and so the air-earth current, would tend to fall, until the rise in potential gradient caused by the retention of its negative charge by the earth produced a balance. Thus it may well be that the variation in atmospheric pollution rather than the variation in pressure is responsible for the changes in the electric field.

There are, it should be remembered, a variety of sources of atmospheric pollution, and the greater or smaller amount of aqueous vapour present may be a vital factor in the electrical problem. But obviously, when adequate pollution data exist for all seasons of the year, a promising field of inquiry should present itself.

A serious difficulty in the previous study of the relation between potential gradient and atmospheric opacity arose from the inadequate supply of really distant objects for visibility observations in summer at Kew Observatory. The scale provided for use in Dr. Owens's pollution recorder during the early months of 1921 also promised to be more suitable for winter than for summer observations, but it is hoped that a modification which Dr. Owens has recently introduced will surmount this difficulty.

Results of the Ball Lightning Inquiry.

As mentioned in our last issue, notices were inserted in the press about the end of July asking for information concerning ball lightning and related phenomena from eye-witnesses.

One hundred and thirteen descriptions of various phenomena were received either personally or by letter in reply to this inquiry. Many of them, however, did not satisfy the essential

* Roy. Soc. Phil. Trans. A., Vol. 106, pp, 329-334.

points in the description of ball lightning, which is a glowing mass, without any solid constituent, stationary or moving slowly in mid-air. The description supplied by Mrs. D —— referred to an example seen in the thunderstorm of June 26th, and a large number of the replies referred to the same storm. On this day the moon was nearly at the third quarter, and Venus was a morning star, rising unusually early. In seven cases it was clear from the steadiness of the light, which some observers had seen at intervals of hours or even days, that the observation referred to Venus. Five reports appeared to refer to the moon seen through the clouds; six objects were shown by their straight and swift movement to be meteors; six were clearly ordinary lightning of unusual violence (which in some cases acquired an appearance of lasting for several seconds owing to several flashes following one another along nearly the same track); three, sheet lightning, which is the appearance presented by the lower side of a cloud lit up by ordinary lightning; and nine, clouds just above the horizon and strongly illuminated by the setting or rising sun so as to appear self-luminous.

The definitely unusual objects reported included a lunar halo, a very fine will-o'-the-wisp, and a miniature tornado, with the typical cloud-form above it, which had removed most of the leaves from a tree. Sixty-five reports appeared to be consistent with the hypothesis that they referred to ball lightning.

A schedule of questions concerning the appearance and behaviour of the objects seen was sent to each of these observers. Out of these, forty-six sent replies. The further information thus obtained was enough to decide that six previously doubtful cases did not refer to ball lightning; two were clearly sheet lightning, one the moon seen through clouds, one ordinary lightning, and one a meteor. One referred to a sixteenth-century tradition, but the object reported was solid; it was possibly a meteorite. This left forty cases of probable ball lightning of which fairly complete descriptions were available.

The main result of the inquiry is that ball lightning is an extraordinarily variable phenomenon. Many observers reported having seen it sufficiently closely for a fairly reliable estimate of the linear dimensions to be made, and in most of these cases the diameter was between three inches and a foot. On the other hand, several were stated to be as high or nearly as high as the clouds; this was confirmed in a few cases by the object having been hidden from view by clouds passing in front of it. The estimated sizes of these high examples were sometimes given in inches or yards, but an object of such linear dimensions at such a height would have appeared like a bright point and not like an extended object. More usually it was given in terms of the size of the moon. Now, an object 2,000 feet above the ground, and with the same angular diameter as the moon, must have a linear diameter of at least 16 feet; and in one case such an object was reported to have four times the dimensions of the moon. The diameter therefore appears to range from three inches to something comparable with sixty feet.

The times during which the objects were visible, again, ranged from two seconds to twenty minutes; the numbers lasting for various times were as follows:—

Less than 10 seconds	8
10 to 60 seconds	3
1 minute to 5 minutes	20
More than 5 minutes	6
Time not given	3

These estimates were non-instrumental, and consequently are subject to considerable error; no observer appears to have timed the object by means of a watch. It is likely that the waiting caused several observers to over-estimate the time, and therefore that many balls said to have lasted more than a minute really lasted between ten seconds and a minute.

The colour, again, ranged from bluish-white to deep red. Two of the bluish-white objects lasted for only a few seconds, and were of small size, and therefore may be suspected of being ordinary lightning; but one of the best accounts obtained also referred to a bluish-white ball. The great majority of the balls, however, were reddish or yellowish.

The shape was usually round, but there were several cases of pear-shaped or elliptical objects. Most of these had their longest dimension vertical; and the pear-shaped bodies had their narrow ends downwards.

An attempt was made to find out whether the balls were surrounded by any glow, indicating a brush discharge or St. Elmo's fire. Twelve observers reported a glow round the ball (in one case flickering), and one of them another glow round neighbouring solid bodies. In thirteen cases there was no glow, and the remainder were undecided. In five cases sparks were emitted.

It has been suggested that ball lightning may be air so strongly heated by the passage of an ordinary flash that it glows for a notable time on its own account. Only one such case was reported, but few persons appear to have observed the origin of a ball. One observer reported a remarkable case of the appearance of three balls simultaneously, coming from a church spire at a point where it had just been struck by an ordinary flash.

The disappearance of the ball lightning was often observed. In four cases it burst into fragments and an explosion was heard. In all others the disappearance was silent, except in one or two instances when an ordinary flash occurred at the same time. The numbers that disappeared in various ways were as follows :—

Bursting, 4. Sudden and silent vanishing, 8. Gradual fading, 7.
Immersion in water, 2. Eclipse by solid obstruction, 5.

In the two cases classified as "immersion in water" the balls appear to have fallen into the sea, one after collision with another ball.

It was hoped to get definite observation about the same ball from several observers, and to utilise their observations of direction to find the actual path. On comparing descriptions, however, they were found to differ in duration, colour, or shape to such an extent that it appeared impossible that any two observers could have witnessed the same ball. Apparently the balls do not necessarily move with the wind, but further information is required before one can assert this definitely.

In no case was damage done by a ball. H. J.

Could the Drought of 1921 have been Forecasted?

By C. E. P. Brooks, M.Sc.

WHILE the abnormal weather of the past spring and summer in Europe is still fresh in everyone's memory, it is an interesting exercise to apply to these seasons the principles of the *Réseau Mondial* and, by constructing charts of pressure and temperature deviations from normal, to attempt a prompt elucidation of the phenomena. The exercise is also useful as testing how quickly it would be possible to draw such charts without the organisation of a telegraphic *Réseau* in the event of their being required for seasonal forecasting. For many parts of the world no information is yet available, but by making use of the data collected for the Climatological Table of the British Empire in this magazine and supplementing these by the monthly and daily reports of various countries, charts have actually been constructed for the months of December 1920 to June 1921 which cover in sufficient detail North America, the Atlantic, Europe, India and much of Africa.

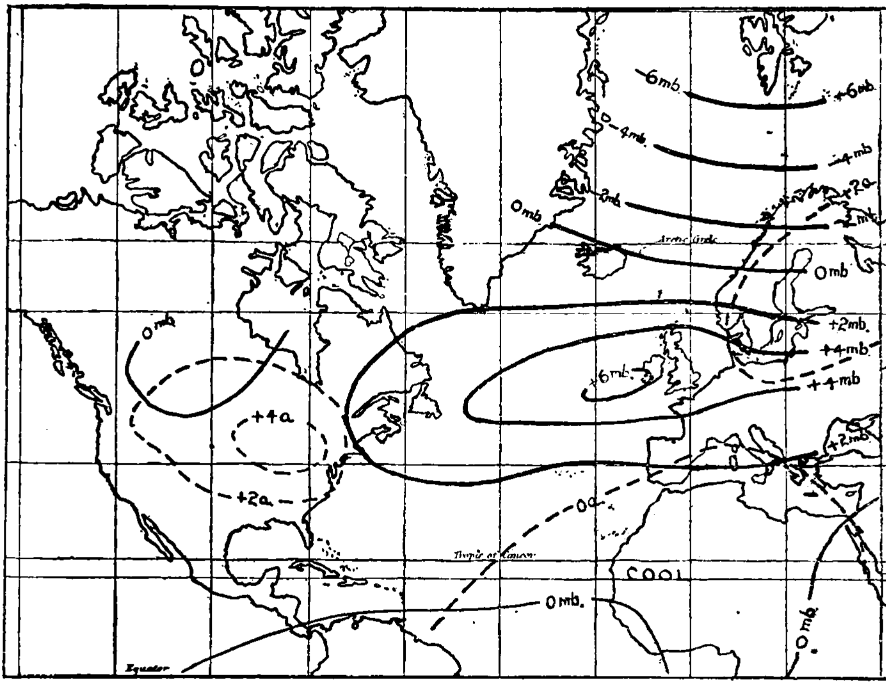
The chart for December 1920 shows a large area of pressure excess covering the whole of Europe, with a positive pressure isanomaly of 10 mb. over Scandinavia. Pressure was below normal in North America and Eastern Asia; but above over most of the tropics. The temperature distribution is also remarkable, showing large areas of excess over continental Europe and North America, reaching 4a (7° F.) in places. The Atlantic was relatively cool, especially within the tropics. This month was dry on the whole. January 1921 showed pressure below normal over northern and central Europe, the deficiency exceeding 10 mb. in Scandinavia. France and the Mediterranean were above normal. Temperature remained unusually high over the temperate lands and low within the tropics. Owing to the low pressure and steep gradient for westerly winds, this was a rainy month in western Europe.

During the period of drought extending from February to June, anticyclonic conditions persisted with very little break over Europe and North America. The average deviations of pressure and temperature during these months are shown in the accompanying figure, where the continuous lines indicate the deviations of pressure from normal in millibars and the broken lines the deviations of temperature in degrees absolute. The results show a wide belt of abnormally high pressure extending from central Europe across the North Atlantic and reaching a maximum near Valencia (+6·2 mb.). In the north of Norway pressure was below normal, the deficiency reaching 6·5 mb. at Spitsbergen. In North America pressure was slightly above normal generally, but below over the districts south-west of Hudson Bay.

Over practically the whole region temperature was slightly below normal in the south, but much above normal in the north, the excess reaching 4·5a (8·1° F.) at Chicago. The abnormally high temperature of the ground over the continents must have contributed to the drought by keeping warm any moist air which found its way in from the oceans, and so making it more difficult for such air to deposit its moisture.

Most of the district covered by the chart suffered from drought, but there were rainy areas including the southern United States and the West Indies, northern and central Africa, the north of Norway and Spitsbergen, the latter station having abnormally heavy precipitation. There was also a small area of excess rainfall in Alberta and Saskatchewan. Mr. "Rainmaker" Hatfield has been operating at Medicine Hat in this district, but the area with rainfall considerably above normal extends at least as far as

Qu'Appelle, 350 miles from Medicine Hat, and the excess is probably to be attributed to the area of low pressure referred to in southern Canada and not to Mr. Hatfield's chemicals.



DEVIATIONS FROM THE NORMAL OF PRESSURE (—) AND TEMPERATURE (- - -) DURING THE PERIOD FEBRUARY TO JUNE 1921.

The districts where the drought was most severe are those along the southern side of the ridge of high pressure, including Switzerland and southern Russia. The pressure distribution favoured an excess of dry easterly and north-easterly winds in these localities, so that the supply of moist air from the Atlantic was very deficient.

The conditions shown in the figure are very similar to those brought out by the *Réseau Mondial* charts for 1911 (*British Meteorological and Magnetic Year Book*, 1911, Part V.), which indicate an area of high pressure over the Atlantic persisting from January to August, with a break in June. This state of things was also associated on the whole with high temperature and low rainfall over Europe, though less markedly than in 1921, and with temperatures below normal over the Atlantic and West Africa. High pressure in the Atlantic might conceivably be related to an excess of ice off Newfoundland, and it happens that in both 1911 and 1921 the ice conditions in the Atlantic were severe, but on the other hand in 1912, the iciest year on record in the North Atlantic, pressure was unusually low. As a matter of fact there is practically no correlation between the ice-conditions off Newfoundland in the spring, as shown in the curves constructed by the late Commander Hepworth,* and rainfall over the British Isles in either spring or summer.

The low pressure which prevailed in the Arctic Ocean, at North Cape and Spitsbergen, in 1911 and 1921 is perhaps a more important feature. The work of Exner (*Computer's Handbook*, Sec. V., p. 78) shows that low pressure over the Arctic basin in winter is normally associated with high pressure over the Atlantic west and south-west of Ireland and with high temperature over the British Isles in the same season. The reason for this connection is probably that when pressure is low over the Arctic, the Icelandic and Aleutian minima lie some distance north of their normal position, and the sub-tropical anticyclones move north in company. This actually happened both in 1911 and 1921 in the North Atlantic, and, as far as the scanty data available show, in the North Pacific also.

This discovery of Exner's may possibly be utilised in two ways. In the first place, low pressure and stormy conditions over the Arctic Ocean probably require high temperature, not only at the time, but for some months previously, in order to break up or melt the polar-ice and produce large areas of open water among the ice-fields, this being the most favourable condition for the development of storminess. Now we find that the last half of 1920 was marked by temperatures considerably above normal in the neighbourhood of North Cape, while in the winter of 1910–11 there was a slight excess near North Cape and a marked excess further east. Secondly, it appears from a study of the *Réseau Mondial* charts that if the winter pressure is low over the Arctic regions, there is a strong probability that spring pressure will also be low. This is to some extent confirmed by a study of nine years' data at Spitsbergen, where the winter pressure (December to February) has a correlation coefficient of +·82 with the pressure of the following spring (March to April). There is no reason to doubt that Exner's correlations, worked out for the winter months, hold for the spring months also, though this point will have to be proved.

It appears probable, then, that some idea of the rainfall of the spring and early summer in the British Isles can be obtained from a study of the pressures and temperatures of the Arctic basin during the preceding months, low Arctic

* *London, Meteorological Office, Geophysical Memoirs*, Nos. 1, 10.

pressure causing low British rainfall and high Arctic pressure, high British rainfall, but before any such relationship can be used for seasonal forecasting, a great deal of careful analysis will have to be done in order to find out the details and select the best data to be used as indices. Another problem which will have to be faced is the cause of what may be termed "anomalous periods," such as January 1921, which gave a month of heavy rainfall intercalated in a period of drought.

Meeting of the International Commission for the Scientific Investigation of the Upper Air, at Bergen.

THE preceding (7th) meeting of this Commission was held in Vienna in 1912, when, it may be recalled, Professor Bjerknes secured the adoption of a resolution for expressing pressure in millibars so far as information about the upper air was concerned. At that meeting the time was mainly occupied with business questions, and such scientific discussion as there was merely filled up the brief intervals which could be spared from the business meetings.

At the meeting at Bergen a new principle was adopted. The leading place was given to scientific contributions from the members of the Commission and other meteorologists interested in the work, on the ground that plans for international work could only be well devised if the members first got clear ideas about the objects to be aimed at in the investigations and about the methods of applying the observations to the solution of definite meteorological problems. This new procedure has advantages, but it is doubtful if it could be applied successfully except under the inspiration of a Bjerknes.

On Monday, July 25th, the delegates to the meeting were received by the President, Prof. V. Bjerknes, at the Geophysical Institute, and after an individual tea and collective photograph, they listened to an account by Mr. Bjerknes, junior, of further developments in the study of the Polar Front. The Scandinavian school finds that, broadly speaking, depressions occur in families of four, each following a track slightly further south than its predecessor, and the first and third of the family generally more intense than the second and fourth. On the average a new family begins every 6¼ days.

On July 26th and the following days the morning programme began at 10 a.m. and, after an interval for tea and cake from 12 to 12.15, continued until about 2.30 p.m. Charts of the day were brought to the meeting-room at about 4 p.m., and after they had been examined and discussed. the business sessions commenced at about 5 p.m.

A short account of the papers contributed to the scientific meetings is given in some 20 pages of the Report of the Proceedings. Six pages are devoted to an account of the business meetings and fifteen pages to Appendices.

The Commission had no difficulty in deciding that an international publication of the results of the investigation of the upper air on certain selected days should be continued. There was, however, much divergence of opinion as to the number of days on which ascents of *Ballons Sondes* should be made. A proposal of the British delegate, that daily ascents should be made for one complete month in each year, met with little support, and it was eventually agreed that the normal number of ascents in each year should be twenty-four: that twelve of these twenty-four should be daily ascents made in two separate periods of six days; that six of the ascents should be twelve-hourly made in a period of three days, and that the remaining six should be arranged by the President of the Commission for the time being. The dates fixed are to be in the middle weeks of the months shown in the following table, the years in heavy type indicating when the twelve-hourly ascents are to be made:—

J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
1922				1922				1922			
	1923				**1923**				1923		
		1924				1924				**1924**	
			1925				1925				1925
1926				1926				**1926**			
	1927				1927				1927		
		1928					**1928**				1928

The form of publication of the results, both of registering ballons and of pilot balloons, was the subject of much discussion. In the case of registering balloons it was eventually agreed that the results for pressure and temperature should be published in graphic form, supplemented by a bulletin of tabular values, the exchange of these tables being effected by the Bureau of the Upper Air Commission. In the case of the observations of upper wind from pilot balloons, no agreement was reached in spite of much discussion and several votes, and it was decided that the form of publication of the data for wind should be left to the Bureau of the Commission, with the proviso that specimens should be circulated to the participating institutes before a final decision.

A complete report of the proceedings of the meeting has already been published with praiseworthy promptitude, and this report will be presented to the International Meteorological Committee at the meetings which will be held in London while this notice is still in the press.

The meeting was scientifically stimulating—how, indeed, could one be otherwise than stimulated by the Director (Devik) of an Observatory (Haldde) where winds of over 130 m.p.h. (average of ten minutes) have been recorded by an anemometer which had to be specially strengthened to prevent it being blown away! The delegates from different countries were received with the most cordial hospitality by the people of Bergen, and most of them were, I think, surprised at the very practical way in which the private shipowners showed what value they attached to the meteorological work of Professor Bjerknes and his staff. E. GOLD.

OFFICIAL NOTICES.

Lectures on Meteorology.

THE following is the provisional programme of lectures and classes for the 1921–22 session in the School of Meteorology, Imperial College of Science and Technology:—

1. *Open Introductory Course on Meteorology: Sir Napier Shaw, F.R.S.*—A course of ten lectures on "The Structure of the Atmosphere and the Meteorology of the Globe," second term, Fridays at 3.0 p.m., beginning January 20th, 1922.

2. *Short Courses of Lectures on Technical Subjects.*

   (i) *Fog: Sir Napier Shaw, F.R.S.*—A course of four lectures, first term, Mondays at 3.30 p.m., beginning October 10th, 1921.

   (ii) *The Winds above Clouds: Sir Napier Shaw, F.R.S.*—A course of three lectures, first term, Mondays at 3.30 p.m., beginning November 7th, 1921.

   (iii) *Terrestrial Magnetism: Dr. C. Chree, F.R.S.*—A course of four lectures, first term, Mondays at 3.30 p.m., beginning November 28th, 1921.

3. *General Course. On Physical and Dynamical Meteorology: Captain D. Brunt.*—First and second terms, Thursdays at 2.30 p.m., beginning October 13th, 1921.

Further particulars of these courses may be obtained from Sir Napier Shaw, School of Meteorology, Meteorological Office, Exhibition Road, South Kensington, S.W.7.

Discussions at the Meteorological Office.

THE series of meetings held at the Meteorological Office, South Kensington, for the informal discussion of important contributions to meteorological literature, will be continued this year.

The meetings will be held on Mondays, at 5 p.m., on the following dates:—October 17th and 31st; November 14th and 28th; December 12th, 1921; January 23rd, February 6th and 20th; March 6th and 20th, 1922.

At the first meeting, October 17th, Sir Napier Shaw, F.R.S., will open the discussion of a paper by Dr. C. F. Marvin on "The Law of the Geoidal Slope and Fallacies in Dynamic Meteorology" (*Monthly Weather Review*, October 1920).

Meteorological Stations.

Leith.—The Telegraphic Reporting Station which has been maintained at Leith since 1861 has been transferred to Inchkeith Lighthouse, which is in the Firth of Forth, about 3½ miles from Leith.

Mr. James Dobbie, who has acted as observer at Leith since 1915, retired on March 31st, and the continuance of regular observations could not be assured. As observations from this neighbourhood are necessary to the Forecast Service of the Meteorological Office, arrangements were made with the Commissioners of Northern Lights whereby the Lighthouse Staff at Inchkeith could continue the work. Reports from Inchkeith were started on June 23rd, 1921.

Official Publications.

Professional Notes, No. 20. The Relation of Bumpiness to Lapse of Temperature at El Kharka, near Cairo, from July 27th to August 3rd, 1920. Price 9*d.* net.

THIS professional note formed part of an official report received from Egypt and, so far as is known, constitutes the first investigation into the relation between bumpiness and the meteorological condition of the upper air.

The note gives an account, illustrated by temperature-height graphs, of 17 ascents to 10,000 feet made by an aeroplane on seven consecutive days. The maximum height to which bumps extended during the hottest part of the day varied from 4000–10,000 feet. It was found that on each occasion an inversion of temperature occurred, forming a limit to all vertical motion in the air. It was possible, therefore, to reach calm air by climbing 300 feet through the inversion. Below this level the bumps do not diminish greatly with height, since the temperature gradient is adiabatic, once convection has started. The inversion of temperature was usually found at the junction of the northerly and westerly currents. As this junction varies greatly in height during summer, the variation in the maximum height of bumps is accounted for.

The maximum shade temperature was found to give no indication of the height to which bumps would extend, but it appeared that if a sudden shift in the direction of wind-aloft was observed, then bumps would not extend above that height.

With regard to the nature of bumps, three distinct types were observed, viz., disturbed air, small vertical currents, and large vertical currents.

Professional Notes, No. 21. The Structure of the Atmosphere over Benson (Oxon.) on 3rd March 1920. By E. G. Bilham, B.Sc.

THIS note is an account of an inquiry based on a registering-balloon ascent recorded by Mr. W. H. Dines. This ascent gave indication of a fairly strong easterly current in the upper air over a westerly current at the surface, decreasing with height. Easterly components at great heights are not rare, but an easterly component occurring over a west or south-westerly current of appreciable thickness is unusual. It is also contrary to the general rule for a westerly component to decrease with height.

Investigation of the meteorological conditions on March 3rd showed that an unusually warm current existed above 5,000 feet.

Prof. V. Bjerknes has found that in a cyclone the surface of separation between the warm and cold currents takes the form of an inclined plane up which the warm air has to ascend. The writer of the note considers that this inquiry shows that similar conditions may exist in an anticyclone.

Correspondence.

To the *Editors, "Meteorological Magazine."*

Cloud Nomenclature.

THE new definition of cirro-cumulus clouds proposed by Dr. Charles F. Brooks contains the following :—

> "Small white flakes or tenuous globular masses which produce no diffraction colours near the sun or moon. . . . . . . Ci.Cu., being composed of ice particles, are usually bright in spite of their tenuity, and do not have the solid appearance characteristic of liquid-droplet, A.Cu. clouds."

On the other hand, Professor Humphreys, another distinguished American meteorologist, writes on page 535 of his recently published "Physics of the Air":—

> "Thin and perhaps slowly evaporating cirro-stratus and cirrocumulus clouds occasionally develop numerous iridescent borders and patches of irregular shape, especially red and green, at various distances from the sun up to 30° or more. A brilliantly coloured iridescent cloud of considerable area is justly regarded as one of the most beautiful of sky phenomena, but one of which until recently there was no satisfactory explanation. Simpson, however, has shown that the coloured patches in question, presumably, are only fragments of coronas formed by exceedingly small droplets of very approximately uniform size."

This appears to contradict two of the statements in Dr. Brooks's definition, for it states definitely that cirrocumulus clouds do exhibit diffraction colours, and implies that they may be composed of water droplets. Of course, Dr. Brooks may not agree with Professor Humphreys, but until they have come to a mutual understanding I think we might continue to carry on with our old international definitions.

May I express the hope that our American colleagues will not give official countenance to changing the old definitions until the new proposals have been submitted to the International Meteorological Committee for discussion?

G. C. SIMPSON.

August 26th, 1921.

July Rainfall at Blue Hill Observatory.

It may interest you to know that the month just ended, July 1921, was not only the wettest July since observations began at Blue Hill 36 years ago, but the wettest month of any name.

The total rainfall was 265 mm. (10·43 in.). The normal rainfall for July is 99 mm. (3·92 in.).

It is difficult properly to characterise the rainfall of a summer month owing to variability in the intensity of thunder showers. A downpour limited in duration and area may distort a record, or rather mask values, which more truly represent normal distribution of rain. Hence both frequency and intensity must be taken into account. There were no unusually heavy rainfalls during the month; but there was one on the last day of June. The month was normal as to frequency, rain falling on 11 days and a trace on one day, the normal being 12 days. The duration was 107 hours, about normal.

There are two long period records, New Bedford, 1814 to date, and Boston, 1818 to date, with which comparison may be made. In the former, heavier rainfalls have occurred only twice—in August 1826 and September 1850. In the Boston record August 1826 and July 1863 have slightly greater amounts. We may fairly conclude that, with the exception of August 1826, the month just ended had the heaviest rainfall in a period of 100 years. We also note that in August 1826 the rainfall was spasmodic, more than 60 per cent. falling in thunder showers on August 11th, 12th and 13th.

Furthermore, this section of the North Atlantic coast is now experiencing a maximum rainfall. At Blue Hill, for the past 19 months, there has been an average monthly excess of 36·8 mm. (1·4 in.).

Some months (7) have been below normal; but the departures have been small. On the other hand the plus values have been quite large, exceeding 100 per cent. in three instances.

There may be some correlation between excess of rain in this locality and a marked deficiency over north-western Europe. A barometric see-saw has long been suspected by meteorologists, and it may be that the present "hyperbar" (stagnant anticyclone) over Great Britain, France, Belgium and Holland offsets an "infrabar" (slow-moving cyclone) over the north-western Atlantic. ALEXANDER MCADIE.

Blue Hill Observatory, Readville, Mass., August 2nd, 1921.

Heavy Rainfall of August 11th at Milton, Northants.

ON Thursday last, August 11th, we had a very severe storm at Milton, about three miles west of Peterborough, commencing at 3.25 p.m.; at 4.30 p.m. 1·91 in. of rain were measured. At 5.30 the total fall was 2·03 in. With the rain measured at 9 o'clock next morning the fall for the 24 hours was 2·25 in. I think that this is the heaviest fall that I can ever remember registering in the time, and thought that it might interest you. H. DEB. WILMOT.

The Milton Estate Office, Priestgate, Peterborough, August 16th, 1921.

Units for Meteorological Work.

MAY I as an amateur meteorologist give my experience of the new units? At first I "hated them" as cordially as the F.R.Met Soc. quoted by Mr. Cross in your columns, but I soon realised that for the barometer it was far more logical to use a unit of pressure rather than the inch, a unit of length. In some parts of Italy if you ask the peasant how far it is to a certain place, he will tell you that it is, say, three-quarters of an hour; he uses a unit of time to measure a length, and the result is rather vague. It is quite as illogical to use a unit of length for a pressure. As regards the actual use of units it is merely a matter of custom. When I first used millibars I had to make a mental calculation every time to know whether so many millibars meant a high or a low pressure even. During the war I had to use millibars, and now I find the position is reversed. I think in millibars, and inches have become a foreign language. If Mr. Cross would get a barometer graduated in millibars and read it frequently, looking at the same time at the Weather Charts in the daily papers, I feel sure that in a month he too would think in millibars.

But this is the crux of the question. The only barometers graduated in millibars are mercury barometers or expensive aneroids. Cannot instrument makers be induced to graduate inexpensive aneroids with millibar scales?

With regard to millimetres for rainfall I think some concession is necessary. Probably more than 95 per cent. of rainfall observers are amateurs who voluntarily supply their data. Their services cannot be dispensed with, and any attempt to force the use of millimetres would result in a great loss of observations. Results should be published in inches as well as millimetres, for everything should be done to interest the observers.

But when metric units are used the Meteorological Office should set a good example, or at any rate should be consistent in its publications.

In the *Daily Weather Report* heights of low cloud are given in feet; the upper wind abroad is given in miles per hour with heights in feet, but the number of feet are multiples of 500 metres, and this being so why not give the heights in metres? For the upper wind for the British Islands, miles per hour are used, and feet for heights, given in even thousands of feet. In the *Weekly Weather Report* wind velocities are given in metres per second with heights of anemometers in feet. In the *Geophysical Journal*, under soundings with pilot balloons, we find metres and metres per second. For temperature, Fahrenheit is used in the *Daily Weather Report*. In the *Weekly Weather Report* we find Fahrenheit in most places, but in the District Values of Temperature, absolute is used in some columns while Fahrenheit is used for the rest of the table. The diagram of upper air temperatures in the supplement to the *Daily Weather Report* gives pressure in millibars, temperature in Fahrenheit with a comparison with absolute below, while heights are in feet. There is, of course, no reason why millibars should not go with feet, but it seems somewhat of a *mésalliance.* Rainfall is given mostly in millimetres, but in some parts of the reports inches are also given.

Perhaps the most curious unit to be found in the Meteorological Office publications is that for atmospheric pollution; this is the pound per million cubic yards; there seems no reason whatever why metric units should not be used for this purpose.

C. J. P. CAVE.

Bergen, July 23rd, 1921.

As you have asked your readers for their views on the above, I entirely agree with the remarks of Mr. Ellison in your last issue. The millimetre is the only new unit with which I am at all at home, it being easy to multiply by four to get hundredths of inches. Millibars and degrees absolute and the new units for depth of snow and force of wind are anathema. It was entir ly for this reason that I resigned membership of the Royal Meteorological Society.

R. P. DANSEY.

Kentchurch Rectory, Hereford, July 22nd, 1921.

MAY I be allowed space to say that I quite agree with all those who protest against the enforced use of the new units for meteorological work?

As for the argument that we are doing it to benefit "posterity," we have already been told that the war was to benefit "posterity," but in what way it is likely to do so it is hard to see.

I have thoroughly studied the new units and gone into the *pros* and *cons* of the matter, and the conclusion I have arrived at is that the *old units* are the best for *practical purposes.*

D. W. HORNER, F.R.Met.Soc.

23, *Woodbury Park Road, Tunbridge Wells, August* 1921.

A Miniature Waterspout.

LAST Thursday, July 7th, about 7 p.m., driving across Holt Fleet Bridge over the Severn, about 7 miles from Worcester, I heard a loud hissing noise, and on looking at the water I saw a whirlpool leaving the one side and making straight across the river. It got larger as it went, and appeared to be about $1\frac{1}{2}$ yards in diameter, sending into the air a fountain of very fine spray about 3 or 4 yards high, which was prettily coloured. The whirl went round at a tremendous rate and the hissing noise was like escaping steam.

There was a sudden freshening of the wind about this time.

WILLIAM T. WALKER.

12, *Bridge Street, Worcester, July 12th,* 1921.

Visibility on the Firth of Clyde.

On Sunday, August 14th, the atmosphere over this area was exceptionally clear. From a small hill behind the village of Tigh-na-bruaich, situated in the Kyles of Bute, the mountain of Merrick (2,764 feet) in Kirkcudbrightshire was visible to the naked eye at a distance of 64 miles.

About 20 miles of the Ayrshire coast became visible, the nearest point being Heads of Ayr, 40 miles, and the farthest away, 54 miles. At about 150 feet above the ground parts of the high land above the Ayrshire coast appeared like scattered islands in the sea, but at sea level this land completely disappeared, giving a good example of the rotundity of the earth's surface. The distance visible to the naked eye on this day was approximately equivalent to one degree of latitude, and, of course, to increase this distance by 360 gave the circumference of the earth, a fact rather difficult to perceive by the lay mind but at the same time emphasising the fact that our globe is not so big, after all. The gullies and ravines on the south side of Glen Sannox, on the Island of Arran, were clearly visible to the naked eye, a distance of over 20 miles.

This has been the most exceptional visibility known to the present writer for a number of years. On examination of the *Daily Weather Report* for Sunday, July 14th (International Section), it will be observed that there were light breezes from west-north-west at the time. Renfrew reported very good visibility (v9) for all observations taken during the day on this date. CHARLES F. PRIESTLEY.

49, Brisbane Street, Greenock, August 29th, 1921.

[It is interesting to notice that, on the assumption that there is no refraction of the rays of light, an object 1,600 feet above sea level is just on the horizon of an observer at 150 feet, 64 miles away, so that in the case reported the top 1100 feet of the mountain would have been visible.—ED. M.M.]

NOTES AND QUERIES.

The Setting Sun as a Photographic Subject.

THE picture reproduced on the plate opposite is from a photograph by Mr. G. A. Clarke, of Aberdeen Observatory, who states that his camera was kept stationary whilst the plate was intermittently exposed at intervals of 6, 8, 6, 4 and 3 minutes. It will be observed that the trace of the sun's path on the photographic plate is concave upwards, and that the

THE SETTING SUN.

A photograph by Mr. G. A. Clarke at Aberdeen, June 6th, 1921.

shape of the sun near the horizon is elliptical with the long axis horizontal. As is well known, such effects are due to refraction of the sun's rays by our atmosphere. Atmospheric refraction increases the altitude but does not affect the azimuth of a celestial object.

At the time of sunset the lower limb of the sun is raised more that the upper limb, and therefore the vertical diameter is smaller than usual, whilst the diameter measured on a horizontal circle is not affected by refraction; hence the ellipticity of the photographic images near the horizon. The distant hills were slightly above the true horizon, so that the fullest effect of refraction cannot be seen. The last exposure was at 20 h. 48 m., the theoretical time of sunset being 20 h. 54 m.

The International Meteorological Committee.

THE International Meteorological Committee was convened to meet in London on September 12th under the presidency of Sir Napier Shaw, F.R.S. Opportunity was taken to arrange for meetings during the preceding week of the Commissions for the Réseau Mondial, for Polar Investigations, for Maritime Meteorology, for Aerial Navigation and for Weather Telegraphy. The social programme included a luncheon to the delegates on Friday, September 9th, at the Carlton, when Major-General Sir F. C. Sykes welcomed the guests on behalf of His Majesty's Government, and a reception by the Director of the Meteorological Office and Mrs. Simpson at South Kensington on September 7th.

The Observatory at Apia, Samoa.

To the cost of maintenance of the Observatory at Apia Samoa, which is being carried on by the Government of New Zealand, a contribution of one-half, *i.e.*, 800*l.*, a year is now being provided by the Imperial Government. The Observatory is to be maintained at full efficiency, magnetic, seismic, and climatological work being included in the programme.

The Brazilian Meteorological Service.

The *Directoria de Meteorologia e Astronomia* of the Brazilian Department of Agriculture has been divided into two separate services, the *Directoria de Meteorologia* and the *Observatorio Nacional*. The new Directoria de Meteorologia is under Sr. Sampaio Ferrez, who intends to continue the climatological work established in 1909 and to issue the information collected, but not published, during the last ten years. Great activity is anticipated in all branches of meteorology, especially in connection with forecasts, marine and upper-air investigations.

Humidity Observations as an Aid to estimating Cloud-Height.

An article by Prof. Alexander McAdie under the title "A Quick Method of Measuring Cloud Heights and Velocities" appears in Part IV., Vol. 83, of the Annals of the Astronomical Observatory of Harvard College.

The method described consists in estimating the height of the lowest clouds from a consideration of the surface humidity, and thence by means of a nephoscope determining their velocity. The latter part calls for no comment, and follows at once if the height can be accurately found.

To determine the cloud-height, Prof. McAdie computes the depression of the dew-point below the dry bulb temperature at the surface by means of a whirling psychrometer, multiplies this by an empirical factor, and so arrives at an estimate of the height at which the surface air, diffusing upwards by eddies and convection, would begin to condense moisture. The value of the whole process depends entirely on choosing suitable values of the factor, applicable to different types of weather. The empirical factors given in the paper are roughly proportional to the reciprocals of the probable lapse-rates of temperature, and seem to have been determined by direct comparison with accurate methods of finding cloud height.

In his discussion of the theory of the method Prof. McAdie makes the unwarranted assumption that if a sample of air with a dew-point $y°$ C. below its temperature were raised adiabatically, it would begin to condense moisture at a height of $\frac{y}{9 \cdot 9}$ kilometres, where 9·9 is the adiabatic lapse-rate for dry air. There is no simple exact relation of this kind, because as the air ascends its pressure falls as well as its temperature, but a simple calculation shows that over the whole range of temperature and humidity met with in temperate regions the expression $\frac{y}{8 \cdot 2}$ gives an approximation close enough for practical purposes. As, however, an empirical factor has to be employed in any case, this slip does not affect the utility of the method.

A practical test was made at Valencia Observatory, the material used being pilot-balloon ascents made in 1920 and

1921, and also a number of observations of cloud height below 800 metres obtained by direct observation of cloud sheets on the neighbouring hills. Care was taken to use only such observations as it was reasonably certain gave the height of the lowest cloud layer prevailing at the time, and in addition all cases in which the surface wind did not exceed 4 metres per second were ruled out, as it was soon apparent that with very light winds the surface humidity had no relation to the conditions prevailing a few hundred metres up.

The dew-point was determined either directly from dry and wet bulb thermometers in a Stevenson screen or from a hair hygrometer standardised from them.

The height h in kilometres at which condensation would occur in a well-stirred atmosphere was computed, and its ratio to the actual cloud height, H kilometres, was determined.

This ratio h/H is denoted hereafter by x. The mean value of x was found to be ·59.

It was found that when the cloud height exceeded one kilometre x fell off rapidly with increasing height; in fact, the relative humidity at the surface practically ceased to fall with increasing cloud height above 1,200 metres, and the method may definitely be said to have failed in such cases. The distribution of the values of x found in 80 observations is shown in the following table:—

Limits for x	1·20 1·00	·99 ·90	·89 ·80	·79 ·70	·69 ·60	·59 ·50	·49 ·40	·39 ·30	·29 ·20
Frequency	5	1	6	9	14	15	19	6	5

There were four cases among the above in which the actual cloud height exceeded 1,500 m., the mean value of x being ·29. It seemed fairer to omit these under the circumstances, and when this was done the mean value of x became ·60 and the frequencies in the last two columns were reduced by 2 each.

If H had been computed from the formula $H = \frac{10}{6}h$, then in 42 per cent. of the 76 cases the error in H would not have exceeded ·25H and in 79 per cent. it would not have exceeded ·4H.

In addition the same observations were classified according to wind direction to see if better results could be obtained by modifying the factor according to the direction of the wind.

Wind direction	N–NNE.	NE–ENE.	E–ESE.	SE–SSE.	S–SSW.	SW–WSW.	W–WNW.	NW–NNW.
Frequency	2	1	4	10	17	18	15	9
Mean value of x	·73	·72	·52	·67	·58	·58	·60	·65

There is no well-defined tendency here, and with the limited number of observations available it is hardly possible to say with certainty that one direction differs from another.

The general conclusion arrived at is that there is some utility in the method, though the possible errors are rather large. There seems to be little difference as between different wind directions, and the method fails when the wind is very light and when the cloud height exceeds about 1,500 m. Subject to the above limitations, the working rule is:—Determine the depression of the dew point below the dry bulb in degrees Centigrade and divide by 5, when the cloud height will be given in kilometres. Alternatively, the depression in degrees Fahrenheit may be divided by 9, when the cloud height will again be given in kilometres. It would be instructive if this method could be tried at an inland station, as it seems possible that more consistent results might be obtained there than on the west coast where the surface humidity rarely falls to any low value.

L. H. G. Dines.

Reviews.

An Astronomical Theory of the Ice Age.

Das Klima des Eiszeitalters, von Rudolf Spitaler. Prag, 1921. (Lithographed.)

For half a century the cause of the immense ice-sheets of the Quaternary period has been one of the great unsolved problems of science. The theories put forward fall into two main classes, terrestrial and astronomical; the former seek the explanation in the earth itself, especially in changes of level and of land and sea distribution, the latter chiefly in variations of the obliquity of the ecliptic and of the eccentricity of the earth's orbit. In 1875 appeared an epoch-making book by J. Croll, in which abnormal climates were associated with high eccentricity. The hemisphere with winter in aphelion is cold because the long severe winter is far from being balanced by the short hot summer; at the same time the opposite hemisphere enjoys a mild equable climate. This theory commanded instant respect, and still finds a place in the text-books, but difficulties soon began to appear. The evidence strongly suggests that glacial periods did not alternate in the two hemispheres, but were simultaneous over the whole earth; even on the equator the snow line was brought low down. Moreover, on Mars the largest snow cap appears on the hemisphere with its winter in perihelion. Although Croll's reasoning was beautifully ingenious, he gave very few figures; while the date which he gives for the conclusion of the Ice Age, 80,000 years ago, has been shown by recent research to be far too remote, 15,000 years being nearer the mark.

The present book is a praiseworthy attempt to meet two of these objections, but though it makes interesting reading, supported by many pages of tables, the author cannot be said to have succeeded. The basis of the work is the calculation of the mean temperature of any latitude by the use of an equation which may be rewritten as follows:—

$$t_\phi = (245{\cdot}63 + 359{\cdot}78\ S_0 + 288{\cdot}94\ S)\ (1-n) + (235{\cdot}46 + 419{\cdot}55\ S)\ n,$$

where t_ϕ is the average temperature in any month in latitude ϕ and is given in degrees Centigrade on the absolute scale; S_0 is the average daily heat on a horizontal surface at the limit of the atmosphere during the year, and S that during the month, in the latitude in question (the units being so chosen that the amount at the equator during an equinoctial day is approximately 0·5); n is the fraction of land and $(1-n)$ that of water covered by the line of latitude. By equating n to unity or zero, this formula is made to give the theoretical temperatures over land and water spheres under present astronomical conditions (p. 8), and by making the appropriate changes in S_0 and S, under different astronomical conditions for the four seasons (pp. 79 to 88).

This part of the work is somewhat difficult to follow, owing to the use of the terms "land- and water-temperatures" for these theoretical distributions over spheres entirely land or entirely water. The author nowhere calculates the change of temperature over the present land areas, which is the important point for glacial theory, but the following figures from a table* on p. 82 will give some idea of the magnitudes

* In computing such tables the author assumes the validity of all the terms of his fundamental formula, even those independent of the local radiation. These independent terms represent, however, the spreading out over the world of the radiation we receive under present circumstances, and if those circumstances were changed these terms would have to be altered.

involved. They represent the difference from the present of the average temperatures of each latitude under maximum eccentricity (0·7775) and maximum obliquity (27° 48′), the distribution of land and water remaining unchanged.

—	Aphelion December.			Aphelion June..		
	Winter.	Summer.	Year.	Winter.	Summer.	Year.
	a.	a.	a.	a.	a.	a.
N. 60° - - -	−5·1	+8·5	−0·7	−2·6	−2·2	−0·7
30° - - -	−7·0	+6·9	−1·3	+0·3	−4·3	−1·3
Equator - -	−4·3	+1·8	−1·3	+0·7	−3·2	−1·3
S. 30° - - -	−3·6	+0·5	−1·1	+1 6	−3·0	−1·1
60° - - -	−1·2	−0·7	−0·6	+0·5	−1·1	−0·6

The author claims that these differences, ingeniously magnified by meteorological arguments, are sufficient to cause a glacial period in the hemisphere with winter in aphelion, but from this point his theory departs widely from Croll's. During the long severe winter great volumes of sea water are brought to a low temperature, and owing to their greater weight sink to the bottom of the ocean, where they remain cold and accumulate from year to year. But the water warmed during the short hot summer remains on the surface, where its heat is dissipated by evaporation and radiation. Thus throughout the cold period, lasting about 10,000 years, the ocean in that hemisphere is steadily growing colder, and this mass of cold water is sufficient to maintain a low temperature through the whole of the following period of 10,000 years with winter in perihelion, which would otherwise be a genial interval. In this way a period of great eccentricity becomes a glacial period over the whole earth, but with crests of maximum intensity alternating in the two hemispheres. Unfortunately the numerical basis of this theory is not presented, and it seems incredible that a deficiency of temperature could be thus maintained through so long a period. Further, the author is not a geologist, and derives his data as to the Ice Age very much at second hand. This entirely invalidates his chronology, and leads him into erroneous and sometimes absurd comparisons, as, for instance, when he gives the hardly distinguishable Laufen oscillation a duration equal to that of the last inter-glacial, which was long enough for immense changes in the face of Europe and in human culture.

Difficulties of printing in Czechoslovakia have caused this work to be lithographed; it is issued as a handsome quarto volume of 138 pages. C. E. P. B.

Obituary.

Mr. Richard Lamport, whose death occurred on August 25th, at the age of 79, entered the service of the late Mr. G. J. Symons in 1885, and retired from the staff of the British Rainfall Organization in October 1919, shortly after the transfer to Government control of the institution to whose history he had contributed during so long a period. After the death of Mr. Symons in 1900, and the retirement of Mr. Sowerby Wallis in 1903, Mr. Lamport's association with the office work had been considerably longer than that of any other member of the staff, and his experience was thus of great value in ensuring the continuity of the routine during the various changes through which the Organization has passed during the last twenty years. Previous experience in legal work fitted him in an especial degree for the place which he filled in the office, and his wonderful accuracy as a computer and copyist enabled him to carry out, with high efficiency, the whole of the work of filling in the permanent files of rainfall records. He was also responsible for the bulk of the checking of the ever increasing number of rainfall returns, and for the compilation of the rainfall and climatological tables appearing each month in this magazine.

Mr. Lamport's strong sense of duty and loyalty gave him a high place in the affection and esteem of his colleagues. He leaves a son and two daughters, one of whom succeeded him in his work in the office of the Organization after his retirement.

Errata.

It is regretted that the following misprints occurred in the August issue of this magazine:—

page 183, *for* $\frac{\delta p}{\delta n} = 2\omega p \sin\lambda$, *read* $\frac{\delta p}{\delta n} = 2\omega v p \sin\lambda$.

page 193, *for* "Benson," *read* "Besson."
page 196, *for* "rouse her to see it set before it vanished," *read* "rouse her to see it before it vanished."

News in Brief.

Capt. Amundsen arrived at Vancouver last month, while his schooner, the *Maud*, is to be repaired at Seattle and equipped with wireless. He intends to leave again for the Arctic early next spring, and is still determined, to prove his theory that by taking advantage of the right current a vessel frozen in the ice will drift across the Polar Sea in three to five years.

It is reported that a Norwegian scientific expedition left last month for Jan Mayen Island, which lies between Norway and Greenland. The expedition will establish a radio-station at Jan Mayen, which is to be connected with Norway, and the station will be used for meteorological service. It is anticipated that weather telegrams will be sent out regularly.

It is a curious fact that although oysters have been artificially cultivated for at least 2,000 years, and the great importance of the warmth of the water for successful breeding has long been known, yet the relation between breeding and temperature has only recently been put in a precise form. Dr. J. H. Orton, of the *British Marine Biological Association* at Plymouth, has now shown that the oyster begins to breed when the water has reached a temperature of approximately 60° F., and it continues to do so as long as there is no fall. During the last half-century 1893 was the record year in oyster-breeding, but it is thought that 1921 will beat this record.

A moderate earthquake was recorded by the seismograph at Eskdalemuir Observatory on Tuesday, August 23rd, at 21 h. 17 m. The actual locality is uncertain, but the distance is calculated to be at about 1,000 miles from the Observatory.

The Weather of August 1921.

Conditions were unsettled throughout the month, with depressions from the Atlantic crossing the British Isles. In the north and west the rainfall was large, but in the south-east of England it was again below normal, being much less than might have been expected from the distribution of pressure. In Scandinavia conditions were very disturbed for nearly the whole month, with frequent heavy rains. In France and Central Europe there was some heavy rain between the 10th and 24th, but conditions were fine near the beginning and end of the month. Temperature was considerably lower generally than it was in July, but there were some very hot days on the Continent early in the month.

From the 1st to the 5th pressure was lowest near the Faröe Islands, and small secondaries moved north-eastward over the British Isles. Heavy rain fell in the western districts on the 1st and again on the 5th, several stations having 20 mm. or more. A south-west gale was experienced on parts of the south-west coasts on the night of the 5th. Thunderstorms occurred rather widely in the north and west on the 2nd, and in the south-east on the 3rd. They were associated with a very low temperature in the upper air, the reading at

THAMES VALLEY RAINFALL, — AUGUST, 1921.

ALTITUDE SCALE

Below 250 feet	250 to 500 feet	500 to 1000 feet	Above 1000 feet

SCALE OF MILES

0 5 10 15 20

H.M. Stationery Office Press, Kingsway W.C.2.

Ps. 3395/346. Wt. 26 D.P.15. 1250. 9/24.

13,600 feet over Baldonnel (Dublin) on the evening of the 2nd being 6° F., or 18° F. below normal. There was a cold northerly current over Iceland which curved round the stationary depression over the Faröe Islands. It is interesting to note that August 3rd, when thunderstorms occurred in south-east England, was the coolest day since July 5th, and that in that region there was no thunder during the hot weather, except very locally on July 17th.

The secondary which brought very heavy rain to our western districts on the 5th developed into an independent centre and moved north-east, attaining considerable depth over the Gulf of Bothnia on the 7th, where it remained until it filled up on the 10th.

Secondaries continued to cross the British Isles and maintained unsettled weather. A shallow depression moved slowly south-eastward over our Islands between the 9th and the 11th, and then moved north-east to Denmark. Heavy rain and thunder occurred locally, but parts of south-east England escaped until the 13th, when a small secondary brought very welcome rainfall, with thunder in places. At Pulham (Norfolk) there was a severe thunderstorm during the afternoon, in which 75 mm. of rain fell in an hour and twenty minutes, the total for the 12 hours being 80 mm. There were 52 mm. of rain at Lowestoft on the same afternoon.

During the first ten days of the month the weather in France and Germany was mainly fine and warm, though there were heavy local thunderstorm rains on the night of the 3rd, Berlin having 80 mm. The shallow depression which lay over the British Isles on the 10th expanded over a large area, and cooler unsettled weather became general, with heavy rain and thunder in many places. Temperature remained high in Poland until the 12th, reaching 99° F. on that date at Warsaw, but colder air then arrived from the west, the maximum at Warsaw being only 61° F. on the 14th. A fresh centre of low pressure developed over this area on the 12th, which moved north to the Baltic, and then turned westward and grew deeper, being centred over the Skagerrak on the 15th. There were gales in the Baltic and the north-east part of the North Sea, and heavy rain near the centre. The disturbance filled up rapidly on the 16th.

An anticyclone, which extended up from the Azores, caused a temporary improvement in the weather over the British Isles on the 14th and 15th, but a depression developed off the north-west of Ireland on the 16th and renewed unsettled weather. Rain fell generally except in the extreme east of England, being heaviest in the south of Scotland, and

(*Continued on* p. 238.)

Rainfall Table for August 1921.

STATION.	COUNTY.	Aver. 1881—1915.	1921.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days
		in.	in.	mm.		in.	Date.	
Camden Square	*London*	2·21	1·65	42	75	·74	23	9
Tenterden (View Town)	*Kent*	2·29	1·28	33	56	·39	23	11
Arundel (Patching Farm)	*Sussex*	2·52	1·76	45	70	·51	23	8
Fordingbridge (Oaklands)	*Hampshire*	2·63	1·62	41	62	·50	12	11
Oxford (Magdalen College)	*Oxfordshire*	2·25	1·51	38	67	·63	16	15
Wellingborough (Swanspool)	*Northampton*	2·38	2·14	54	90	·49	16	17
Hawkedon Rectory	*Suffolk*	2·59	1·76	45	68	·68	23	12
Norwich (Eaton)	*Norfolk*	2·37	1·52	39	64	·32	7	14
Launceston (Polapit Tamar)	*Devon*	3·18	2·61	66	82	·52	5	21
Sidmouth (Sidmount)	"	2·81	2·55	65	91	·65	21	17
Ross (Chasedale Observatory)	*Herefordshire*	2·57	2·34	59	91	·38	10	15
Church Stretton (Wolstaston)	*Shropshire*	3·25	4·72	120	145	·70	28	21
Boston (Black Sluice)	*Lincoln*	2·39	2·98	76	125	1·35	11	12
Worksop (Hodsock Priory)	*Nottingham*	2·45	3·92	100	160	1·38	11	16
Mickleover Manor	*Derbyshire*	2·72	4·79	122	176	1·07	5	20
Southport (Hesketh Park)	*Lancashire*	3·48	4·92	125	141	1·03	1	18
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·87	3·86	98	134	·89	28	20
Hull (Pearson Park)	" *E. R.*	2·91	2·84	72	98	·76	28	17
Newcastle (Town Moor)	*North'land*	2·92	6·65	169	228	1·93	29	26
Borrowdale (Seathwaite)	*Cumberland*	11·57	14·45	367	125	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	4·32	3·18	81	74	·67	5	20
Haverfordwest (Gram. Sch.)	*Pembroke*	4·17	7·16	182	172	1·55	5	17
Aberystwyth (Gogerddan)	*Cardigan*	4·87	6·22	158	128	1·37	5	16
Llandudno	*Carnarvon*	3·02	3·94	100	130	1·26	2	21
Dumfries (Cargen)	*Kirkcudbrt.*	4·40	7·40	188	168	1·07	20	23
Marchmont House	*Berwick*	3·31	4·39	111	133	1·00	22	22
Girvan (Pinmore)	*Ayr*	4·45	5·40	137	121	·85	9	24
Glasgow (Queen's Park)	*Renfrew*	3·54	5·84	148	165	·77	29	21
Islay (Eallabus)	*Argyll*	4·36	4·78	121	110	·85	26	23
Mull (Quinish)	"	4·91	4·16	106	85	·70	9	25
Loch Dhu	*Perth*	6·75	9·60	244	142	1·70	16	21
Dundee (Eastern Necropolis)	*Forfar*	3·38	3·85	98	114	·77	16	22
Braemar (Bank)	*Aberdeen*	3·36	3·54	90	105	1·43	20	16
Aberdeen (Cranford)	"	2·88	1·96	50	68	·44	16	17
Gordon Castle	*Moray*	3·17	3·05	77	96	1·14	20	19
Fort William (Atholl Bank)	*Inverness*	6·14	5·12	130	83	·80	26	21
Alness (Ardross Castle)	*Ross*	2·95	2·21	56	75	·54	10	18
Loch Torridon (Bendamph)	"	6·60	4·59	117	70	·54	9	21
Stornoway	"	3·97	3·31	84	83	·73	5	21
Loch More (Achfary)	*Sutherland*	5·84	4·77	121	82	·87	26	21
Wick	*Caithness*	2·75	1·86	47	68	·38	20	24
Glanmire (Lota Lodge)	*Cork*	3·65	4·01	102	110	·75	1	20
Killarney (District Asylum)	*Kerry*	4·42	5·11	130	116	1·00	1	24
Waterford (Brook Lodge)	*Waterford*	3·83	5·08	129	133	1·10	5	19
Nenagh (Castle Lough)	*Tipperary*	3·95	3·91	99	99	·49	9	25
Ennistymon House	*Clare*	5·15	5·53	141	107	·91	9	24
Gorey (Courtown House)	*Wexford*	3·33	5·08	129	153	1·07	1	19
Abbey Leix (Blandsfort)	*Queen's Co.*	3·95	4·78	121	121	·60	1, 5	24
Dublin (FitzWilliam Square)	*Dublin*	3·04	2·56	65	84	·58	5	23
Mullingar (Belvedere)	*Westmeath*	4·17	3·64	93	87	·70	9	24
Woodlawn	*Galway*	4·58	3·82	97	83	·63	16	24
Crossmolina (Enniscoe)	*Mayo*	4·51	4·65	118	103	·65	27	24
Collooney (Markree Obsy.)	*Sligo*	4·32	6·04	153	140	·77	9, 31	26
Seaforde	*Down*	3·75	4·00	102	107	·54	9	21
Ballymena (Harryville)	*Antrim*	4·27	4·02	102	94	·64	27	25
Omagh (Edenfel)	*Tyrone*	4·27	3·58	91	84	·58	9	21

Supplementary Rainfall, August 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate..........	1·03	26	XII.	Langholm, Drove Rd.	6·79	173
„	Sevenoaks, Speldhurst	1·50	38	XIII.	Ettrick Manse.......	6·81	173
„	Hailsham Vicarage...	1·72	44	„	North Berwick Res....	4·17	106
„	Totland Bay, Aston ..	2·06	52	„	Edinburgh, Royal Ob.	3·84	98
„	Ashley, Old Manor Ho.	1·48	38	XIV.	Biggar...............	5·82	148
„	Grayshott...........	2·34	59	„	Leadhills	11·23	285
„	Ufton Nervet........	1·75	44	„	Maybole, Knockdon...	..	..
III.	Harrow Weald, Hill Ho.	1·81	46	XV.	Dougarie Lodge.......	5·55	141
„	Pitsford, Sedgebrook..	2·01	51	„	Inveraray Castle......	7·66	195
„	Chatteris, The Priory.	1·04	26	„	Holy Loch, Ardnadam	8·93	227
IV.	Elsenham, Gaunts End	1·06	27	XVI.	Loch Venachar.......	7·20	183
„	Lexden, Hill House ..	1·12	28	„	Glenquey Reservoir...	8·20	208
„	Aylsham, Rippon Hall	1·64	42	„	Loch Rannoch, Dall...	4·06	103
„	Swaffham...........	1·42	36	„	Blair Atholl Gardens..	4·16	106
V.	Devizes, Highclere...	1·06	27	„	Coupar Angus....... .	3·99	101
„	Weymouth..........	1·24	31	„	Montrose Asylum.....	1·85	47
„	Ashburton, Druid Ho.	..	..	XVII.	LogieColdstone,Loanh'd	2·27	58
„	Cullompton.........	1·64	42	„	Fyvie Castle..........	2·15	55
„	Hartland Abbey.....	2·93	74	„	Grantown-on-Spey ...	3·47	88
„	St. Austell, Trevarna .	2·75	70	XVIII.	Cluny Castle	4·16	106
„	North Cadbury Rec. .	1·35	34	„	Loch Quoich, Loan ...	10·60	269
„	Cutcombe, Wheddon Cr.	2·85	72	„	Fortrose............	2·14	54
VI.	Clifton, Stoke Bishop.	..	..	„	Faire-na Squir........	4·23	107
„	Ledbury, Underdown.	2·69	68	„	Skye, Dunvegan......	5·21	132
„	Shifnal.HattonGrange	3·69	94	„	Loch Carron, Plockton	..	..
„	Ashbourne, Mayfield .	4·96	126	„	Dunrobin Castle......	2·03	51
„	Barnt Green, Upwood	3·68	93	XIX.	Tongue Manse	3·24	82
„	Blockley, Upton Wold	2·51	64	„	Melvich Schoolhouse ..	2·68	68
VII.	Grantham, Saltersford	3·41	87	XX.	Dunmanway Rectory..	5·36	136
„	Louth, Westgate.....	3·78	96	„	Mitchelstown Castle...	5·31	135
„	Mansfield, West Bank	3·98	101	„	Gearahameen	9·00	229
VIII.	Nantwich, Dorfold Hall	4·10	104	„	Darrynane Abbey....	7·28	185
„	Bolton, Queen's Park.	5·93	150	„	Clonmel, Bruce Villa..	4·69	119
„	Lancaster, Strathspey.	7·35	187	„	Cashel, Ballinamona...	4·98	127
IX.	Rotherham..........	4·50	114	„	Roscrea, Timoney Pk..	3·67	93
„	Bradford, Lister Park.	4·11	104	„	Foynes..............	4·96	126
„	West Witton.........	4·10	104	„	Broadford, Hurdlesto'n	4·67	119
„	Scarborough, Scalby..	4·70	119	XXI.	Kilkenny Castle.......	4·54	115
„	Middlesbro', Albert Pk.	5·46	139	„	Rathnew, Clonmannon	3·33	85
„	Mickleton..........	3·60	91	„	Hacketstown Rectory .	5·03	128
X.	Bellingham	6·74	171	„	Balbriggan, Ardgillan .	3·61	92
„	Ilderton, Lilburn	5·07	129	„	Drogheda...........	3·21	81
„	Orton..............	7·76	197	„	Athlone, Twyford.....	3·76	95
XI.	Llanfrechfa Grange ..	3·24	82	XXII.	Castle Forbes Gdns....	3·38	86
„	Treherbert,Tyn-y-waun	9·46	240	„	Ballynahinch Castle...	6·09	155
„	Carmarthen Friary ..	5·88	149	„	Galway Grammar Sch.	5·04	128
„	Llanwrda, Dolaucothy	7·72	196	XXIII.	Westport House......	3·79	96
„	Lampeter, Falcondale	6·44	164	„	Enniskillen, Portora...	..	..
„	Cray Station........	7·20	183	„	Armagh Observatory ..	3·55	90
„	B'ham W.W.,Tyrmyndd	6·25	159	„	Warrenpoint.........	3·92	100
„	Lake Vyrnwy.......	6·53	166	„	Belfast, Cave Hill Rd..	4·10	104
„	Llangynhafal, P. Drâw	3·78	96	„	Glenarm Castle.......	4·01	102
„	Oakley Quarries.....	14·55	370	„	Londonderry, Creggan.	4·75	121
„	Dolgelly, Bryntirion..	9·45	240	„	Sion Mills...........	3·69	94
„	Lligwy	6·15	156	„	Milford, The Manse ...	4·79	122
XII.	Stoneykirk,ArdwellHo.	4·43	113	„	Narin, Kiltoorish.....	3·95	100
„	Carsphairn, Shiel.....	9·77	248	„	Killybegs, Rockmount .	5·70	145

Climatological Table for the

STATIONS	PRESSURE Mean M.S.L. mb.	PRESSURE Diff. from Normal mb.	TEMPERATURE Absolute Max. ° F.	Absolute Date	Absolute Min. ° F.	Absolute Date	Mean Values Max. ° F.	Mean Values Min. ° F.	Mean Values ½ max. and min. ° F.	Mean Values Diff. from Normal ° F.
London, Kew Observatory	1018·2	+4·4	63	24	29	3	53·8	39·2	46·5	+4·1
Gibraltar	1019·5	+3·7	70	21	48	21,22,31	61·7	52·3	57·0	−0·5
Malta	1019·2	+5·3	65	8	48	1	60·3	52·0	56·1	0·0
Sierra Leone	1009·8	−1·1	94	17,22,27	70	13	91·5	72·5	82·0	−0·6
Lagos, Nigeria	1011·5	+2·1	97	28	60	16	89·0	77·5	83·3	+0·4
Kaduna, Nigeria	1013·0	+4·9	99	25	59	3	92·5	67·0	79·7	−2·0
Zomba, Nyasaland	1009·6	−0·1	85	3	59	16	80·5	64·8	72·7	+2·0
Salisbury, Rhodesia	1009·5	−1·9	84	26, 27	55	15	79·7	60·7	70·2	+2·1
Cape Town	1014·7	+0·2	99	13	52	27	79·4	60·8	70·1	+1·9
Johannesburg	1014·3	+0·5	84	3	45	13	71·3	54·4	62·9	−0·4
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	87	2	48	13	77·9	57·6	67·7	+0·3
Calcutta, Alipore Obsy.	1007·3	−2·6	102	23	63	2	92·7	73·0	82·9	+2·8
Bombay	1009·1	−1·6	91	4	69	3	87·9	74·1	81·0	+1·5
Madras	1009·7	−1·1	95	18	68	1, 5	90·1	72·4	81·3	+0·3
Colombo, Ceylon	1009·8	−0·2	91	1	65	2	88·4	73·4	80·9	−1·1
Hong Kong	1015·9	+0·1	82	1	45	4	68·9	59·5	64·2	+0·9
Sydney	1018·5	+2·3	99	25	55	7	77·1	62·7	69·9	+0·7
Melbourne	1019·1	+2·3	95	24	43	27	75·5	54·6	65·1	+0·6
Adelaide	1019·0	+2·0	97	23	49	17	81·4	59·3	70·3	+0·4
Perth, Western Australia	1014·3	−1·1	101	5	52	30	86·5	64·2	75·3	+4·5
Coolgardie	1014·8	0·0	102	20	46	31	89·5	60·1	74·8	+3·1
Brisbane	1016·9	+2·8	90	25	60	8, 22	79·5	65·8	72·7	−1·7
Hobart, Tasmania	1015·4	+1·3	89	14	42	27	69·2	51·6	60·4	+1·0
Wellington, N.Z.	1015·3	−1·7	77	16	43	9	67·5	53·2	60·3	−0·4
Suva, Fiji	1010·7	+2·2	93	9	70	30	87·6	72·8	80·2	+0·1
Kingston, Jamaica	1015·2	+0·2	90	27	66	29	86·9	68·5	77·7	+0·6
Grenada, W.I.	1012·8	−0·1	89	24, 25	68	11	82·7	71·5	77·1	−0·6
Toronto	1018·5	+1·5	70	26	7	4	47·0	30·1	38·5	+9·6
Winnipeg	1017·4	−1·4	44	29	−16	8	26·0	5·7	15·9	+1·5
St. John, N.B.	1019·3	+5·1	56	27	8	5	41·5	26·7	34·1	+5·7
Victoria, B.C.	1016·8	+1·0	56	30	30	11	49·7	38·1	43·9	+0·7

London, Kew Observatory.—1 day with hail, 1 day with thunder heard, 2 days with fog. Mean speed of wind 9·8 mi/hr.

Gibraltar.—1 day with fog, 2 days with gale.

Malta.—Prevailing wind direction WNW; mean speed 6·6 mi/hr.

Sierra Leone.—Prevailing wind direction SW.

December 1920.										
*Perth, W. Australia	1013·3	0·0	102	18	50	12	80·6	60·9	70·7	0·0

* Maximum in sun 166° F.

British Empire, March 1921.

Temperature: Mean Wet Bulb. °F.	Temperature: Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	Precipitation: Amount in.	Precipitation: Amount mm.	Precipitation: Diff. from Normal mm.	Precipitation: Days	Bright Sunshine: Hours per day	Bright Sunshine: Percentage of possible	Stations
43·9	18	74	6·6	1·33	34	– 9	14	4·0	35	London, Kew Observatory.
53·1	41	77	5·7	7·90	201	+ 79	6	..	..	Gibraltar.
..	..	81	5·4	2·47	63	+ 28	11	6·6	55	Malta.
74·7	..	63	3·1	0·11	3	– 25	1	..	..	Sierra Leone.
74·9	59	55	7·8	4·02	102	+ 6	5	..	..	Lagos, Nigeria.
64·7	..	49	..	0·02	1	– 9	1	..	..	Kaduna, Nigeria.
..	..	91	7·9	10·98	279	+ 69	26	..	..	Zomba, Nyasaland.
64·1	52	73	7·0	7·83	199	+ 92	18	..	..	Salisbury, Rhodesia.
63·9	..	65	3·0	0·28	7	– 17	5	..	..	Cape Town.
56·9	45	81	6·3	7·69	195	+ 88	16	5·8	48	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
61·0	..	79	4·7	3·78	96	– 5	13	..	..	Bloemfontein.
73·7	53	46	1·8	0·73	19	– 13	1	..	..	Calcutta, Alipore Obsy.
73·3	60	66	0·5	0·00	0	– 1	0	..	..	Bombay.
75·3	..	82	1·1	0·00	0	– 5	0	..	..	Madras.
77·5	55	65	5·4	4·90	124	+ 12	11	..	..	Colombo, Ceylon.
60·0	..	78	7·8	4·51	114	+ 38	15	3·8	31	Hong Kong.
64·8	48	67	6·1	3·12	79	– 52	18	5·4	44	Sydney.
58·4	36	56	3·8	1·02	26	– 29	6	..	..	Melbourne.
59·3	37	46	2·5	1·65	42	+ 15	2	9·3	76	Adelaide.
65·5	46	50	1·7	0·95	24	+ 6	3	..	..	Perth, Western Australia.
63·7	40	35	1·1	0·13	3	– 16	1	..	..	Coolgardie.
68·1	56	74	6·3	7·86	200	+ 48	19	..	..	Brisbane.
52·5	35	59	5·4	0·77	20	– 22	12	8·7	70	Hobart, Tasmania.
55·4	30	72	5·3	1·29	33	– 50	11	6·4	52	Wellington, N.Z.
76·5	..	80	..	12·64	321	– 52	23	..	..	Suva, Fiji.
..	..	74	5·6	1·42	36	+ 10	8	..	..	Kingston, Jamaica.
71·9	..	72	4·7	4·07	103	+ 33	20	..	..	Grenada, W.I.
34·2	5	82	7·2	2·11	54	– 13	20	..	..	Toronto.
14·1	..	90	5·3	1·09	28	+ 1	9	..	..	Winnipeg.
31·7	7	83	6·2	4·64	118	+ 3	16	..	..	St. John, N.B.
40·2	26	81	6·0	1·23	31	– 34	16	..	..	Victoria, B.C.

COLOMBO, CEYLON.—Prevailing wind direction W.; mean speed 3·8 mi/hr; 4 days with thunder heard.

HONG KONG.—Prevailing wind direction ENE.; mean speed 9·4 mi/hr.

SUVA.—5 days with thunder heard.

GRENADA. Prevailing wind direction E.

62·1	39	52	3·3	0·16	4	– 11	3	..	..	Perth, W. Australia.

thunder occurred locally. The depression passed away to the south of France on the 17th and became less deep, and a ridge of high pressure formed over the British Isles, bringing fine weather generally on the 18th and 19th, though there was much fog on our north-east coasts. These were the warmest days of the month in most places, temperature exceeding 80° F. at several stations. The depression came back from France on the 20th, moving north to the neighbourhood of the Wash by the morning of the 22nd. The weather became overcast over the greater part of the country, and heavy local rain and thunder again occurred. The depression moved east and dispersed, but several places, including London, experienced thunderstorms on the 23rd.

Heavy rains and thunderstorms were renewed in France and Switzerland from the 17th to the 24th. On the 18th there were 94 mm. at Perpignan, on the south coast of France, and 98 mm. at Sanguinaire, in Corsica, and on the 22nd there were 135 mm. at Lugano, in southern Switzerland.

From the 25th till the end of the month a westerly type of weather again prevailed. The weather was mainly fair in southern England, France, and Central Europe, while Atlantic depressions brought rain to the northern districts of the British Isles and to Scandinavia. A secondary which formed off the Hebrides on the evening of the 26th developed quickly into a deep cyclone which moved away up the Norwegian coast. A new depression formed off the west of Ireland on the 28th, and moved eastward over England and then north-north-east to the Gulf of Bothnia, which it reached on the 31st, having become much deeper. It caused heavy rain along its track, the largest falls in the British Isles being in north-east England and south-west Scotland, to the left of the centre. On the night of the 28th Howden had a heavy thunderstorm and a total of 27 mm. of rain, and Tynemouth had 10 mm., followed by 44 mm. on the 29th. Except for thunderstorms on the coast of Kent during the early hours of the 29th, south-east England escaped rain from this depression altogether. A cold northerly current extended over the British Isles in the rear of the depression, temperature being very low in the north all day on the 29th, and low generally on the nights of the 29th and 30th, with local ground frost. The screened thermometer fell to 30° F. at Eskdalemuir and 30° F. at South Farnborough on the night of the 30th, and on the previous night fell to 40° F. as far west as Valencia Observatory.

On the grass a reading of 25° F. was recorded at Eskdalemuir and Greenwich on the night of the 30th. On the last day of the month a depression off the west of Ireland caused a warmer southerly current, with rain in the western districts.

Fog was persistent on our north-east coasts from the 18th to the 23rd, and extended as far south as Yarmouth at times from the 21st to the morning of the 24th. There was also thick fog over the Irish Sea on the 19th, which cleared during the 20th. There was local morning fog inland during this period, and low cloud and mist persisted all day locally from the 21st to the 24th. For the remainder of the month visibility was mainly good, though there was occasional mist or fog on our south-west coasts. C. K. M. D.

At the beginning of the month the drought was continuing in France with undiminished severity. Forest fires and the destruction of mills and farms were being reported daily, the largest being that of the forest of Vorey-sur-Azon, which at one time threatened the towns of Vorey and Bellevu. Heavy rain fell later in southern France, and severe floods on the Garonne and its tributaries followed. Snow fell in Savoy on the 15th. A violent storm considerably damaged Doua Wireless Station, near Lyons, about the same time, suspending communication with America and the Far East.

Heavy rain has fallen in many parts of Switzerland, breaking up the prolonged drought. Snow also fell in various parts of the Alps. A tornado swept over the Montreux district (Lake of Geneva) on the evening of the 3rd.

Hailstorms of exceptional violence occurred on the 16th in Bavaria and Württemberg, doing extensive damage. In some places large hailstones lay piled on the ground to the depth of a foot.

Great heat was being experienced in Italy at the beginning of the month.

Prolonged drought has ruined the Hungarian and Yugo-Slav maize crops, but the Austrian corn harvest is excellent.

The total rainfall of India from June 1st approximates to the normal or exceeds it everywhere except in eastern Rajputana. A telegram dated August 10th stated that the monsoon was strong in northern India, but weak in the Peninsula. Unprecedented floods have occurred in the Malia district of Kathiawar, and considerable damage has also been caused in Waziristan and other parts of the Afghanistan frontier.

The gales and floods in eastern Australia in July were followed in New South Wales and Victoria by the coldest weather experienced for a quarter of a century. Snow has fallen in districts where it has never been seen before.

The harvest in Canada has been early, but is satisfactory on the whole.

In the south-east of England generally the deficiency of rain continued throughout August. For the seven months February to August the fall was less than half the average over the country between Kent, Norfolk and Somerset. At Oxford only 42 per cent. and at Camden Square (London) only 44 per cent. of the average for this period was recorded.

Less than the average rainfall for August occurred generally south of a line from the Bristol Channel to the Wash, in the northern half of Scotland, and in the north and centre of Ireland. The area with deficiency over the British Isles was roughly equal to that with excess, although the deficiency was not well marked, falling only to about 40 per cent. below the average along the south-east coast. More than twice the average occurred locally near Newcastle, where the heavy rain of the 29th of about 2 in. (50 mm.) was the heaviest recorded in one day since 1913. Falls of less than 1 in. (25 mm.) for the month were confined to small areas in the south-east of England. Less than 3 in. (75 mm.) fell only to the south-east of a line from about Cardiff to Boston, over small areas in the east of Scotland, and in the neighbourhood of Dublin. The area with more than 6 in. (150 mm.) was unusually large, occupying the greater part of Wales and the south-western half of Scotland, considerable areas in the north of England, and the mountain regions of Kerry and Connemara. More than 10 in. (250 mm.) occurred in the usually wet areas of the United Kingdom, as much as 25 ins. being recorded in the Lake District. With the numerous thunderstorms of the month several heavy falls in short periods were recorded, of which that at Milton, near Peterborough, of 1·91 in. (49 mm.) in 65 minutes ranks as a "remarkable fall."

The general rainfall of August, expressed as a percentage of the average, was:—England and Wales, 115; Scotland, 106; Ireland, 108; British Isles, 110.

In London (Camden Square) the conditions were generally fair or fine, but with a good deal of cloud and occasional showers. The mean temperature, 63·7° F., was 1·3° above the average, and it was the twelfth successive month with temperature in excess of the average. Duration of rainfall, 15·0 hours; evaporation, 2·56 inches.

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The Loss of the Airship N.S. 3.

THE airship N.S. 3, on patrol from East Fortune, was wrecked at sea off Dunbar in the early morning of June 22nd, 1918. The occurrence subsequently became of considerable meteorological interest on account of the suggestion that a "wind barrage" of a more or less permanent nature exists over the mouth of the Firth of Forth during southwesterly winds.

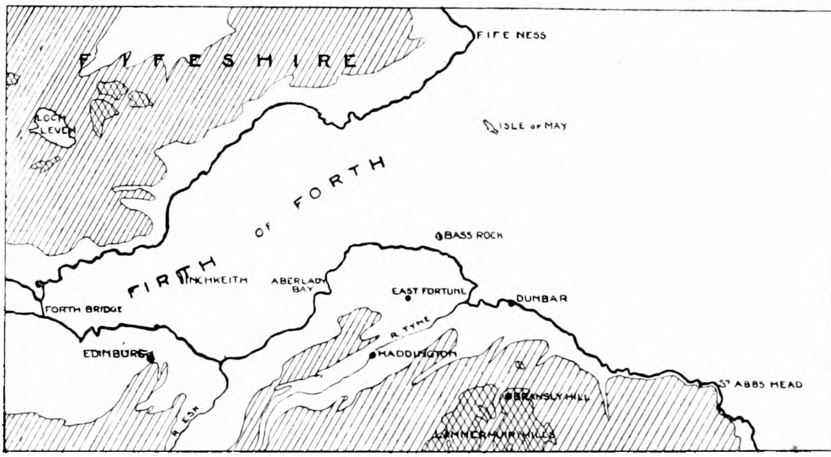
Evidence bearing on this supposed wind barrage was referred for investigation to the Meteorology Sub-Committee of the Advisory Committee for Aeronautics. The papers discussed by the Sub-Committee have been used in the preparation of the following notes by permission of the Aeronautical Research Committee.

At 0 h. 40 m. (summer time) on June 22nd, 1918, the N.S. 3 was 7 miles south-east of the Bell Rock. The wind was estimated to be 35 miles per hour, rising to 45 miles per hour in gusts, and was increasing, and course was laid at full speed for East Fortune. At 3 h. 15 m., when the airship was passing south-east of May Island, the wind was 45 miles per hour, with violent bumps. Three attempts were made to cross the coast near Dunbar, but the first two were defeated by violent gusts which drove the airship outwards from the coast. The third attempt was successful, but, owing to the violence of the gusts and to up-currents throwing the ship up to 1500 feet, no further headway could be made. The ship therefore re-crossed the coast seawards in order to try to work home up the Firth, but before she could be turned into the wind she

O (64)16064 Wt 105—P 35 1250 10/21 E & S

was rapidly driven down into the water, in spite of a large elevation of the bows.

The area over which the supposed wind barrage is operative has a triangular shape with apex at the island of Inchkeith, the north and south coasts of the Firth as the sides, and a line drawn from Fifeness to St. Abb's Head as the base. The evidence of wind abnormality may be summarised as follows:



THE FIRTH OF FORTH.

The lighter shading indicates ground above 250 feet, the heavier that above 1000 feet.

The existence of regions of high and irregular winds when the general wind was westerly or south-westerly had been recognised by pilots for some time. According to a memorandum prepared at East Fortune, it frequently happens that, whilst the wind experienced in the triangular area at the usual patrol height, 500 to 1000 feet, is between north-west and south-west, the wind at a similar height over the waters beyond Fifeness is from a different direction, between north-west and north-east, and that off the coast south of St. Abb's is between south and south-east. Severe bumpiness is experienced off St. Abb's Head and along the southern coast of the Firth on these occasions, the disturbances being most pronounced in the region of Belhaven Sands and Dunbar. The gusts vary rapidly in velocity and direction, and are accompanied by violent "updunts." The district west of Bass Rock, particularly over Aberlady Bay, is relatively free from these unpleasant conditions. A year's general experience of pilots has shown that up to a height of 1500 to 2000 feet the wind velocity is about 10 miles per hour greater at the mouth of the Forth than over East Fortune. The suggestion was put forward that during westerly winds the valley of the Forth forms a funnel through which the wind at a height of 500 feet and upwards has increased velocity. The valley of the small River Tyne near Dunbar might have a similar effect.

The synoptic chart for 1 h. (G.M.T.) on June 22nd showed that the geostrophic wind in the East Fortune region was about 42 miles per hour from west-north-west, but the wind shown by the 40-feet anemometer at East Fortune was 15 miles per hour from west-south-west at that hour, and at Blackford Hill, Edinburgh, the anemometer reading was 21 miles per hour from west-south-west. At Glasgow the wind was estimated to be 21 miles per hour from the same direction. There had been a gust of 39 miles per hour at midnight from west at Blackford Hill, and the microbarographs there and at Eskdalemuir also gave indication of disturbed conditions.

As regards the funnel effect it is not at present possible to say definitely what result river-valley configuration has upon the winds on the slopes or summits, and the theory that the wind in such circumstances is substantially increased is not readily verified. It is often supported by reference to strong winds which sweep down gulleys on to the sea, but these are characteristic of long mountain valleys and are attributable to thermal causes. It is unlikely that an effect of this kind would have been produced on a windy night in either of the valleys under consideration.

The ordinary result of the wind passing over a hilly region is a very considerable eddy-effect which reduces the velocity at, say, 30 feet above the surface to about half that in the free air, the reduction being greatest in the valleys and least on the hill tops. This eddy-motion, which is the direct result of an arrest of momentum at the ground, may be regarded as the superposition upon the mean wind of motion in confused and imperfect eddies, and takes the form of transient upward or downward motion, forward or backward, to one side or the other. The superposed velocities in all six directions probably have about equal ranges.

Records from anemometers show that the effect of eddy-velocity in a region such as that near Dunbar is to make the actual wind at, say, 30 feet from the ground fluctuate between the limits of 0·5 and 1·5 times the mean velocity, *i.e.*, approximately 10 to 40 miles per hour for a geostrophic wind of 50 miles per hour. Over trees the range tends to be somewhat greater. Very little is known about the vigour of eddies at a height of 500 feet, but it can be assumed that with a strong westerly wind in this neighbourhood the air would have a good deal of its energy of motion in the form of irregular eddies. In any case a ship in a strongly eddying current could not keep trim and would be very likely to lose headway and become unmanageable; it would catch the wind at a variety of angles and, if driving at full speed, would meet a succession of blows of perhaps nearly double the full speed resistance in still air. The effect of turbulence due to hilly ground would extend for a considerable distance to leeward of the hills.

The temperature difference of sea and land tends to complicate ordinary eddy-motion at the coast. The air coming off the land with the westerly wind on the night of the loss of N.S. 3 was relatively cold, but the temperature difference does not seem to have been sufficient to cause much additional disturbance of the air.

There is a further coastal effect which may be operative in windy weather, when the local temperature gradient is not very marked. This is the dynamical effect upon the stream of air produced by the sudden transition from a hilly land-surface, with a comparatively high coefficient of eddy viscosity, to the sea-surface, with a comparatively low one. This change must probably be represented by a sudden transition of pressure in the surface layers which produces a "refraction of the isobars" at the coast.

There was nothing in the ordinary meteorological conditions to suggest a cause for the violent up-current experienced by the N.S. 3. The largest rising current that has been measured by a two-theodolite pilot balloon ascent in this country was one of 12 miles per hour (J. Durward, *Meteor. Mag.*, Vol. 56, p. 97). J. S. Dines (*ibid.*, p. 96) has measured one of 11 miles per hour, and had four of over 7 miles per hour in 66 ascents. The largest downward current at a considerable height appears to have been one of 5 miles per hour deduced by G. A. Clarke (*Q.J.*, *Roy. Met. Soc.*, XLVII., p. 117) from a single-theodolite ascent at Aberdeen. The experience of N.S. 3 suggests something considerably more violent, but the conditions were generally the same as in Clarke's case, the wind eddying downwards between the hills and the sea.

Bransly Hill, the spur of the Lammermuirs to the south of Dunbar, is 1300 feet high and 5 miles from the coast, and the airship coming landwards would probably have met increasing turbulence up to a maximum at the front of the hill eddy.

On consideration of all the evidence, the Meteorology Sub-Committee were satisfied that a sufficient explanation of the experiences of N.S. 3 was to be found in the eddy-motion of the atmosphere, which would in all probability be especially prominent in the district under consideration and in all hilly regions near the coast line. There seems to be no evidence of any funnelling effect in the Forth Valley such as would justify the use of the word "barrage". Certain elements of the turbulence, notably the Bransly Hill eddy, are probably permanent in winds of similar strength and direction. One feature of general interest which emerged during the inquiry is the not infrequent existence of a sharp maximum velocity at about 1000 feet which is not necessarily confined to the coast but is certainly prominent there. This is likely to be of importance for airships navigating at that level.

In connection with the inquiry, research on the effect of eddies on the drag experienced by an airship model was initiated at the National Physical Laboratory. A report by Messrs. Relf and Lavender has been published.* A model airship 3 feet long was set up in a wind channel and artificial eddies were produced by passing the air through nets of thick cord. It was found that the eddies produced by the cords died out rather quickly; their effect was halved when the network was moved from close up to the nose of the model to a distance of 3 feet, and almost eliminated at 6 feet. The greatest drag exceeded double that in a free channel. It was found that the eddies from a gridiron arrangement of cords running one way were more persistent than those from a network, and that the eddies made by a thick cord carried further than those from a thin one, but no obstacle comparable with a hill was included in the tests.

The moral of the investigation appears to be that when meeting an eddying wind an airship loses a great deal of the advantage of the streamline shape.

Official Publications.

The Observer's Handbook, 1921. Price 7s. 6*d*. net.

THE new edition of the *Observer's Handbook* differs only slightly from its predecessors. Attention may be drawn to the code for mist and fog, based on the range of visibility, which is described on pages 53 and 54. The visibility code in its relation to this fog and mist code is given in the May issue of this Magazine.

An illustrated description of the Assmann Psychrometer is a new feature of Part III., while Part IV. contains an additional

* *Advisory Committee for Aeronautics Reports and Memoranda No.* 597.

table for computing the velocity-height-ratio of clouds in milliradians per second from Fineman Nephoscope readings. The newer type of instrument designed at the Meteorological Office and known as Mark II., is described on page 48. The diagram formerly reproduced in the Handbook to illustrate the method of computing the velocity-height-ratios is no longer shown. According to this diagram the tip of the pointer is adjusted until it is in the same straight line as the cloud-image and the central point of the mirror, whereas in actual practice it is the *image* of the tip that is adjusted to the straight line. Both methods are described in Fineman's paper *Spegelnefoskopet*, Stockholm, 1889.

Professional Notes.—No. 22. A Comparison of Minimum Temperatures for the periods 17 h. to 9 h. and 17 h. to 17 h. By M. A. Giblett, M.Sc. Price 1s. 3*d*. net.

THE investigation recorded in this note was undertaken in connection with a suggested revision of the scheme of observations at Health Resorts. The revision of the terminal hours for maximum and minimum temperatures took place in March and April of this year and an account of the change was published in this Magazine, April 1921, page 75.

Mr. Giblett's work shows that the average night-minimum (17 h.–9 h.) differs in winter from the average 24-hour minimum by about 0·4° F. whilst the difference is negligible in summer.

The minimum for the longer period is found to occur after 9 h. about 20 times a year, mostly in winter.

Professional Notes.—No. 24. The Variation of Wind with Place. By Captain J. Durward, M.A. Price 6*d*. net.

THIS note gives an account of an investigation undertaken in 1918 to test the accuracy of "Meteor" reports to artillery. A preliminary inquiry into results from two stations in north-east France, 50 miles apart, showed that between the heights of 2,000 and 10,000 feet, 70 per cent. of the winds agreed to within 5 ft./sec. and 90 per cent. to within 10 ft./sec. A more detailed investigation was then made from observations from seven stations along the British Front. One station was taken as the standard, and the winds at the other six stations were resolved first along the wind—the "following component"—and then at right angles to the wind—the "cross component."

It was found that, between 2,000 and 6,000 feet, in the case of the following component the 50 per cent. zone of agreement within 5 ft./sec. had a radius of 55 miles, and in the case of the "cross component" the 55 per cent. zone had the same radius. The agreement at 10,000 feet was found to be somewhat better than this. It was considered that, on the average, errors arising from neglect of the variation with place are comparable with those arising from other causes.

Meteorology in Edinburgh, September 1921.

THE meeting of the British Association in Edinburgh, from September 7th to September 14th, was characterised by a marked revival of meteorological activity, and this, together with the meeting of the Royal Meteorological Society in the same city on September 7th, combined to make the occasion a memorable one for those meteorologists who were able to be present.

The claims of meteorology to a place in the programme of Section A of the British Association have again been recognised by the reappointment of a meteorological secretary to that section, an office vacant since the retirement of Lieut.-Col. E. Gold, F.R.S., in the early days of the war. Of the papers read a number were of geophysical interest. Dr. A. Crichton Mitchell described the new Geophysical Observatory in the Shetlands established by the Meteorological Office for research on aurora and magnetic and electrical phenomena. Terrestrial magnetism was represented by two papers, "The Magnetic Storms of the Present Solar Cycle," by the Rev. A. L. Cortie, and "The Magnetic Anomaly in the District of Kursk, Russia," by Prof. Kriloff. The various theories of cyclones were reviewed by Dr. H. Jeffreys in a paper "On the Cause of Cyclones," while Capt. C. K. M. Douglas contributed "Some Remarks on Bjerknes' Theories of Cyclones and Anti-cyclones." The outstanding difficulty in the "radiation" theory of the stratosphere, viz., "The Discontinuity of Temperature at the Top of the Troposphere," formed the subject of a paper by Mr. W. H. Dines, F.R.S. "The Dry Period of 1921 in England and Wales" was described by Mr. M. de Carle S. Salter, and compared with those of 1887, 1893, and 1911. In an address on "Internal Movements in the Sea," Dr. Hans Pettersson described in a delightful way, and illustrated experimentally, how, under favourable conditions, dense sea water freshly saturated with oxygen enters the Baltic, and, sinking into the deepest hollows, renews the supply of oxygen there and renders them habitable by marine fauna. The Report of the Seismological Committee was delivered by Prof. H. H. Turner, F.R.S., and contained, amongst other things, a brief account of further research by Mr. J. J. Shaw on the travel of microseisms, preliminary work on which was described in the report last year. The Report of the Committee on Tides was drawn up by Dr. A. T. Doodson, and it is interesting to note that one of the subjects of reference for future investigation is the effect of meteorological conditions on the degree of accuracy obtainable in the analysis and prediction of tides.

In Section B, recent work for the Advisory Committee on Atmospheric Pollution was described by Dr. J. S. Owens in a paper on "Suspended Impurities in City Air."

The occasion was a particularly suitable one for the meeting of the Royal Meteorological Society in view of its amalgamation early this year with the Scottish Meteorological Society. The meeting was held in the Natural Philosophy Department of the University, the building devoted to Section A of the British Association, and there were present some 50 or 60 Fellows and visitors from both sides of the Border. Proceedings opened with an address by the President, Mr. R. H. Hooker, on "The Functions of a Scientific Society with special reference to Meteorology." Dr. Angus Macdonald then read a paper on "Meteorology in Medicine," which was followed by "Some Notes on Meteorology in War Time" by Mr. C. J. P. Cave, and a paper "On the Diurnal Variation of Atmospheric Pressure at Castle O'er and Eskdalemuir Observatory, Dumfriesshire," by Dr. A. Crichton Mitchell. The meeting closed with a paper by Dr S. Fujiwhara of the Central Meteorological Observatory, Tokyo, on "The Natural Tendency towards Symmetry of Motion and its Application as a Principle to Meteorology."

A joint Exhibition of Meteorological Diagrams and Photographs was arranged in two rooms of the Natural Philosophy Department and remained open to Fellows of the Society and Members of the Association from Wednesday, September 7th, until the end of the week. One room was devoted to autographic records from Eskdalemuir Observatory, and, of these, a number showing pulsations of the Earth's vertical magnetic force, were of outstanding interest. Prominent in the other room were cloud photographs by Mr. G. A. Clarke and Capt. C. K. M. Douglas and photographs illustrating waves in water, sand, snow and air, by Dr. Vaughan Cornish, while diagrams illustrative of Mr. Salter's paper on the "drought" and others by Dr. J. S. Owens showing the diurnal variation of suspended impurity in city air and by Dr. E. M. Wedderburn showing temperature variations in Loch Earn, attracted much attention.

As announced in the *Meteorological Magazine* of last August, a temporary branch of the Meterological Office was opened in the Natural Philosophy Department, and a wireless receiving set was installed there by the Communications Department of the Air Ministry, for the reception of the synoptic messages issued several times daily by this and other countries. The data received were exhibited in the Entrance Hall in the form of a synoptic chart on a large blackboard covering an area from Spitzbergen to Algiers and from Iceland to the Russian frontier. In this way it was shown effectively how much weather information is distributed day by day through the "æther," a great deal of it available to the amateur equipped with a not very expensive receiving set. Numerous practical demonstrations were given of reception by wireless and of the subsequent decoding and charting of information. In addition a "Local Daily Weather Report" was prepared and duplicated, and forecasts were issued to the Press and to private inquirers. The Daily Weather Report was issued soon after 10 h. G.M.T. and contained, in addition to the 7 h. synoptic chart, tabulated details of surface and upper air conditions over the British Isles and a "General Inference" and local forecast for Edinburgh. Copies were exhibited not only in the buildings occupied by the British Association but in many public places in Edinburgh.

Two functions of a less serious nature were an excursion of Fellows of the Royal Meteorological Society to Eskdalemuir by motor char-a-banc on Tuesday, September 6th, and the "Meteorological Luncheon." The party of about 25 who joined the excursion spent a very enjoyable day and were shown over the Observatory by the Superintendent, Dr. A. Crichton Mitchell, afterwards being entertained to tea by Mrs. Crichton Mitchell. They were favoured with delightful weather. For many years the "Meteorological Luncheon," as before it the "Meteorological Breakfast," has afforded an opportunity for the gathering together of geophysicists attending the British Association meeting. This year the party, augmented by Fellows of the Royal Meteorological Society and their friends, numbered 45, and a very successful luncheon was held in the Advocates' Dining Hall, Parliament House, on Tuesday, September 8th. Dr. H. R. Mill, who presided, delivered a very entertaining speech in which the history of the function was traced from its earliest days. Subsequently speeches were delivered by Prof. R. A. Sampson, F.R.S., Astronomer Royal of Scotland, and by Mr. R. H. Hooker, President of the Royal Meteorological Society. An interesting feature of the luncheon was the reproduction, on the back of the menu, of the synoptic weather chart of 7 h. the same morning.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

Visibility.

THE letter of Mr. C. F. Priestley in the September number of this Magazine on "Visibility on the Firth of Clyde" is interesting and suggests comparisons with other west-coast stations. I do not think that visibilities such as he describes are at all uncommon.

There being no distant mountains suitable for observation in the neighbourhood of Valencia Observatory, resource has been had to clouds low down on the horizon over the Atlantic and the results of a few such observations may be of interest.

The most suitable conditions occur with a sky thinly dotted with fracto-cumulus cloud; with unusually good visibility the outlines of such clouds can sometimes be seen distinctly right down to the water-horizon. The heights of the bases of clouds of this type are generally pretty definite and can be estimated with very fair accuracy in the case of those near at hand by comparison with the neighbouring mountains. Such clouds are seldom seen at Valencia Observatory below about 2,000 ft.

In computing distances the effect of refraction is considerable and should not be ignored. Calculation shows that in the case of tangential rays of light the radius of curvature is normally about 5·3 times the radius of the earth. It may readily be determined that the effect of refraction in such case is to increase all horizon distances by 11 per cent. If then an observer at height h ft. above sea level observe on the water-horizon another object at H ft., the distance in miles between them, after allowing for refraction, will be $1{\cdot}36\,(\sqrt{H} + \sqrt{h})$.

On August 28th last in the afternoon the visibility was not quite good enough to be classed as "v," the sky was dotted with fracto-cumulus and a light westerly wind was blowing. The outlines of the clouds could be traced down to about ·05° above the Atlantic horizon by an observer standing about 50 ft. above sea level, and the height of the bases of similar neighbouring clouds was at least 2,000 ft. If we take 2,000 ft. as the height of the part of the clouds seen, and allow for the ·05° elevation the distance works out as 65 miles.

On the next day in the afternoon the sky was again dotted with fracto-cumulus, the wind-force 4 from north-west, and the visibility classed as "v." The bases of local fracto-cumulus clouds were at from 2,500 to 3,000 ft., while the outlines of distant ones could be made out to within about ·1° of the horizon, viewed from a point 82 ft. above sea level. If 2,700 ft. be taken as the height of the clouds the distance works out as 75 miles.

The best observation of all was obtained in the evening of the same day after sunset, when the outlines of fracto-cumulus clouds could be seen with perfect distinctness against a light background of sky, right down to the Atlantic horizon. Local clouds in this case had bases about 2,000 ft. high, so that a distance of 73 miles is indicated.

Somewhat similar observations have been made before at Valencia, though not with such precision as in this case, and I think that the result justifies the conclusion that the conditions indicated by Beaufort letter "v" at Valencia represent a visibility of at least 60 to 70 miles, and sometimes more. Roughly speaking, Beaufort letter "v" has been noted during recent years on about 15 to 20 days per annum.

L. H. G. DINES.

Valencia Observatory, Cahirciveen, September 26th, 1921.

I HAVE read with interest the article on p. 224 of this Magazine on "Visibility on the Firth of Clyde," and it has occurred to me that some account of a view from Blackpool Tower on a day when visibility was very great may be considered worth publishing.

As an old mountaineer who has seen many views, I considered this view, in the amount of detail visible over a wide area, to be unique in my experience. A tower has the advantage over a mountain that it has no skirts or outliers to obstruct the view.

The counties included in the view under consideration would be Cumberland, Westmorland, Yorkshire, Lancashire, Cheshire, Flint, Denbigh, Carnarvon, and the Isle of Man.

September 3rd, 1921, was a day of exceptional clearness. The view from the summit of the Tower at Blackpool (about 500 feet high) was remarkable, not only from the extent of country covered but also from the immense amount of visible detail at great distances. It was exceptional, too, in that the view was equally clear in every direction.

The Isle of Man, visible from the promenade only as a series of detached islets, stood high out of the water 70 miles away and dark blue. The hills of Wales, 60 to 70 miles away, were equally clear. In this connection it may be of interest to note that some years ago I was on Snowdon with the Rev. R. P. Dansey, and he made out the top of Blackpool

Tower (70 miles away) with glasses, showing through a gap in the ridge of Glyder Fawr.

To the east the view is more restricted, but to the north the hills of the Lake District were visible in great detail; every mark and gully on Black Combe, 33 miles away, could be seen with the naked eye, and Saddleback, 57 miles away, was clearly distinguishable through the gap of Dunmail Raise. Further east the Howgill Fells, which rise to the north of Sedbergh in Yorkshire could be made out.

To mention smaller details, Great Orme's Head, above Llandudno, 48 miles away, could be recognised, and the white wall of the lighthouse enclosure on its north-west point could be made out with glasses; with the same aid the colours of fields and woods on the nearer Welsh coast, 40 miles away, could be distinguished; the buildings in Liverpool and the top of the transporter bridge over the Mersey at Runcorn, 35 miles away, were also visible.

Northwards, even from the ground level, the colours of cornfields, pastures, and woods on the nearer hills some 27 miles away beyond Morecambe Bay, and the purple of the heather above, could be made out with the naked eye.

From the tower with glasses I could clearly recognise the tower on Eller Horn, a hill to the north-east of Grange-over-sands 29 miles away, and could see the houses in Grange itself.

A little to the west of Black Combe an isolated islet rose dark blue from the sea. This I took at the time to be a hilltop in Scotland, but the map showed it to be the top of St. Bee's Head, the most westerly point of Cumberland, 52 miles distant.

I have only mentioned some of the more distant features; a view which included a great deal of detail in nine different counties and the whole of the coast line from Llandudno round to Barrow is so exceptional that it seems worth recording. Probably visibility was at its maximum, and everything which the sphericity of the earth allowed to be seen was distinguishable. VICTOR H. GATTY.

Whiteholme, near Preston, October 2nd, 1921.

Are Upper Air Temperatures better Evidence for Horizontal or for Vertical Movements?

THERE have been several allusions lately by various writers in the *Meteorological Magazine* to the effect of wind direction upon temperature in the upper air, possibly as echoes from the theory of the polar front, but there is another cause of temperature variation that is apt to be overlooked.

It can be simply and readily proved that a mass of air has to move with an inclination of only 3′ to the horizon, which is a slope of 1 in 1160, to produce on itself a change of temperature equal to that due to the change of latitude produced by a south or north wind, and further that it will require a very thick current of air and very rapid motion before fully saturated air moving at so small an angle to the horizontal can produce perceptible rain.*

Since rain is common, air currents at much greater inclinations than 3′ must be common also, neither is there any reason to suppose all inclined air currents to consist of rising saturated air; they may be dry or wet, rising or falling. In these currents we have a powerful source of change of temperature, and it is not safe to ascribe an anomaly of temperature to some other cause without first proving that this is ruled out. Thus, suppose at some definite height and place an anomaly of + 10° F. is found, if the air has run down an incline of 30′ for 100 miles with sufficient speed to have escaped change by radiation, the + 10° is explained. It does not follow that this is the cause, but it quite certainly may be, and very likely is. We are accustomed to ascribe rain to such causes, why not also changes of temperature some of which are admitted by all to be the primary cause of rain? W. H. DINES.

Weather Lore.

I WAS interested in letters on this subject which appeared in the January and March numbers of your Magazine, concerning red sky at sunset. I have observed that with a rosy afterglow fine weather follows, but with a dark red inevitably rain comes next day, as to morning red, I can only conclude

* Sin 3′ = 1/1160 = 250 metres/290 kilometres.

If air rises 250 m. adiabatically it falls 2°·5 C. and the average fall of temperature for 250 m. in height is 1°·5 C.; thus the air which has risen 250 m. is 1° C. below the air at its new level.

From the *Book of Normals* (M.O. 236), Section III., the fall of temperature towards the north over England is about 1° F. per 100 miles = 1° C. per 180 miles, and 180 miles = 290 kilometres, hence the two causes exactly balance.

From a table given by Hann (*Lehrbuch der Meteorologie* 1906, p. 162), it appears that 1 cu. metre of saturated air at 0° C. condenses ·33 gramme of water vapour on cooling 1° C., and, therefore, ·83 g. on cooling 2°·5 C. Consider a current 1 m. wide and 1,000 m. deep running up a slope of 3′ with a velocity of 50 miles or 80 km. per hour. Suppose for the moment that all the water is given off at the last metre the amount per hour is ·83 × 1,000 × 80,000 g. But it rains equally fast all up the 290 km. slope, or this is distributed over 290 × 1,000 × 10,000 sq. cms.

The rate is $8 \cdot 3 \times 8 \times 10^6/29 \times 10^8$ cm. per hour
$= 2 \cdot 29 \times 10^{-2}$ cm. per hour,
= ·01 in. per hour nearly.

The rate would be less than this because the latent heat set free would not allow a cooling of 2°·5 C. W. H. D.

the same results. This month of September I have specially noted sunrises and I give the following as recorded from my observations:

12th. Dark red and yellow sunrise, with falling barometer and backing wind, rain at night, strong wind morning and noon. Rain on 13th and 14th but not heavy, barometer rising.

15th. A vast expanse of red rosy sky at sunrise, wind veering—a fine day followed.

16th. Rosy sunrise, rising barometer, veering wind—a fine day followed.

17th. Sunrise not so rosy or so full in volume with steady barometer and wind—fine morning followed but with strong wind from NE. Cloudy sky overcast at times, a shower followed at 13 h. 30 m. and rain at 15 h. G.M.T. Wind variable, E, NE, ENE. Barometer, slight fall of 0·02 in. and rise of 0·04 in. from morning observation to noon.

These signs of colour can be taken into consideration with some assistance from the observation of wind changes, barometer movements, and variation of temperature as aids to forecasting local weather.

It is, I think, a subject worth the consideration of our professors. HENRY A. ROGERS.

3, Victoria Square, Bristol, Sept. 21st, 1921.

A Cyclist's Experience of Rime in September.

On the morning of Wednesday, September 28th I was cycling from Newbury to Reading. I left Newbury at 8 h. 50 m. G.M.T. and happened to note that the air temperature was 43° F. A thick clammy mist was prevailing, but occasionally the sun's position was visible, the inference being that the sky was cloudless. After a mile or so towards Woolhampton my jacket became white with frost crystals, although grass around and the meadows were wet with dew (the hoar-frost on them having already melted away). C. W. HEINEMANN.

Kensal Green, October 1921.

[It is to be presumed that the fog at Woolhampton was much colder than that in the town of Newbury and that it contained super-cooled water drops which would be deposited as rime. Perhaps this cold fog had drifted into the valley after the melting of any hoar-frost there may have been during the night.

The observations at Bucklebury Place, 2 miles north of Woolhampton, at 8 h. G M.T. were :—Dry bulb temperature, 42°·5 F.; minimum temperature, 37°·2 F.; grass minimum, 30° F.; weather, foggy.—ED. M.M.]

Units for Meteorological Work.

May I point out one or two further aspects of the present discussion? Whilst every scientific meteorologist will acknowledge the desirability, and in many cases the necessity, of using absolute C.G.S. units in physical problems involving calculation, it does seem rather unnecessary to have effected so drastic a revolution in the ordinary tabular matter which is periodically published. And remember it is not the ordinary reader on whom the burden of the change has fallen most heavily, but the writer of books desirous of appealing to as many classes of readers as possible. Imagine the plight nowadays in which such an author finds himself. If he is to court favour with the select scientific few he must rigidly adhere to absolute C.G.S. units, but thereby numbers of readers in the wider world will be "put off" the book. If he uses one set of units in one section of the work, another in another, as seems most fitting in accordance with general usage he is sure to be denounced for inconsistency. If, again, in every figure he quotes he gives the equivalent in brackets he must sacrifice literary smoothness, or if he refers his readers to a table of equivalents in an appendix many will resent the trouble, although the last seems to be the best solution of the difficulty.

It is to be hoped therefore that the difficulties of authors in this matter will be sympathized with.

As many correspondents have pointed out, the actual advantages are by no means entirely with C.G.S. units. Personally, for ordinary climatological descriptive or comparative purposes, I much prefer the small Fahrenheit degree because one can disregard fractions in many instances where it would not be justifiable to do so with Centigrade degrees.

L. C. W. Bonacina.

27, *Tanza Road, Hampstead, September 25th*, 1921.

The Word "Drought."

The writer of the article entitled "The Deficient Rainfall" in the August number of this magazine draws a distinction between the "popular" and "technical" meanings of the word "drought." The question arises as to whether any such distinction exists.

Mr. G. J. Symons, in 1887, drew up definitions of the terms "absolute drought," "partial drought" and "engineers' drought" for purposes of discussing spells of rain shortage in *British Rainfall*, and, so far as I am aware, no one objects to the use of these terms for the special purposes of that and similar publications. There appears to me, however, to be a very real objection to restricting the meaning of the single word "drought" to cover only the three types of rain shortage to which those definitions refer. "Drought" is an extremely ancient word, meaning, among other things, "lack of rain" (*New English Dictionary*), and surely Symons's definitions need not prevent anyone using the word in that sense without regard to special limitations.

In a recent newspaper interview a meteorologist complained of the loose and inaccurate use of the word "drought" in the press. The implication is that it is incorrect to describe as a drought a spell of dry weather which does not conform to Symons's definitions. The right of anyone to so clip and limit the meaning of a common English word is surely very questionable, and in this instance, at any rate, there is no reason to believe that any such general limitation was intended when the above definitions were introduced.

E. G BILHAM.

August 29th, 1921.

[Mr. Bilham's criticism would appear to be directed rather towards the anonymous meteorologist mentioned in the last paragraph (who will, we hope, duly note it) than to the writer of the article entitled "The Deficient Rainfall." The article does not appear to demand any restriction in the use of the word "drought," but quite properly avoids any misunderstanding by defining the sense in which the word is being employed. Scientific terminology must narrow the application of words, if it is to be scientific at all, for exactness is the soul of science. Probably the real crime, if crime there be, was Symons's preference for an old English word rather than some artificial new one the restriction of which no one would dispute.—ED. M.M.]

An Observation of the 22° Halo with an Infralateral Arc of Contact.

AT 16 h. G.M.T. on Monday, August 8th, while at New Pitsligo, a village some 30 miles north of Aberdeen, I saw a very fine example of a solar halo.

The halo of 22° was complete and very bright; there was in addition an upper arc of contact to this halo. On both sides of the sun and just without the halo were extremely brilliant parhelia, and below the right-hand parhelion, at about 45° from it, there was seen another arc of contact to the 22° halo.

G. M. RATTRAY.

Aberdeen Observatory, August 18th, 1921.

[Mr. G. A. Clarke reports that at Aberdeen, on the same date, at 18 h., a very strongly coloured and very bright right-hand parhelion was seen, but no trace of halo or arcs was visible.]

NOTES AND QUERIES.

A Comparison between the Double Theodolite and Tail Methods of Obtaining the Height of Pilot Balloons.

A SERIES of ascents has recently been made at Larkhill to determine what degree of accuracy can be got by the use of the tail method. The method consisted of following each balloon with two theodolites, the home station observer taking readings of the micrometer as well as of the azimuth and altitude scales. In all, 25 ascents have been made, though in some cases readings have not been obtained every minute.

The balloons were followed chiefly by means of a Mark C theodolite—the micrometer of which has a scale value of 5,900 units to a radian. A few were followed by the Dines recording theodolite, of which the micrometer scale value is 3,570, and naturally the results obtained by the latter are not so good as by the former. In both instruments the movable cross-wires were only roughly fixed with Gloy, and were liable to shift. The correction was determined before and after each ascent.

Some of the pendants consisted of a circular piece of paper cut along a spiral nearly to the centre. This spins, but it is not very easy to see after 6 or 7 minutes on account of the small extent of surface. A sheet of foolscap gummed along the shorter edges and cut upwards for an inch or two at the bottom, with the corners turned outwards, makes a more suitable form of pendant. This spins well and can be followed for a longer interval.

Attempts were made to colour the pendants, with red or black ink, water colours or pastels. But nothing is gained by so doing; the white foolscap shows up very clearly against blue sky; and even when clouds are present it shows up as dark as a coloured pendant does. Still, coloured pendants made of paper having a highly polished surface would doubtless prove very satisfactory.

On one occasion a small balloon was used as a pendant, but this proved to be quite useless, as the tail oscillated about 45° from the vertical at times, and it was impossible to get readings with any accuracy.

In all cases the pendant was attached to the balloon by a length of ordinary cotton thread, the length from the centre of the balloon to the centre of the pendant being 30 feet.

To allow of a reading being taken at the first minute a piece of tissue paper was hung 15 feet from the balloon; this, however, was not altogether satisfactory, as it seemed to cause the thread to sag a little.

When the azimuth and altitude of the balloon are altering quickly, it is better to take a reading of the micrometer at the half minute and a reading of the other scales at the minute. But when the balloon is fairly steady it is possible to take the three readings at the minute with fair accuracy. Most of the heights given in the table below were calculated from readings taken at the minute, but some, especially in the first five minutes of an ascent, have been interpolated from the heights calculated from the half-minute values.

Results—In Table I. the average heights in feet at successive minutes are given. The heights attained by the tail method are calculated from the actual micrometer reading and are not smoothed.

TABLE I.—HEIGHTS OF BALLOONS AT SUCCESSIVE MINUTES.

Minutes	1	2	3	4	5	6	7
Heights by two-theodolite method.	503	949	1,224	1,613	2,104	2,568	2,895
Height by tail method	516	903	1.231	1,644	2,034	2,379	2,728
Height from formula	500	1,000	1,500	2,000	2,500	3,000	3,500
Percentage error in tail method.	2·6	5·1	0·6	1·9	3·3	7·3	5·8
Number of observations	10	22	23	20	21	22	18

Minutes	8	9	10	11	12	13
Heights by two-theodolite method.	3,275	3.802	4,071	4,566	4,631	5,093
Height by tail method	3,096	3,662	3,841	4,321	4.343	4,858
Height from formula	4,000	4,500	5,000	5.500	6,000	6,500
Percentage error in tail method.	5·5	3·7	5·6	5·4	6·2	4·8
Number of observations	16	16	11	10	7	7

The heights given by the tail method agree on the average with the heights calculated by the double theodolite method to within about 5 per cent. The method is therefore very useful for the determination of winds in the lowest layers of the atmosphere; in particular the irregularities of wind velocity which appear in an ascent calculated by the single theodolite method disappear. For example, on June 28th, 1921, at 13 h. 45 m. G.M.T., the single theodolite method gave the 2,000 feet wind as 82 feet-seconds from 73°; actually it was 25 feet-seconds from 73°. If the first few minutes of an ascent are all that are required, it would be sufficient to make the tail about 15 feet long, and readings could then usually be obtained at the first minute.

It will be observed that the heights obtained by the tail method are on the average lower than those got by the double theodolite method after the 4th minute. This is rather strange, seeing that if the tail swings the micrometer readings will be low and the heights too great. Most, though not all, of the balloons have been observed personally, and the heights almost invariably work out too low. It is probable that the error is due to the lengthening of the tail caused by the thread unravelling. Further experiments are being made to test this theory.

With regard to the measurement of heights greater than those generally obtained during the first thirteen minutes of an ascent—measurements usually obtained when the sky is blue and a white pendant is used—the micrometer readings usually need smoothing, as an error of 0·1 in the reading may mean an error of 300 feet in the height when the micrometer reading is in the neighbourhood of 5. A few heights obtained in various ascents are given below :—

TABLE II.

Time.	Height (Tail method).	Height (Double Theodolite method).
Minutes.	Feet.	Feet.
59	28,700	28,450
21	10,100	9,600
18	5,460	5,500
30	13,980	13,500
21	8,580	8,550
19	8,260	8,780
35	16,350	17,000

It appears then that the tail method gives quite a useful check on the altitude at any time on days of blue sky when balloons can be observed to considerable heights.

J. DURWARD.

Cessation of Summer Time.

SUMMER Time in this country came to an end on October 3rd at 2 a.m. In New York it ceased at 2 a.m. on September 25th, and in Belgium at midnight on the same day, while France will not revert to the normal time until October 25th.

Effect of Salt Spray on the ordinary Wet-Bulb Thermometer at Valencia Observatory.

It is known that the effect of salt water on a wet-bulb thermometer is to cause it to read too high. In an experiment carried out at Valencia Observatory some time ago, two wet-bulb thermometers were mounted in the standard manner with their reservoirs alongside containing fresh water. The muslin of one of the thermometers was thoroughly moistened at intervals with sea water, and as a result was found invariably to read higher than the other one, the difference for humidities, about the value 70 per cent., being as much as 1·3° F., and the effect a permanent one.* At this Observatory the Stevenson screen, in which the dry-bulb and wet-bulb thermometers are mounted, stands about 200 yards from a narrow estuary to the west, and about three miles from the open sea, so that the wet-bulb thermometer would be exposed to the effects of invisible spray carried by the wind off the sea, though visible spray has seldom been seen to fall on the thermometer screen, perhaps on three occasions in six years.

The probability of the ordinary wet-bulb thermometer being affected in a manner similar to that described in the experiment mentioned above is, of course, apparent, and it was with the object of investigating to what extent this occurs that the present inquiry was undertaken. A wet-bulb thermometer was fitted with a syphon wick and a muslin cap was lightly tied round the bulb of the thermometer, and then a few cotton threads were loosely twisted round the cap. The thermometer was set up in the Stevenson screen, so that whilst one end of the bundle of threads dipped into the ordinary reservoir, the other end passed through a tube and was attached to a small plummet about the level of the bottom of the screen. By means of capillary attraction water passed continually over the bulb and carried away any salt that may have fallen on it. Once a fortnight the muslin and threads of the wet-bulb thermometer used for the routine observations at the Observatory were removed, washed in rain water, and replaced, but the syphon wet-bulb thermometer was left untouched.

Simultaneous readings of the two thermometers were taken at one or more of the hours 7 h., 10 h., 13 h., 16 h., 18 h., and 21 h. on most days over a period of approximately a year, in all 683 observations. These were arranged in two classes :—

(1) Readings taken during a week prior to the washing of the threads and muslin ;

* *Meteorological Office Circular*, No. 5, p. 4.

(2) Readings taken during a week subsequent to the washing of the threads and muslin.

In each of these classes individual observations were grouped according to the readings of the ordinary wet-bulb thermometer, and the corresponding mean difference between the two thermometers was calculated. The two thermometers had been calibrated together, and the difference of their index errors had been estimated to ·01° F., so that suitable corrections could be applied to the readings. No systematic relation between the wet-bulb temperatures and the differences in question could be traced.

The result of the investigation may briefly be summarised thus:—

Let A be the temperature of the ordinary wet-bulb thermometer with clean muslin and wick, say, three days old; B, the corresponding temperature with muslin and wick 10 days old; S, the temperature of the syphon wet-bulb thermometer. Then on the average

$$S-A = 0{\cdot}021^\circ \text{ F.}$$
$$S-B = 0{\cdot}013^\circ \text{ F.}$$

Little importance is to be attached to the actual figures. The interesting point is the practically negligible difference between them. This is in marked contrast with the behaviour of the Richard hair hygrograph which is housed in a larger Stevenson screen adjoining the thermometer screen. This instrument has been found to be immediately affected by salt on the incidence of a westerly wind of force 5 or over, the error being as much as from 8 to 10 points with a humidity of 82 per cent.

Hence we see that with fortnightly washing of the muslin and threads of the wet bulb thermometer the effect of the salt in an impalpably fine condition in the air is negligible. On the other hand, salt which falls in visible spray has a deleterious effect, and the recommendation that muslin and wick should be washed or changed after the fall of such spray has occurred appears to be well justified.

Large Hailstones in New Zealand.

Mr. C. Mahoney of Ruatoki, New Zealand, reports that on Sunday, May 8th, he witnessed a thunderstorm at Raukokore. Torrents of rain were falling when there was a sudden vivid flash of lightning, and immediately from amidst the swaying, splashing shower there fell at intervals of a few feet extraordinary large hailstones. One of these stones was measured and found to be $1\frac{3}{8}$ inch long, $1\frac{1}{8}$ inch wide, and $\frac{3}{4}$ inch thick.

It was a mass of rugged, glittering ice. In the centre there was a white nucleus, softer than the outside and uncrystalline.

It is noted that the stones "pattered" on the roof of a verandah and did no serious damage. A possible explanation is that the hailstones were caught in a violent ascending current just before reaching the ground, and, therefore, fell with comparatively low velocity. Experience does not support a suggestion made by Mr. Mahoney that the hailstones were formed near the ground. They could only be formed in the cold upper portion of the squall cloud.

Radiation from the Sky.

RADIATION MEASURED AT BENSON, OXON, 1921.

Unit: one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays). Averages for Readings about time of Sunset.		June.	July.	Aug.	Sept.
Cloudless days:—					
Number of readings	n	..	..	..	7
Radiation from sky in zenith	πI	..	647	545	558
Total radiation from sky	J	..	684	610	635
Total radiation from horizontal black surface on earth.	X	..	860	776	775
Net radiation from earth	$X—J$	..	186	166	140
DIFFUSE SOLAR RADIATION (luminous rays). Averages for Readings between 9 h. and 15 h. G.M.T.					
Cloudless days:—					
Number of readings	n_0	..	..	..	7
Radiation from sky in zenith	πI_0	65	72	65	45
Total radiation from sky	J_0	58	70	60	48
Cloudy days:—					
Number of readings	n_1	..	..	..	20
Radiation from sky in zenith	πI_1	296	196	248	171
Total radiation from sky	J_1	250	160	216	151

Very few observations with a cloudless sky could be obtained in August and hence the means are not reliable.

Variation of Wind with Height at Ballybunion.

It was reported in the *Meteorological Office Circular*, No. 5,* that a series of observations of wind velocity at different heights on towers at the wireless station, Ballybunion, on the coast of County Kerry, had been made by Mr. S. P. Wing in 1915. An account of the experiments appeared in *The Electrician* of July 1st, 1921. Three Robinson anemometers were mounted at heights of 492 feet, 300 feet, and 15 feet. The determination of the wind velocity from the records appears to be reliable. The observations were compared with each other and with the geostrophic wind. The influence of the direction of the wind on the ratio of the velocity of the observed wind to that of the geostrophic wind is well marked, the ratio being greatest at all heights for northerly and easterly winds and least for southerly winds. This is somewhat surprising, as the south side appears to have had the best exposure. The ratio is, however, very variable, as is usual in such comparisons. The general conclusion is, that on an average the wind velocity increases with height and at a height of 500 feet is about 1·4 times that at 15 feet. The average ratio of the wind velocity at 500 feet to the geostrophic velocity is about 88 per cent.

The experiments were carried out with a view to designing wireless towers 750 feet in height in such a way as to prevent destruction by gales. It may be mentioned in this connection that the ground wind is a smaller fraction of the upper wind at inland stations than at coast stations; consequently in inferring the maximum wind force at a considerable height from the ground wind, a larger factor will be necessary than at Ballybunion.

Plant Diseases and Climatic Conditions.

The Report on the Occurrence of Insect and Fungus Pests on Plants in England and Wales for the year 1919, issued by the Ministry of Agriculture and Fisheries, contains a series of diagrams illustrating Temperature, Rainfall, and Sunshine. The first figure shows values of these elements for the four seasons Autumn 1918 to Summer 1919 at the six districts into which England and Wales are divided for the purpose. A diagram for each district follows, in which weekly values for January to December 1919 are shown. The series of diagrams forms a useful supplement to the Weekly Weather Report of the Meteorological Office.

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* See also Sir Napier Shaw's *Manual of Meteorology*, Part IV, Page 12.

It is interesting to note which attacks of, or periods of immunity from, disease are considered to be due to climatic conditions. The year 1918–19 was characterised by high rainfall in Autumn, Winter, and Spring—July also was very wet in many places—and by a dry warm spell from May to mid-June.

The dry spell is held responsible for extensive damage to root crops by flea-beetles and to potatoes by scab-fungus, but, on the other hand, the slightness of the attacks of black mould on wheat, American mildew on gooseberries, and wart disease on potatoes are also attributed to it.

The wet season, especially in December and January, caused great havoc among the potato clamps, causing excessive heating and decay.

The year 1919 was noteworthy for the small amount of blight on potatoes, except in the south-west of England and North Wales. Freedom from blight is usually attributed to a dry summer, but although July 1919 was very wet, East Anglia was almost free from attack. On the other hand, rainfall in Devon and Cornwall was very low but the blight very severe. It is suggested that the intensity of attack in these counties and in North Wales was due to the high atmospheric humidity.

The Unprecedented Drought—the Salisbury Plain Figures.

Mr. F. J. WARDALE, writing from Shrewton, Wilts, points out that the low rainfall of the last year at that place is unprecedented in his series of observations extending over 20 years, and that smaller totals have only been recorded at Chitterne, 5 miles distant, once in the long series of observations at that place. The figures are :—

12 months :—

Shrewton, August 1920—July 1921, 17·37 in.
Chitterne, November 1858—October 1859, 17·32 in.

13 months :—

Shrewton, August 1920—August 1921, 18·58 in.
Chitterne, November 1858—November 1859, 18·78 in.

The Chitterne gauge is 4 ft. above ground, and has no tube to the receiver, and Mr. Wardale writes :—

> " . . . if we add 4 per cent. for the former and a substantial amount for evaporation in such a dry spell on account of the latter defect, I think the record character of the recent drought will be fairly established as far as this district is concerned."

The Measurement of Snow.

CONSIDERABLE diversity of practice appears to exist among rainfall observers in the method of measuring unmelted snow which has accumulated in the funnel of the rain gauge. In some specially constructed gauges a hot water chamber is provided, but this is not common. When subjected to heat snow rapidly evaporates, and the longer the time occupied in the process of melting the greater is the loss on this account. The method most commonly employed is to carry the funnel containing the unmelted snow into the house and to stand it near a fire. This method is open to the objection already mentioned, and it has the further disadvantage that if snow or rain is still in progress whilst the gauge funnel is not in position, some of it is not recorded. Another method is to pour a measured quantity of hot water into the funnel in order to melt the snow, making an appropriate allowance when taking the reading. This involves a considerable risk of cracking the measuring glass by subjecting it to extremes of temperature, and also the occasional risk of forgetting to allow for the added water.

A method which is open to neither of these objections is to wrap a cloth which has been dipped into hot water round the funnel of the gauge whilst the funnel is still *in situ*: this melts the snow rapidly and effectively. The only precaution necessary is to see that no water drips from the cloth into the funnel.

The same method can be used in melting ice which has formed in the receiver of the gauge. In this case the receiver is removed and the hot cloth applied directly to it.

Meetings for the Discussion of Geophysical Subjects.

MEETINGS for the discussion of geophysical subjects will take place at the rooms of the Royal Astronomical Society, Burlington House, W. 1, on the first Fridays in November, December, February, March, and May next. In each case the meeting will commence at 5 p.m. Tea will be provided at 4.30.

The November discussion will deal with the Eötvös Gravity Balance, and will be opened by Col. H. G. Lyons. In December, Dr. H. Jeffreys will open a discussion on the geological effects of the cooling of the Earth. Full particulars of these and other discussions will appear in *Nature*. They may also be obtained on application to the Assistant Secretary of the Royal Astronomical Society.

Exceptional Weather in October.

DURING both the day and the night very high temperature readings were recorded at the beginning of October at several London stations. At Kew, 80° F. and over was recorded several times, the highest reading being 83° F. (north-wall screen) on October 6th. The previous record during 50 years was 77° F. on October 4th, 1886. Minimum temperatures of 60° F. and over occurred on several nights. The highest was 62° F. (north wall screen) on the 3rd. The significance of this may be gathered when it is considered that the mean absolute maxima for October at Kew is 66° F.

The Quest.

SIR ERNEST Shackleton's ship the *Quest* left London for a voyage of exploration in the Southern Ocean on September 17th, 1921. In addition to the usual meteorological instruments the *Quest* was furnished by the Meteorological Office with equipment for the observations of pilot balloons by day and by night, and with Marvin meteorographs for the recording of upper air temperatures: the meteorographs are to be carried by kites.

Audibility of the Oppau Explosion in England.

A NOTICE has been inserted in the Press asking for particulars from persons who believe they heard the explosion at Oppau, near Mannheim, on September 21st. Many letters have been received in reply to this request, and further particulars will appear in the next number of the *Meteorological Magazine.*

Smoke-Rings formed by an Aeroplane.

ON the evening of September 3rd, the attention of many people in North London was drawn to a curious appearance in the sky of luminous rings. One correspondent refers to them as "oblong hoops of light, cloudy mist," with a "bright silvery" appearance; another speaks of "bright streaks" and "circles of light." It was not realised by many that these "rings" were formed by an aeroplane, as the machine itself was not visible from some places. The air on the night in question was very still, so that the smoke-rings persisted for some time.

Meteorological Stations.

Woking.—With the exception of the record of rainfall, the climatological observations made at Knapp Hill, Woking, since 1908 have, unfortunately, to be discontinued. Captain E. R. Taylor established a station in 1895 at Pirbright Camp and transferred it to Knapp Hill in 1908. Mr. G. C. H. Simmonds has been the observer for the whole period. The observations have been utilised in the *Monthly Weather Report* since 1911.

Obituary.

George Walker Walker, A.R.C.Sc., M.A., F.R.S., formerly Superintendent of Eskdalemuir Observatory, died in University College Hospital on September 6th, 1921, at the age of 47, after a short illness.

After a brilliant academic career Walker was elected Fellow of Trinity College, Cambridge, in 1900, and appointed lecturer in Physics at Glasgow University. While holding that appointment he suffered from nervous breakdown and had to give up work for a time. In 1908 he was invited to accept the post of Superintendent of the new observatory then being built at Eskdalemuir for the National Physical Laboratory.

Walker was an enthusiastic and original worker and, in the four years during which he held the appointment, the scope of the Observatory developed rapidly, the transfer of the observatory to the administration of the Meteorological Office occurring in the middle of the period. Unfortunately, his health again became precarious at the end of 1912 and he had to resign his post. His most notable subsequent work was the magnetic re-survey of the British Isles, for the Royal Society. At the time of his death he was chief Scientist to the Royal Naval Training School, Portsmouth.

Walker's published work includes numerous papers on magnetics and on molecular physics. His book, *Modern Seismology*, published in 1913, which expresses his experience at Eskdalemuir, contains the standard account of seismological instruments.

Dr. Francis Edward Carey of Villa Carey, Guernsey, who died on October 1st at the great age of 86, was a remarkable figure among the many quietly unobtrusive meteorological observers who have made the standard of voluntary recording in this country so high. Dr. Carey came from a distinguished Guernsey family, and would undoubtedly have made a great name as a medical man but for his devotion to the island of his birth which he could never be brought to leave for any length of time. He commenced meteorological observations in St. Peter Port in 1880, and for more than 40 years maintained a daily register of sunshine, temperature and rainfall, taking the readings personally to the last in spite of his great age.

Review.

Bibliotheca Chemico-Mathematica: catalogue of works in many tongues on exact and applied science, with a subject index. Compiled and annotated by H.Z. and H.C.S. 2 vols. 127 pl. London: Sotheran & Co., 1921. Price, 3*l.* 3s.

THERE are few pleasanter ways of passing a spare half-hour than in turning over the pages of old scientific books, picking out the curious illustrations, and noting the development of ideas. Such pleasures are given in full measure by the catalogue of the scientific literature on their shelves which has been issued by Messrs. Sotheran in two handsome volumes. Looking at the catalogue as a price list from the meteorologist's point of view, it is of interest to notice that a set of the *Daily Weather Report* covering 22 years from 1872 is offered for 16 guineas; the publications of the *Royal Meteorological Society* for 46 years are offered for 15*l.*; and 30 volumes of *Symons's Meteorological Magazine* for 2 guineas. Amongst the illustrations are found pictures from very rare books; we may cite that of the first idea of a parachute, described by Veranzio, a Hungarian bishop, in a work published in 1595, and that of the first electric telegraph set up in 1816 by Sir Francis Ronalds, afterwards the first Superintendent of Kew Observatory for the British Association. The original picture of the wheel-barometer, invented by Robert Hooke, is reproduced from his work *Micrographia*, dated 1665.

From sundry bibliographical notes we learn that Turnor's *Astra Castra—Experiments and Adventures in the Atmosphere*, contains the best account of ballooning between 1783 and 1848, with the meteorological observations during the ascents, that the properties of the black bulb thermometer were discovered by Richard Watson in the middle of the 18th century, and that the first discovery of a freezing mixture was described by John Bate in *The Mysteryes of Nature and Art* in 1634, though credit for the invention is usually given to Robert Boyle, whose experiments were 33 years later.

Amongst Robert Boyle's own works one of the most inviting titles is *A Sceptical Dialogue about the Positive or Privative Nature of Cold.* Surely the invention of an absolute scale of temperature must have been foreshadowed.

In the index we find about 50 entries under *Meteorology*, but there are also about 30 for *Early Works on Meteorology*, three for *History of Meteorology* as well as cross references to *Air*, *Barometry*, *Climatology*, *Clouds*, *&c.*, *&c.* Following up the cross reference to *Dew, Theory of*, we find six works. Of these the most important is Wells's *Essay on Dew* which is to be had in the first edition for 2 guineas, but the others include Hamilton's *Essays* of 1772, about which the note runs: "Interesting for containing the Author's theory of dew and evaporation 'proceeding on a principle very different from any that has hitherto been used on this occasion, whereby I shall avoid those objections which later writers have made to the former accounts that have been given us of these Phænomena.'—Preface. It was unknown to G. J. Symons, F.R.S." Of Pictet's *Essay on Fire*, 1791, it is stated "The author found in the above work an explanation of the formation of dew by which he was able to explain a dew maximum on clear nights. His theory was completed in 1811 by Dr. W. C. Wells." Another of the references is to Prévosts *Du Calorique Rayonnant*, famous for the author's Theory of Exchanges and valuable "as having to some extent anticipated the theories of Dr. Wells."

Credit for the preparation of the Bibliotheca Chemico-Mathematica is given by his fellow compiler Mr. H. C. Sotheran to Heinrich Zeitlinger "an equal well-wisher of learning and of England." Both are to be thanked for a notable service to Science. F. J. W. W.

News in Brief.

The death on October 1st, 1921, is announced of *Dr. Julius von Hann*, of Vienna, in his 83rd year. The news will be received by meteorologists with deep regret.

The Report of morning observations at Health Resorts, which has been issued daily during the past summer, was discontinued after September 30th.

On September 27th, the "Further Outlook" of the *Daily Weather Report* included a forecast of fine weather for seven or ten days ahead, and on the 28th it was stated that the break-up of the conditions ensuring the fine spell was unlikely to occur within a fortnight. This is the longest range on record for an official forecast in this country.

A report from Dayton, Ohio, states that on September 28th Lieutenant John Macready broke the world's record for high flying. The reading of his altimeter reached 40,800 feet when his engine gave out and forced him to descend. Ice formed on the oxygen tank at 39,000 feet. Further details of this ascent are awaited with interest.

The Weather of September, 1921.

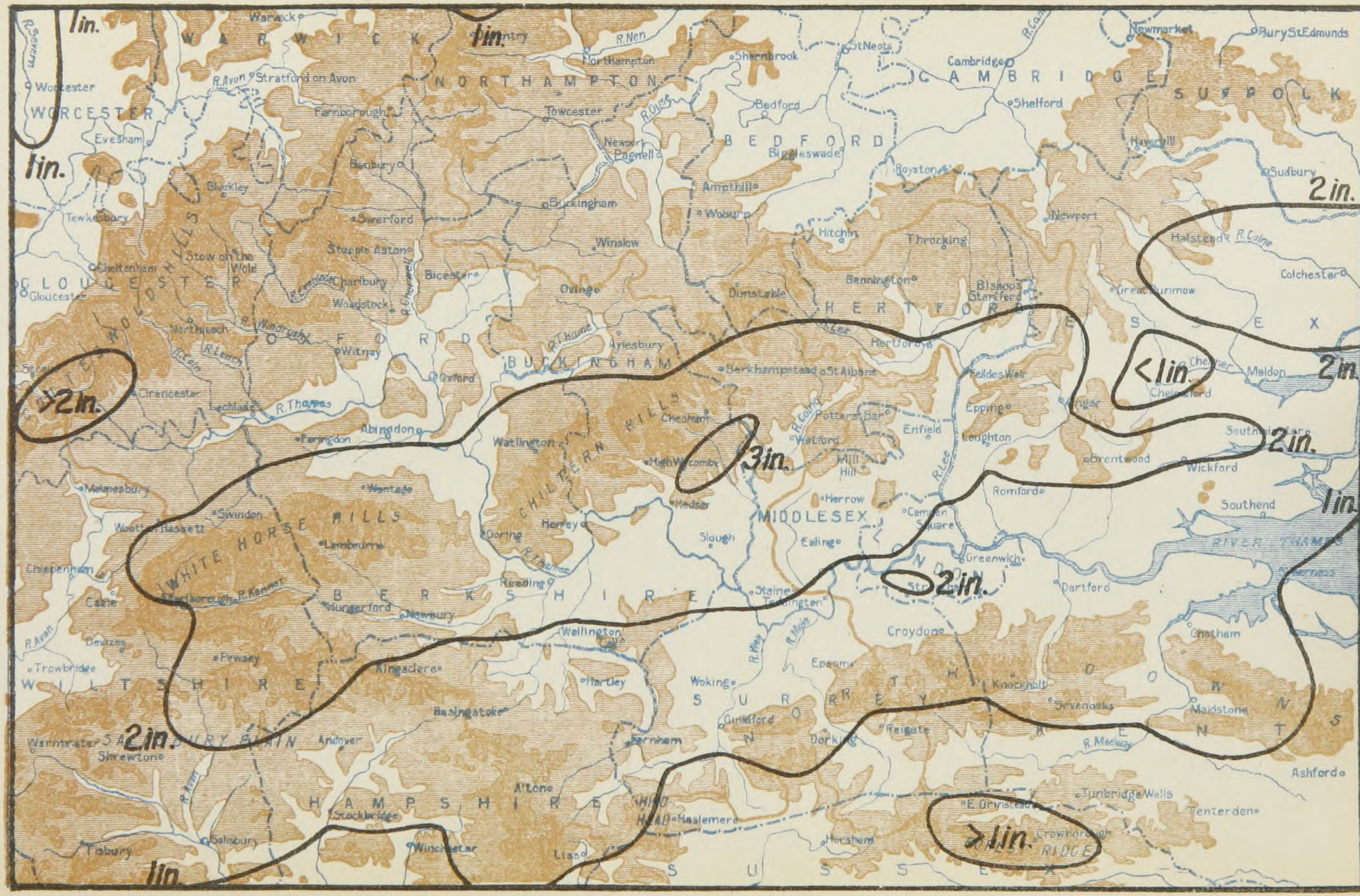
THROUGHOUT the greater part of September pressure was high over the British Isles and Southern Europe so that the month was, in the main, fine, warm and dry. At the end of August there was a depression off the west of Ireland, and as this depression moved towards the Baltic there were heavy local rains with some thunderstorms in northern districts. On the 4th a fresh depression appeared off Iceland and a shallow "low" covered Central Europe.

The southern districts, however, experienced fine weather from the 4th of the month; high day temperatures were recorded, 80° F. being general over south and south-east England, France and Spain. In England there was morning mist and the nights were often cold, ground frost occurred locally on the 4th and at inland stations the daily range at times exceeded 40° F.

The anticyclone over these southern districts began slowly to withdraw eastwards, from the 7th, while the Icelandic depression deepened and spread southwards. On the 9th, the temperature again exceeded 80° F. generally in England, France, Germany and Holland and local thunderstorms were experienced. In south and south-east England the night of the 9th–10th was unusually warm, temperature remaining over 60° F. generally, but the following day there was a very marked drop in temperature amounting to 15° or 18°. The northerly current did not reach as far as France or Germany, however, and in those countries temperature remained high on this day.

On the 11th a very deep secondary appeared to the south of Ireland. It passed rapidly up the Channel causing heavy gales and severe thunderstorms over a large area. London received 50 mm. of rain, Belfast 70 mm. and Berne 60 mm. This was the only occasion during the month when there was heavy precipitation in the British Isles outside the more northerly districts. From the 12th to the 17th a series of depressions occurred. One off the west of Ireland brought further rain to that country and gales again in the Channel. Another was in the neighbourhood of the Azores on the 14th and yielded heavy rain—80 mm. being reported from Madeira and 60 mm. from Ponta Delgada; while on the 16th and 17th a shallow depression moving northwards from Spain caused strong easterly gales in the Channel and a thunderstorm at Jersey with 22 mm. of rain.

THAMES VALLEY RAINFALL —— SEPTEMBER, 1921.



Watershed of River Thames above Teddington, and River Lee above Feildes Weir.

Isohyetals.

ALTITUDE SCALE

Below 250 feet	250 to 500 feet	500 to 1000 feet	Above 1000 feet

SCALE OF MILES 0 5 10 15 20

H.M. Stationery Office Press, Kingsway W.C.2.
Ps.3336/347. Wt.26. D.P.15. 1250. 10/21.

On the morning of the 18th pressure rose to 1040 mb. over the Skagerrak and by the 20th the conditions over England and Europe generally were anticyclonic, the area of high pressure being very large and stretching from Russia to beyond the west coast of Ireland. Occasional depressions in the neighbourhood of Iceland passed to the north of the British Isles but fair, quiet weather prevailed until the end of the month. Morning mist and fog were prevalent, especially in south and south-east England, and on the 19th a dense low gloom was experienced over a wide area, in London continuing nearly all day, while on the 22nd thick fog was experienced all day at Scilly and Pembroke. Otherwise, the days were warm and sunny, the nights cold and sometimes frosty. In England ground frosts were reported locally towards the end of the month, and in Scandinavia the night of the 20th was characterised by a sharp frost.

Very heavy rain fell during the 17th to 19th over the Department of Corrèze, France. Severe floods resulted, and the Murat viaduct was swept away.

The olive harvest in the districts of Languedoc and Provence was the finest for many years as a result of the hot summer and subsequent rainfull.

A thunderstorm of exceptional violence broke over Rome on the evening of the 22nd and on the next day a violent storm visited Sicily doing considerable damage, especially at Syracuse and Palermo, both to vessels and on shore. These storms were associated with a very irregular distribution of the isobars to the east of, and between, a region of low pressure over Southern Spain and Northern Africa, and a region of high pressure over Southern England and Northern France.

In South Africa the worst blizzard for many years was experienced between the 8th and the 10th. Railway and other services were disorganized.

The Indian monsoon was weak at the beginning of the month, but a message dispatched from Simla on the 21st stated that owing to recent rain all anxiety as regards the monsoon in Bombay and the Deccan had been removed.

Heavy rain and snow stopped all harvesting operations in Saskatchewan early in the month, and Manitoba also had heavy rain but without frost. On the last day of the month a very severe storm passed over Ontario and Quebec with much resulting damage to property.

There has been excellent rain throughout the settled areas of South Australia and many districts anticipate a record harvest.

(*Continued on p.* 276.)

Rainfall Table for September 1921.

STATION.	COUNTY.	Aver. 1881—1915.	1921.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days.
		in.	in.	mm.		in.	Date.	
Camden Square	*London*	1·82	2·50	63	137	1·95	11	6
Tenterden (View Tower)	*Kent*	2·14	·62	16	29	·47	11	
Arundel (Patching Farm)	*Sussex*	2·40	·72	18	30	·66	11	4
Fordingbridge (Oaklands)	*Hampshire*	2·15	·91	23	42	·72	11	8
Oxford (Magdalen College)	*Oxfordshire*	1·68	1·67	42	99	1·09	11	8
Wellingborough (Swanspool)	*Northampton*	1·80	1·03	26	57	·55	11	5
Hawkedon Rectory	*Suffolk*	1·93	1·45	37	75	·97	11	4
Norwich (Eaton)	*Norfolk*	2·14	1·31	33	61	·68	11	8
Launceston (Polapit Tamar)	*Devon*	2·80	1·37	35	49	·41	17	9
Sidmouth (Sidmount)	„	2·30	·61	15	..	·51	11	5
Ross (County Observatory)	*Herefordshire*	2·02	1·60	41	79	1·04	11	7
Church Stretton (Wolstaston)	*Shropshire*	2·03	·84	21	41	·34	12	7
Boston (Black Sluice)	*Lincoln*	1·76	·68	17	39	·37	12	7
Worksop (Hodsock Priory)	*Nottingham*	1·52	·61	16	40	·22	12	6
Mickleover Manor	*Derbyshire*	1·79	1·17	30	65	·58	12	6
Southport (Hesketh Park)	*Lancashire*	2·75	1·83	47	67	·43	13	9
Harrogate (Harlow Moor Ob.)	*York, W. R.*	1·92	·92	23	48	·38	13	9
Hull (Pearson Park)	*„ E. R.*	1·72	·61	15	35	·30	13	5
Newcastle (Town Moor)	*North'land*	2·04	1·17	30	57	·80	13	8
Borrowdale (Seathwaite)	*Cumberland*	9·92	3·25	83	33	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	3·10	3·50	89	113	1·22	11	9
Haverfordwest (Gram. Sch.)	*Pembroke*	3·55	1·82	46	51	1·05	12	6
Aberystwyth (Gogerddan)	*Cardigan*	3·64	1·74	44	48	·72	11	5
Llandudno	*Carnarvon*	2·28	1·89	48	83	·90	11	8
Dumfries (Cargen)	*Kirkcudbrt.*	2·94	2·25	57	77	1·11	13	10
Marchmont House	*Berwick*	2·41	·48	12	20	·21	1	5
Girvan (Pinmore)	*Ayr*	3·83	2·74	70	72	·92	13	16
Glasgow (Queen's Park)	*Renfrew*	2·77	2·06	52	74	·67	13	11
Islay (Eallabus)	*Argyll*	4·18	2·54	65	61	·49	10	18
Mull (Quinish)	„	4·79	3·47	88	72	·42	13	23
Loch Dhu	*Perth*	5·73	4·70	119	82	1·70	10	11
Dundee (Eastern Necropolis)	*Forfar*	2·08	1·71	43	82	·86	13	13
Braemar (Bank)	*Aberdeen*	2·52	1·18	30	47	·45	13	9
Aberdeen (Cranford)	„	2·34	1·09	28	47	·40	13	13
Gordon Castle	*Moray*	2·50	1·18	30	47	·15	12*	14
Fort William (Atholl Bank)	*Inverness*	6·28	5·49	139	87	·95	10	22
Alness (Ardross Castle)	*Ross*	2·92	1·65	42	54	·31	1	19
Loch Torridon (Bendamph)	„	6·95	5·38	137	77	1·01	10	19
Stornoway	„	3·95	4·64	118	117	1·22	3	22
Loch More (Achfary)	*Sutherland*	5·75	8·66	220	151	3·32	3	24
Wick	*Caithness*	2·50	3·18	81	127	·89	15	21
Glanmire (Lota Lodge)	*Cork*	2·80	1·20	31	43	·43	9	8
Killarney (District Asylum)	*Kerry*	3·58	1·88	48	52	·52	11	13
Waterford (Brook Lodge)	*Waterford*	2·77	1·26	32	45	·53	9	7
Nenagh (Castle Lough)	*Tipperary*	2·81	1·72	44	61	·43	12	13
Ennistymon House	*Clare*	3·85	2·91	74	76	·72	13	12
Gorey (Courtown House)	*Wexford*	2·47	1·01	26	41	·40	12	7
Abbey Leix (Blandsfort)	*Queen's Co.*	2·72	1·65	42	61	·50	9	8
Dublin (FitzWilliam Square)	*Dublin*	1·92	1·33	34	69	·61	12	7
Mullingar (Belvedere)	*Westmeath*	2·67	1·08	27	40	·90	12	7
Woodlawn	*Galway*	3·10	1·91	49	62	·67	13	16
Crossmolina (Enniscoe)	*Mayo*	3·92	1·49	38	38	·33	12	15
Collooney (Markree Obsy.)	*Sligo*	3·39	1·42	36	42	·34	19	12
Seaforde	*Down*	2·75	1·69	43	61	·89	13	6
Ballymena (Harryville)	*Antrim*	3·11	1·53	39	49	·44	12	16
Omagh (Edenfel)	*Tyrone*	3·05	1·59	40	52	·52	13	11

* *Also* 13 *and* 14.

Supplementary Rainfall, September 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	·63	16
,,	Sevenoaks, Speldhurst	1·21	31
,,	Hailsham Vicarage	·58	15
,,	Totland Bay, Aston	·71	18
,,	Ashley, Old Manor Ho.	·94	24
,,	Grayshott	·94	24
,,	Ufton Nervet	2·33	59
III.	Harrow Weald, Hill Ho.	2·62	67
,,	Pitsford, Sedgebrook	1·14	29
,,	Chatteris, The Priory	·78	20
IV.	Elsenham, Gaunts End	1·84	47
,,	Lexden, Hill House	2·69	68
,,	Aylsham, Rippon Hall	·95	24
,,	Swaffham	1·14	29
V.	Devizes, Highclere	1·83	47
,,	Weymouth	·71	18
,,	Ashburton, Druid Ho.	1·20	30
,,	Cullompton	·94	24
,,	Hartland Abbey	2·30	58
,,	St. Austell, Trevarna	1·13	29
,,	North Cadbury Rec.	1·39	35
,,	Cutcombe, Wheddon Cr.	2·90	74
VI.	Clifton, Stoke Bishop	4·07	103
,,	Ledbury, Underdown	1·21	31
,,	Shifnal. Hatton Grange	·54	14
,,	Ashbourne, Mayfield	1·18	30
,,	Barnt Green, Upwood	·99	25
,,	Blockley, Upton Wold	1·70	43
VII.	Grantham, Saltersford	·56	14
,,	Louth, Westgate	·47	12
,,	Mansfield, West Bank	·89	23
VIII.	Nantwich, Dorfold Hall	·73	19
,,	Bolton, Queen's Park	1·35	34
,,	Lancaster, Strathspey	2·21	56
IX.	Rotherham	..	..
,,	Bradford, Lister Park	1·13	29
,,	West Witton	..	..
,,	Scarborough, Scalby	1·11	28
,,	Middlesbro', Albert Pk.	·63	16
,,	Mickleton	1·40	36
X.	Bellingham	1·88	48
,,	Ilderton, Lilburn	1·44	37
,,	Orton	2·49	63
XI.	Llanfrechfa Grange	2·68	68
,,	Treherbert, Tyn-y-waun	4·79	122
,,	Carmarthen Friary	2·10	53
,,	Llanwrda, Dolaucothy	2·61	66
,,	Lampeter, Falcondale	1·86	47
,,	Cray Station	3·50	89
,,	B'ham W.W., Tyrmyndd	1·80	46
,,	Lake Vyrnwy	2·31	59
,,	Llangynhafal, P. Drâw	·72	18
,,	Oakley Quarries	4·43	113
,,	Dolgelly, Bryntirion	2·45	62
,,	Lligwy	1·53	39
XII.	Stoneykirk, Ardwell Ho.	1·82	46
,,	Carsphairn, Shiel	3·73	95
XII.	Langholm, Drove Rd.	2·32	59
XIII.	Ettrick Manse	2·98	76
,,	North Berwick Res.	1·39	35
,,	Edinburgh, Royal Ob.	1·60	41
XIV.	Biggar	1·52	39
,,	Leadhills	2·88	73
,,	Maybole, Knockdon	..	..
XV.	Dougarie Lodge	2·29	58
,,	Inverary Castle	6·76	172
,,	Holy Loch, Ardnadam	4·03	102
XVI.	Loch Venachar	3·05	77
,,	Glenquey Reservoir	3·00	76
,,	Loch Rannoch, Dall	2·15	55
,,	Blair Atholl Gardens	1·81	46
,,	Coupar Angus	1·95	49
,,	Montrose Asylum	1·24	31
XVII.	Logie Coldstone, Loanh'd	·97	25
,,	Fyvie Castle	1·30	33
,,	Grantown-on-Spey	1·27	32
XVIII.	Cluny Castle	2·65	67
,,	Loch Quoich, Loan	14·40	366
,,	Fortrose	6·7	17
,,	Faire-na Squir	5·50	140
,,	Skye, Dunvegan	3·58	91
,,	Glencarron Lodge	6·85	174
,,	Dunrobin Castle	1·94	49
XIX.	Tongue Manse	4·59	117
,,	Melvich Schoolhouse	3·98	101
XX.	Dunmanway Rectory	2·74	70
,,	Mitchelstown Castle	1·94	49
,,	Gearahameen	3·90	99
,,	Darrynane Abbey	1·49	38
,,	Clonmel, Bruce Villa	1·47	37
,,	Cashel, Ballinamona	1·61	41
,,	Roscrea, Timoney Pk.	1·27	32
,,	Foynes	1·74	44
,,	Broadford, Hurdlesto'n	2·09	53
XXI.	Kilkenny Castle	1·31	33
,,	Rathnew, Clonmannon	1·26	32
,,	Hacketstown Rectory	1·44	37
,,	Balbriggan, Ardgillan	1·54	39
,,	Drogheda	1·44	37
,,	Athlone, Twyford	1·46	37
XXII.	Castle Forbes Gdns.	1·40	36
,,	Ballynahinch Castle	1·63	41
,,	Galway Grammar Sch.	1·99	51
XXIII.	Westport House	1·83	47
,,	Enniskillen, Portora	1·40	36
,,	Armagh Observatory	1·24	31
,,	Warrenpoint	1·55	39
,,	Belfast, Cave Hill Rd.	1·78	45
,,	Glenarm Castle	1·69	43
,,	Londonderry, Creggan	1·85	47
,,	Sion Mills	1·42	36
,,	Milford, The Manse	1·73	44
,,	Narin, Kiltoorish	1·99	51
,,	Killybegs, Rockmount	2·47	63

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	° F.		° F.		° F.	° F.	° F.	° F.
London, Kew Observatory	1020·0	+6·1	70	28	32	20	56·8	39·7	48·3	+1·0
Gibraltar	1015·2	−0·1	74	24, 30	48	1, 10	67·1	53·2	60·1	−0·7
Malta	1011·7	−0·8	65	20	51	4, 7	62·9	52·0	57·5	−2·2
Sierra Leone	1011·2	+0·2	94	11	68	2, 7, 11	89·9	71·8	80·9	−1·9
Lagos, Nigeria	1011·2	+1·4	99	16	72	16	84·1	76·9	80·5	−1·8
Kaduna, Nigeria	1012·8	+4·5	102	1	64	24	92·0	71·3	81·7	−0·8
Zomba, Nyasaland	1013·2	+1·3	83	5, 24	53	28	76·7	60·3	68·5	−0·8
Salisbury, Rhodesia	1013·3	−1·1	82	1, 2	46	27	78·1	53·6	65·9	0·0
Cape Town	1016·4	+0·1	94	18	40	27	74·3	53·4	63·9	+0·8
Johannesburg	1017·6	+0·9	74	13	40	24	68·5	49·6	59·1	−0·5
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	78	18	35	28	71·4	48·4	59·9	−0·9
Calcutta, Alipore Obsy.	1007·0	+0·7	101	1	71	22	94·4	76·2	85·3	−0·4
Bombay	1008·3	−0·3	96	29	75	1	90·9	78·9	84·9	+1·8
Madras	1008·4	+0·2	96	22, 23	73	17	92·5	78·2	85·4	+0·1
Colombo, Ceylon	1009·9	+0·8	90	28	73	5	87·9	75·5	81·7	−1·0
Hong Kong	1013·3	+0·7	85	27	61	8	76·4	68·7	72·5	+1·6
Sydney	1018·7	+0·4	84	15	51	11	73·5	58·8	66·1	+1·7
Melbourne	1019·4	+0·3	82	3, 14	41	27	69·4	50·8	60·1	+0·6
Adelaide	1020·5	+0·7	86	29	49	10	74·2	54·6	64·4	+0·6
Perth, Western Australia	1020·2	+1·8	87	12	49	20	76·2	57·1	66·7	+0·4
Coolgardie	1019·2	+0·7	96	18	45	21	80·1	53·6	66·9	+1·8
Brisbane	1017·7	+0·4	86	7	57	21	78·0	63·2	70·6	+0·2
Hobart, Tasmania	1015·1	+0·7	76	14	40	6, 9	64·0	47·8	55·9	+0·8
Wellington, N.Z.	1018·5	+0·7	69	9	37	28	62·0	47·1	54·5	−2·3
Suva, Fiji	1012·6	+2·0	89	17	68	16	85·8	71·6	78·7	0·0
Kingston, Jamaica	1014·8	+0·5	91	1	67	28	86·8	69·9	78·3	−0·1
Grenada, W.I.	1013·2	+0·6	87	14	71	Sev.	83·8	72·9	78·3	−0·5
Toronto	1016·4	+0·9	75	5	26	1	58·3	40·3	49·3	+7·9
Winnipeg	1015·3	−1·7	70	18	16	8	47·5	28·8	38·1	+0·3
St. John, N.B.	1018·6	+5·0	75	28	20	7	49·7	34·7	42·2	+3·2
Victoria, B.C.	1018·1	+0·8	66	9	32	3	53·1	40·0	46·5	−1·2

LONDON, KEW OBSERVATORY.—Mean speed of wind 8·0 mi/hr., 3 days with snow, 2 days with hail, 4 days with thunder heard, 5 days with fog.

MALTA.—Prevailing wind direction NW, mean speed 10·7 mi/hr.

GIBRALTAR.—2 days with thunder heard.

SIERRA LEONE.—Prevailing wind direction SW, 5 days with thunder heard.

MAURITIUS :—

November 1920	1015·4	−0·7	86	..	60	..	82·6	66·6	74·6	−0·9
December 1920	1014·2	+0·2	90	29	64	5	84·6	71·1	77·9	−0·4
Year 1920	1016·2	+0·1	91	Jan.20	52	July28	80·0	66·5	73·2	−0·8

November.—Prevailing wind direction E, mean speed 8·2 mi/hr.
December.—Prevailing wind direction E, mean speed 8·0 mi/hr.

British Empire, April 1921.

Temperature: Mean Wet Bulb °F.	Temperature: Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	Precipitation: Amount in.	Precipitation: Amount mm.	Precipitation: Diff. from Normal mm.	Precipitation: Days	Bright Sunshine: Hours per day	Bright Sunshine: Percentage of possible	Stations
45·0	22	69	4·9	1·06	27	− 10	7	6·5	47	London, Kew Observatory.
55·8	45	76	3·5	2·94	75	+ 7	5	..	..	Gibraltar.
..	..	79	5·8	2·41	61	+ 41	5	6·8	52	Malta.
75·9	..	69	4·5	1·45	37	− 68	5	..	..	Sierra Leone.
80·5	63	83	7·5	4·81	122	− 27	13	..	..	Lagos, Nigeria.
74·3	..	80	..	4·05	103	+ 35	5	..	..	Kaduna, Nigeria.
..	..	87	6·1	5·22	133	+ 28	13	..	..	Zomba, Nyasaland.
58·5	42	61	4·6	0·62	16	− 10	6	..	..	Salisbury, Rhodesia.
58·4	..	64	4·2	1·50	38	− 13	6	..	..	Cape Town.
51·4	35	71	4·7	0·72	18	− 34	7	8·3	73	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
53·1	..	78	4·1	2·05	52	− 2	8	..	..	Bloemfontein.
79·1	64	56	2·4	2·85	72	+ 28	8	..	..	Calcutta, Alipore Obsy.
77·6	67	68	1·7	0·00	0	− 2	0	..	..	Bombay.
78·3	..	77	4·5	1·99	51	+ 36	5	..	..	Madras.
78·7	70	71	6·5	8·97	228	− 24	22	..	..	Colombo, Ceylon.
68·0	..	81	8·1	2·82	72	− 68	5	4·2	33	Hong Kong.
62·5	45	75	5·1	5·77	147	+ 8	8	5·5	49	Sydney.
55·8	37	65	5·5	0·60	15	− 43	10	..	..	Melbourne.
56·5	34	55	4·6	0·45	11	− 36	5	6·3	57	Adelaide.
60·7	39	60	3·5	0·83	21	− 20	4	..	..	Perth, Western Australia.
59·7	38	45	3·3	0·16	4	− 20	1	..	..	Coolgardie.
66·5	54	75	4·6	8·06	205	+112	20	..	..	Brisbane.
50·0	34	64	6·1	1·43	36	− 12	13	5·4	50	Hobart, Tasmania.
50·0	27	71	5·6	1·41	36	− 63	7	6·1	56	Wellington, N.Z.
73·2	..	85	..	25·62	651	+364	19	..	..	Suva, Fiji.
..	..	73	6·2	1·71	43	+ 12	9	..	..	Kingston, Jamaica.
73·1	..	71	4·4	1·82	46	− 14	13	..	..	Grenada, W.I.
43·7	23	77	4·8	4·89	124	+ 63	11	..	..	Toronto.
34·2	..	77	4·4	1·86	47	+ 9	8	..	..	Winnipeg.
37·7	19	83	6·3	4·39	112	+ 23	17	..	..	St. John, N.B.
42·1	26	75	6·0	1·13	29	− 15	13	..	..	Victoria, B.C.

MADRAS.—4 days with thunder heard.

COLOMBO, CEYLON.—Prevailing wind direction SW; mean speed 3·7 mi/hr; 4 days with thunder heard.

HONG KONG.—Prevailing wind direction E; mean speed 10·6 mi/hr; 1 day with thunder heard, 5 days with fog.

GRENADA.—Prevailing wind direction E.

										MAURITIUS :—
..	..	68	5·3	0·41	10	− 30	8	9·5	73	November 1920.
..	60	71	5·9	2·08	53	− 67	18	8·8	66	December 1920.
..	63	75	6·0	50·37	1279	+ 18	228	7·7	64	Year 1920.

Year.—Prevailing wind direction ESE; mean speed 7·8 mi/hr; 13 days with thunder heard.

During the middle of the month warm and dry weather prevailed over the cotton belt of the United States, but the crop shows further deterioration. On the 10th a severe flood destroyed a large part of San Antonio, Texas, with heavy loss of life.

A typhoon passed over Western Honshin (Japan) about the 27th with much damage to property and loss of life.

The rainfall of the month was below the average over practically the whole of the British Isles. Less than half the average occurred south of a line from roughly Launceston to Canterbury, and over the greater part of England and Wales north of a line from near Aberystwyth to the Wash. More than the average occurred in the extreme south of Wales and over most of the Thames Valley. In Scotland less than half the average fell along the east coast, while in the extreme north-west more than the average fell. Less than 50 per cent. occurred in Ireland along the north-west and south coasts. The rainfall in Ireland nowhere reached the average, approaching it most closely in the central plain. Areas with less than 25 mm. (1 in.) were confined almost entirely to England, especially along the south and east coasts, and on the Welsh border. In south Midlands more than 50 mm. (2 in.) fell over a broad band from Marlborough to Felixstowe, mainly as a result of the thunderstorm of the 11th when from 25–50 mm. (1–2 in.) fell over practically the whole of the Thames Valley. More than 100 mm. (4 in.) for the month fell locally in the wet districts of Wales, the English Lake District and the mountains of Kerry, but in Scotland the area with 4 in. was considerable, stretching from Dumbarton to Cape Wrath. More than 250 mm. (10 in.) occurred at Loch Quoich. On the 3rd heavy rain fell locally in the north-west of Scotland as much as 84 mm. (3·32 in.) being registered at Loch More (Achfary).

For the eight months February to September a considerable area in the south-east of England has had less than half the average rainfall. At Patching near Arundel only 44 per cent. of the average of this period fell.

The general rainfall for September, expressed as a percentage of the average, was:—England and Wales, 54; Scotland, 81; Ireland, 53; British Isles, 64.

In London (Camden Square) the mean temperature was 60·5° F., or 2·8° F. above the average. This was the thirteenth successive month with mean temperature in excess of the average of the 60 years 1860–1919. Duration of rainfall, 20·0 hours; evaporation, 1·72 inches.

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Audibility of the Oppau Explosion in England.

A GREAT explosion took place at the works of the Badische Anilin und Sodafabrik at Oppau, at 7 h. 32 m. Central European Time, on the morning of September 21st last. Oppau is situated in the Bavarian Palatinate, about 3 miles north-west of Mannheim. It is clear from statements in the Press that the destruction caused in Mannheim was considerable, and that the shock was felt in Munich, 175 miles away. From Oppau to Dover is only twice as far, and it therefore seemed possible that the sound produced by the explosion might have been sufficiently loud to be heard in England.

The audibility of explosions at great distances has been discussed by several writers. It often happens that the region in which the sound is audible is composed of two or more parts, separated from one another by a region in which it is certain that no sound was heard. Sometimes, again, there is an isolated region of silence in the middle of a region of audibility. The chief suggested explanations of these phenomena are those of Fujiwhara and von dem Borne. Fujiwhara's theory is that the velocity of the wind is the controlling factor. If we suppose the wind is from the east and increases in velocity with height, and consider sound waves propagated in a westerly direction, we see that the upper parts of the wave-fronts travel faster than the lower and consequently the wave-fronts tend to lean forward. Thus

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the sound is propagated in the lower layers of the atmosphere. On the other hand, if the wave is travelling towards the east, the wind distribution being the same, the sound travels fastest near the ground, and is therefore soon refracted upwards out of hearing. Hence, in such a case the region of audibility that surrounds the source would extend further to the west than to the east. If, however, there is a west wind above the east wind, the sound on the eastern side will be refracted down again when it reaches this wind, and there will be an isolated region of audibility to the east of the first. Fujiwhara has shown that in many cases of audibility at long distances the distribution of the sound can be accounted for by plausible assumptions about the vertical distribution of the wind at the time. To decide the question finally, however, it is necessary to have independent evidence about the vertical distribution of the wind, and hitherto the comparison has not been available.

On von dem Borne's theory, the effect is to be ascribed principally to the propagation of sound at much greater heights, where lighter gases predominate over nitrogen and oxygen. The velocity of sound is greater in hydrogen and helium, and consequently the downward bending of sound rays when they have reached a height of some scores of kilometres is to be expected.

The best method of testing these theories is by a direct comparison with the actual conditions, and for this reason a notice was inserted in the press by the Air Ministry asking for information from persons who heard the Oppau explosion. Up to the time of writing, 58 replies have been received. It is clear, however, that only a few of the sounds reported can have been caused by the explosion. Central European Time being the same as British Summer Time, the sound of the explosion should have been heard in London within a few minutes of 8 h. 5 m. B.S.T. Only four of the replies definitely refer to a time consistent with this, and even if we suppose that all of these really refer to the sound of the explosion, they are too few in number to determine the region of audibility.

An interesting feature of the replies was the number of circumstantial reports, mostly from London, of a noise heard about 7 h. 35 m. or 7 h. 45 m. These possibly refer to a single noise made near London. The time is consistent with the hypothesis that they were caused by a sound-wave from the Oppau explosion, travelling through the earth instead of the air, but previous records of audibility suggest that sound received in such a way is too feeble to be perceived.

Experience during the war showed that audibility of the firing on the Western Front in England was confined to the summer months. Mr. Miller Christy made careful observations at Chignal St. James, near Chelmsford, and his latest entries for the years 1915, 1916, 1917 and 1918* were on September 11th, August 15th, September 6th and August 26th respectively.

The Oppau explosion, occurring on September 21st, would seem to have been too late in the year to have been heard in England. No explanation of the seasonal variation in audibility has been worked out: it has been suggested by Whipple† that there may be air currents of the nature of monsoons at very great heights. Such currents would refract the sound downwards in the appropriate season in accordance with Fujiwhara's theory.

Great explosions, notably the Silvertown explosion of January 19, 1917, have been recorded in the past by barographs, and the records from the barographs and microbarographs at various British Stations have therefore been examined. No trace of any disturbance at the appropriate time has been observed. In view of the fact that the Silvertown explosion gave an increase of pressure of only about 1·5 mb. at Kew, it is not surprising that the Oppau explosion, at 30 times the distance, produced no noticeable effect.

Seismic records of the explosion were obtained at de Bilt and Strasbourg. H. J.

Long-Range Forecasts.

THE issue by the Forecast Service of a Long-Range Forecast covering a fortnight has been the subject of much favourable comment and we are glad to be able to publish the following note by Mr. E. V. Newnham on the circumstances which justified the forecast. Two points of importance should be emphasized:—(1) That it is not at present possible to extend the "Further Outlook" to such long intervals as a general rule, and (2) That the method adopted is the systematic use of well-classified experience.

Note on the Long-Period Forecasts issued on September 26th and 28th. By E. V. Newnham, B.Sc.

ON September 26th the pressure distribution over the British Isles and adjacent portions of the Continent was that classified by Gold, in *Geophysical Memoir* No. 16, as Type VIIIB., a large anticyclone being centred over the British Isles. This is obviously a very favourable type for

* *Q.J.R. Met. Soc.*, 1916, 1918, 1919.
† *Q.J.R. Met. Soc.*, 1918, p. 285

dry weather at any time of the year. Additional reasons existed for expecting prolonged fair weather on this occasion such as would not generally apply to other cases of Type VIIIb., nevertheless it is interesting to see what happened in past years when this type occurred in September without obviously unfavourable circumstances. Such occasions are

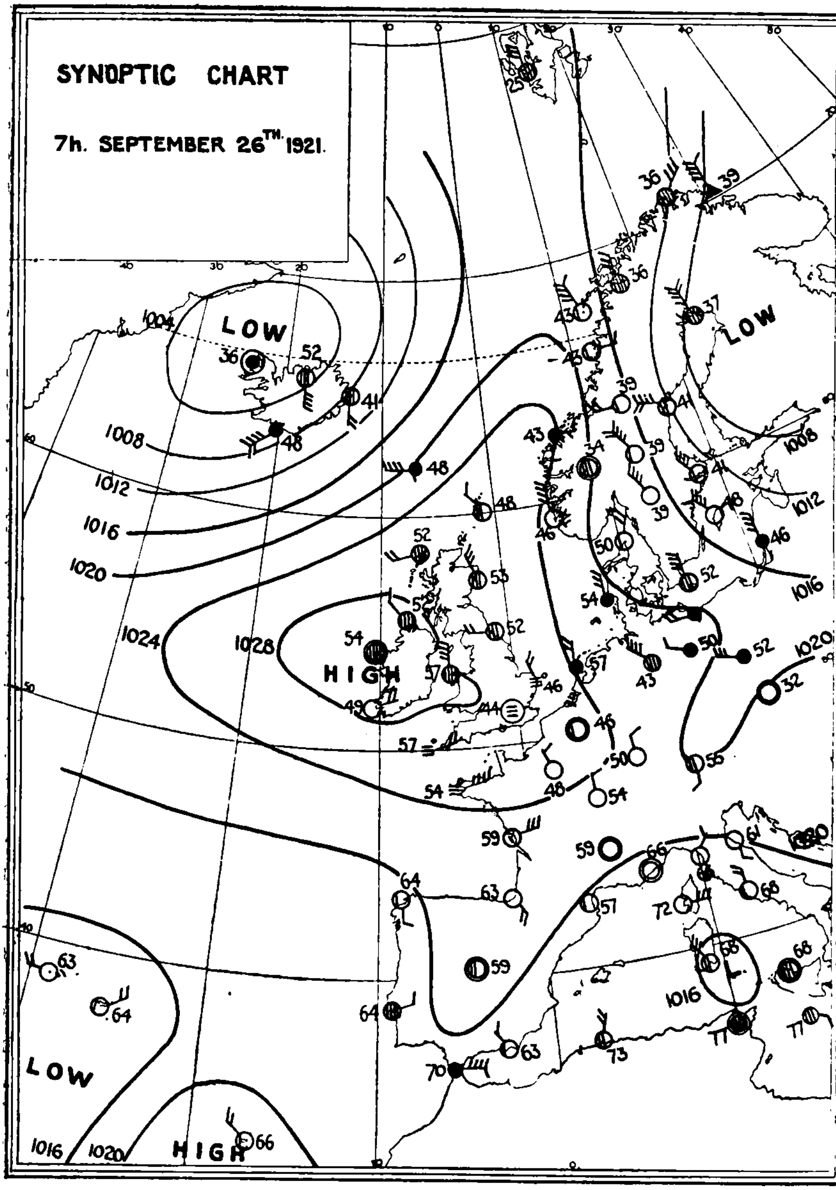


Chart for the morning of September 26th, 1921. Type VIIIb.

given in the following table.* The duration of "mainly fair" weather refers to the following stations south of the Mersey and Humber: Liverpool (Bidston), Holyhead, Pembroke, Portland, Dungeness, Dover, Yarmouth, Clacton, Nottingham, Bath, (or Falmouth), Oxford (or Benson) and London (Kew). The weather was taken to be "mainly fair" when no two of these stations reported 1 mm. or more of rain on two successive days.

Date.	Duration of "Mainly Fair" Weather. South of Mersey and Humber.	Time elapsing before complete Break-up South of Humber.	Notes.
	Days.	Days.	
Sept. 8th, 1907 -	23	23	Break up caused by depression from Atlantic.
Sept. 10th, 1910 -	4	20	Heavy rain in parts of East Anglia, 15th and 16th, otherwise rainless. Eventually depression from west of Ireland.
Sept. 22nd, 1910 -	8	—	
Sept. 4th, 1911 -	9	16	Rainless except temporary break 12th and 13th. Eventually depression from Atlantic.
Sept. 12th, 1912 -	16	17	Temporary break 28th and 29th, heavy rain latter date. Eventually depression from south-east.
Sept. 29th, 1914 -	16	16	V-shaped depression from Atlantic caused break up.
Sept. 7th, 1916 -	4	11	Partial break 10th and 11th. Eventually depression from south of Iceland.

The time elapsing before the complete break up of each fair spell over eastern England, south of the Humber (Dungeness, Dover, Yarmouth, Clacton, Nottingham, Oxford,

* Where Type VIIIB. reappeared during a fair spell this was not taken as an additional case to be investigated; adoption of this plan would have increased the number of examples to 20 and the average fair spell south of the Mersey and Humber to about 12 days, but undue weight would have been given to those years in which VIIIB. occurred several times in quite a short period.

It is worth mentioning that in the "mainly fair" spells here considered most stations experienced quite rainless weather.

and London), is also given in the table, a complete break up being taken to coincide with the recording of at least 1 mm. of rain at two or more of these stations on three successive days. It will be seen that in only one of the cases investigated did the break up in the specified area occur within a fortnight.

The forecast issued on September 26th, 1921, was as follows:—"Mainly fair and dry weather is probable for the next week or ten days over the southern half of the Kingdom." Two days later, when the information summarised above was available, the additional statement was made that:—"Over the eastern and central parts of England, south of the Humber, the chances are distinctly against a definite break up of these conditions within the next fortnight."

The following figures give an idea as to what happened during the 10 days covered by the first forecast:—

In the south of Ireland no appreciable rain (more accurately, not as much as 1 mm.) occurred until the sixth day, then definitely unsettled weather set in. At Holyhead and Liverpool there was complete absence of rain until the seventh day, except for 1 mm. only at Holyhead on the fifth day, and there was then a break up. In the south-west there was a temporary break in some places on the seventh and eighth days, in others on the seventh only. In the region of northern England including Nottingham and Cranwell (Lincs), appreciable rain fell on the eighth and ninth days only, but was exceedingly heavy on the eighth day (44 mm. at Cranwell and 25 mm. at Nottingham). At Benson (Oxon) and Clacton appreciable rain fell on the eighth day only. At South Farnborough, Kew, Dungeness, and Lympne no appreciable rain fell at all. At all stations except those in the extreme north the amount of bright sunshine was very large. At Lympne the total actually amounted to 100 hours. Over eastern and central England, south of the Humber, a definite break up had not occurred even at the time of writing (October 14th).

It will be seen that the 10-day forecast was not altogether successful for part of the area referred to, but that the 14-day forecast for the eastern counties was successful.

The large area covered by the working charts of to-day should make it possible to attempt further long-period forecasts of the general character of the weather from time to time. It seems not unreasonable to hope for greater success with these than with regular 24-hour forecasts of the detailed character of the weather, since the minor eccentricities of the weather which so often cause failure in a 24-hour forecast become relatively unimportant during the longer period.

OFFICIAL NOTICES.

Lectures on Meteorology.

In the September number of this magazine a provisional programme was published, of lectures and courses for the 1921–22 Session in the School of Meteorology, Imperial College of Science and Technology. With regard to the *Short Courses of Lectures on Technical Subjects* it is now announced that the order of courses (ii) and (iii) has been reversed. The course of four lectures by Dr. C. Chree, F.R.S., on Terrestrial Magnetism, 3.30 p.m. on Mondays, started on November 7th, and the course of three lectures by Sir Napier Shaw, F.R.S., on Wind above Clouds, will be given on Mondays at 3.30 p.m., beginning December 5th.

Spurn Head—Reinstallation of Anemograph and Sunshine Recorder.

At Spurn Head, the Dines anemograph and the Campbell-Stokes sunshine recorder have recently been reinstalled, and both are again in operation. These instruments which are in the care of the chief lightkeeper, were originally installed in February 1913, the site nearly at the end of the long narrow low spit of sand which forms the Head, being regarded as ideal for wind and sunshine measurements. From the meteorological point of view the exposure is probably the best that could be found in the United Kingdom, but the instruments suffered considerably during gales from the effects of blown sand, which is both fine and exceedingly "sharp." Notwithstanding the adoption of various devices to prevent it, sand found its way in large quantities into the wooden hut in which the recording portion of the anemometer was placed and so put the instrument out of action. In the case of the sunshine recorder it was found that the effect of sand storms was to sand-blast the glass sphere of the recorder to such an extent as to render it quite useless. A similar effect was observed upon some of the thermometers in the Stevenson screen, the tubes and scales of which became "frosted" and indecipherable.

A concrete hut with a vestibule has now been built to house the recording portion of the anemometer, and access to the inner room containing the instrument is obtained through two doors. Great care has been taken to prevent the access of sand above the instrument where the tube of the direction recorder enters the hut. Around the sunshine recorder a metal frustum of a cone, apex upwards and axis vertical, has been arranged in such a position that the upper edge of the frustum is in the horizontal plane through the centre of the sphere. It is hoped that by this arrangement the blown sand will be deflected over the top of the sphere.

Meteorological Office Publications.

THE Stationery Office having undertaken responsibility for the sale of Meteorological Office publications, the list of these publications forming sections K–M of M.O. Circular 001, has now been superseded by " List M," which is issued by the Stationery Office. Copies may be had on application to *Air Ministry Publications Department*, 10, *Leake Street, S.E.* 1.

Official Publications.

Professional Notes.—No. 23. A Comparison between the Dry-Bulb-Temperature in the Climatological Screen at Valencia Observatory and that in a Stevenson Screen exposed in an Open Field adjoining. By L. H. G. Dines, M.A. Price 6*d*. net.

THE recording of the variations of air temperature is one of the first duties of a meteorological observatory, but it is a duty which involves considerable difficulties.

The members of the Meteorological Committee, at that time a Committee of the Royal Society, who were responsible for the equipment of the seven observatories of the Meteorological Office in 1868 were aware of some of these difficulties. In adopting photographic registration of the temperature as indicated by mercury thermometers they naturally installed the apparatus in substantial buildings. To avoid direct sunshine on the thermometer screens they placed them on the north walls of the buildings. More or less searching comparison between the temperatures recorded in these north-wall screens with the readings obtained in Stevenson screens in more open situations have been made from time to time, though direct investigation of the relation between these north-wall temperatures and the temperature of the free air as measured by an aspirated thermometer has not yet been undertaken in this country. It is known, however, that in general the daily range of temperature is considerably less in the north-wall screen than at a like height above ground in the open whilst the mean temperature of the day is about the same in the two positions.

In the present note Mr. Dines has investigated the relation between temperatures recorded in the north-wall screen at

Valencia Observatory, Cahirciveen, and in the Stevenson screen in the adjacent field.

The north-wall screen temperatures are used for Parts II., III., and IV. of the *Meteorological Yearbook*, whilst the Stevenson readings appear in the *Daily* and *Weekly Weather Reports*, so that it is important to know how nearly they are consistent.

Mr. Dines finds that the rules found in other places do not hold good in the special circumstances of Valencia Observatory. On the average his north-wall screen gives the higher readings at all hours of the day in summer, the Stevenson screen the higher readings in winter. Closer analysis of the data showed that the most conspicuous difference, the excess of north-wall temperature above Stevenson temperature at midday in summer, was characteristic of winds, especially light winds, from westerly quarters. As such winds predominate they govern the average values of the temperature difference. No explanation of the curious phenomenon is suggested in the note, but it may be surmised that the air is warmed as it passes the heated walls of the observatory before it reaches the screen. It is hoped that the publication of the note will stimulate further investigation of a problem which is of considerable interest from many points of view.

Professional Notes.—No. 25. A Minor Line-Squall. By Captain M. T. Spence. Price 9*d.* net.

THE line-squall of August 14th, 1919, discussed in this note, is remarkable as having occurred in an anticyclonic area. The change of wind direction was also unusual, from south-west to north-east.

It is believed that this is the first occasion on which pilot-balloon observations have been available for discussion in connection with a line-squall.

Discussions at the Meteorological Office.

Oct. 17th. *The Law of the Geoidal Slope and some Fallacies in Dynamic Meteorology.* By C. F. Marvin. Monthly Weather Review, October 1920.

THE main fallacy attacked in this paper, which was summarised by Sir Napier Shaw, is involved in the wrongful application of the law of equal areas. Authors have assumed that, in the absence of friction, a particle changing its latitude would retain its moment of momentum about the earth's axis, ignoring the fact that the very forces which move the particle from one latitude to another will generally have a component tending to change this moment of momentum. Ferrel's theory of the general circulation of the atmosphere was based on this assumption, and led him to contemplate wind velocities of thousands of miles per hour. Ferrel attributed the mitigation of these velocities in the actual atmosphere to friction, but Marvin denies its adequacy. He uses the term geoidal surface for a level surface, and enunciates his law of the geoidal slope as follows: "A geoidal surface is a neutral or horizontal surface only for bodies at rest upon it. That is, gravity is powerless to set up any lateral motions among such bodies. The surface slopes towards the equator for every body having a relative motion eastward, and towards the pole for every body with a motion westward. A component of the force of gravity pulls the moving bodies down the slopes." This language does not seem very appropriate because the characteristic of a geoidal surface is that it has no slope; by its very definition it is everywhere horizontal. When a particle is moving on the level surface there is no longer equilibrium between the horizontal components of the centrifugal force and of gravitational attraction, but it is the centrifugal force that is fickle, not gravity. The conclusion of Prof. Marvin's argument is that the only observable effect of the earth's rotation is a deflection of the motion of a particle and not an acceleration, and that the moderate velocities in the actual atmosphere can be accounted for without exaggerating the importance of friction.

Although the points brought out by Prof. Marvin are familiar to most workers on dynamical meteorology, the publication of the paper should call attention to the weak spot in many textbooks and so improve the standard of teaching the subject.

Oct. 31st. *On the correlation between the fluctuations of the sun-spot area and the terrestrial precipitation.* S. Kunitomi and H. Tako. Bull. Cen. Met. Soc., Japan, 3.

The discussion on this paper was opened by Mr. Salter. The paper gives an account of a portion of an investigation on statistical lines on the direct relation between the areas of solar faculae and the rainfall in various parts of Japan, and deals solely with short period variations. A tendency for a 7 day period in the autumn rainfall was shown to have some relationship with the incidence of faculae at the time of their passage across the solar "meridian." Faculae were most numerous between 5° and 10° distant from the solar equator and the correlation with rainfall was shown to be at a maximum in respect of faculae in these latitudes. The correlation coefficients were, however, too small to be significant considering the short period of the observations.

Discussion turned principally upon the existence of a 7 day periodicity and the opinion was expressed that if any such existed it would more probably be terrestrial in origin.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

Thermometer Exposure at Kew Observatory, Richmond.

WITH reference to my letter in the August issue of the *Meteorological Magazine* and to your comments thereon, I am astonished to learn that the official records at Kew are taken from the readings of thermometers exposed in a north-wall screen instead of from instruments in a regulation Stevenson screen.

Presumably the instruments at Kew were originally exposed in a wall screen and, therefore, they have continued to be used for the sake of continuity and comparison. Even if that is so, however, there would appear to be no reason why readings in the Stevenson screen should not have been used as the "official" ones since the establishment thereof, thus being in conformity with readings taken at the majority of Meteorological stations. In the same way, instruments at both Greenwich Observatory and Camden Square are also exposed in Stevenson screens, I believe, as well as on Glaisher stands, and I see no reason why the figures obtained from the Stevenson screen should not be quoted in the *Daily Weather Report* instead of the latter ones. This would make them more strictly comparable with readings obtained at the other London stations.

I notice that the difference between the north-wall screen minimum and that in the Stevenson screen at Kew on the night of December 12–13th last was as great as 5°—a very remarkable divergence (incidentally, I see you now quote the minimum at Kew as 20° F. instead of 21° F. as given on page 138 of the Magazine for last June). In spite of the explanation now given with regard to the use of the north-wall screen and which, of course, accounts largely for the divergencies to which I called attention, the reading still seems exceptionally high, in view of the figures recorded at practically all other stations in the metropolis and the surrounding area, and of the fact that the frost was severe and continuous throughout the day of December 12th and readings below 20° F. were registered in most places quite early in the evening. H. FREIR.

Bylock Hall, Ponders End, August 29th, 1921.

WITH reference to Mr. Freir's letter in the August number about what was apparently a large difference of temperature between Kew and other places in the neighbourhood on the coldest night last year, your note clears up the mystery but also suggests that a student of the official Reports might as well ignore the Kew readings. The use of the Glaisher screen at Camden Square and Greenwich is indicated in these Reports, but not in newspaper accounts of heat or cold, and, in any case, such complications would not be generally understood. Last summer when temperatures of 90° F. or so occurred in Stevenson screens, I heard people remarking that once the temperature rose to 100° F. (at Greenwich in 1911), and naturally they did not appreciate that this reading was the result of a method of exposure which, at least in fine weather, generally shows higher maxima and lower minima than does the ordinary method.

Could not the difficulty be eliminated if those stations, which maintain abnormal methods of exposure for historical reasons, would publish only Stevenson screen readings? (I assume the superiority of the latter method, as even that one is apt to show higher temperatures than are recorded by a thermometer placed in an open but shady position, and the Glaisher method is, consequently, open to greater objection from this point of view.) G. WESTON.

47, *Chester Terrace, S.W.1, September 29th,* 1921.

A FUNDAMENTAL point, to which I see no reference by Mr. Freir or Mr. Weston, is that Kew Observatory is a first-order station, for which hourly values from a thermograph are deemed essential. The ordinary Stevenson screen is not suitable for the accommodation of the Kew pattern thermograph in use at first-order stations. The north-wall screen referred to in the correspondence is intended primarily for the thermograph, and seems to serve satisfactorily the purpose to which it has been devoted for over 50 years. If we published hourly values from our thermograph, and maxima and minima derived from the Stevenson screen, we should introduce a promiscuity into our results in addition to a discontinuity between the past and the future. Whether these disadvantages are outweighed by the advantage of publishing data more directly comparable with those at ordinary stations is a matter of opinion.

A third course would be to publish two sets of maxima and minima, taking such precautions as may be possible to prevent confusion.

As to the accuracy of the minimum reading from the north-wall screen on the night of December 12th–13th, 1920, we had as a matter of fact two minimum thermometers in the screen, and their readings differed by only 0°·2 F. We had also two thermographs running, there being a Callendar electrical-resistance recorder as well as the Kew photographic instrument. The two thermographs are not quite as sensitive as the ordinary minimum thermometer, and their readings were higher by a few tenths, both being 21° F. to the nearest 0°·5.

The difference between the minima from the two screens was probably due in considerable measure to circumstances other than the differences between the types of screen. Not merely is the north-wall screen at a greater height above the ground than the Stevenson screen, but the ground level is also higher at the position of the former screen. There was fog on the occasion in question, and also snow on the ground, so the variation of temperature with height was probably abnormal.

C. CHREE.

October 3rd, 1921.

A Shallow Sea Fog. Spithead, October 23rd, 1921.

DURING the passage across the water from Ryde to Portsmouth on Sunday evening, October 23rd, I noticed a curious phenomenon which is of somewhat rare occurrence in home waters. The wind was blowing strongly from north-north-east with squalls of cold rain, and the whole surface of the sea, as far as the eye could reach, was covered with a layer of fog moving rapidly from north to south and only about 3 feet thick. I believe this phenomenon is known as the sea "smoking," and is usually observed in Southern waters—in the Levant and also in the Straits of Gibraltar. It is caused, I suppose, by the flow of cold air across sea which is very much warmer than the air itself. At the time of my observing this, 5 p.m., the temperature of the air at Calshot was 40° F., while the sea temperature must have been 60° F. or even above, for the steamship *Arundel* gave in mid-channel a sea temperature of 59° F. and an air temperature of 46° F. at 4.30 a.m. next morning.

J. E. COWPER.

October 1921.

Mirage at Skegness.

THE mirage observed at Skegness on Sunday, July 10th, appeared to be the finest example of this phenomenon remembered at the town.

The weather previously had been consistently bright and dry, with vapour pressures and humidity percentage as follows:—

Date.	Time.	Vapour Pressure.	Relative Humidity.
	S.T.	mb.	%
July 7th - -	18 h.	15·6	85
„ 8th - -	10 h.	13·2	76
„ 8th -	18 h.	16·9	73
„ 9th - -	10 h.	15·6	73
„ 9th - -	18 h.	15·9	63
„ 10th - -	10 h.	12·6	62
„ 10th - -	18 h.	16·9	65

The wind on the previous days had been in an easterly direction, but early on the morning of the 10th it changed to south-south-west. The sky being clear, the direction of the upper air currents could not be observed. At about mid-day peculiar cloud effects were noticed on the horizon, giving the appearance of a well-wooded tropical coast line. This became somewhat indistinct until 16 h. 30 m., when a faint darkness appeared on the horizon, increasing in density and in its liquid appearance until objects were noticed in an inverted position at an altitude of about two degrees above the horizon. The phenomenon was apparent from a point north-north-east at sea, to a little west of Snettisham tower, across the Wash, in the south. The last-mentioned object could be seen inverted, and looked like a waterspout, being apparently enlarged but not so distinct as the other objects seen. A concealed chalk pit at Hunstanton was also seen reflected, as well as a few sailing boats. The effect passed off soon after 18 h.

The next day was still very hot, but misty, the maximum temperature being 85° F., against 81° F. on the 10th. The mirage, however, was not seen again.

By reason of the drought, all the dykes are dry, and at the end of the month there was no water in the main land drain. Such a thing could not be remembered by old inhabitants.

R. H. JENKINS.

Council Offices, Skegness, August 10th, 1921.

Exceptional Weather in October 1921.

On October 18th, the shade temperature rose to 72° F. under the influences of a nearly cloudless sky and southerly breeze; but the more exceptional incident was the extreme mildness of the night which followed, for the thermometer did not fall below 61° F., though rain began at 8.40 p.m. and lasted some time.

Greenwich records 1841–1905 show no minimum for any date in October above 59°·5, so that the reading for the morning of October 19th this year deserves special notice.

W. F. Denning, F.R.A.S.

Bristol, Oct. 19th, 1921.

The Recent Drought. A Seventh Century Parallel.

Bede in his *Ecclesiastical History* records that at the time when Wilfrid baptized the first converts of Sussex: . . . "no rain had fallen in that province in three years before his arrival, whereupon a dreadful famine ensued, which cruelly destroyed the people. In short, it is reported, that very often, forty or fifty men, being spent with want, would go together to some precipice or to the sea shore, and there, hand in hand, perish by the fall, or be swallowed up by the waves. But on the very day on which the nation received the baptism of faith, there fell a soft but plentiful rain."

No doubt the statement that no rain fell for three years is an exaggeration, but it is interesting to note that a very serious shortage of rainfall occurred about 680 in the same corner of England in which a shortage has been felt this year.

A. E. Swinton, F.R.Met.Soc.

Swinton House, Duns, Berwickshire, Oct. 1921.

NOTES AND QUERIES.

Sequence of Wind Changes at Different Levels in a Depression.

I have often noticed that a change of wind begins at the ground level and spreads upwards, not always, but especially in connection with a depression. This was very marked on October 23rd, when a shallow depression passed to the south from north-west to south-east. At 8 a.m. it was clear and sunny and clouds moving from north-west; the church vane—which is extremely sensitive—pointed the same way. After 10 a.m. the sky became clouded from the west, there was no appreciable wind but the vane pointed south-west. At 11 a.m. rain started, the clouds moving from west at an altitude of about 2,000 feet. At noon the vane pointed south-east and the clouds had drawn to south-west and were below 1,000 feet. At 1.30 p.m. the vane was east and the clouds, below 1,000 feet, were coming from south; the rain drove from the east in agreement with the vane, there being now a fresh breeze. The rain stopped at 3.30 p.m. with clouds, still at 1,000 feet, coming from east and the vane at north-east and temperature as low as 40°. The sky became clear before 6 p.m. except for a few low clouds coming from north to which direction the vane had pointed for nearly an hour so that vane and clouds were now in agreement. At one time it was curious to see the rain driving in an almost opposite direction to the clouds from which it fell. R. P. DANSEY.

Kentchurch Rectory, Hereford, November 1st, 1921.

[Reference to the *International Daily Weather Report* shows that the sequence of events was occasioned by the passage of a small secondary depression. The 7h. map for October 23rd, 1921, shows Hereford under the influence of the principal depression over Denmark, the secondary being over the north of Ireland. By 13 h. the secondary had reached South Wales and by 13 h. it was over northern France.—ED. M.M.]

Meteor Trails and Upper Air Currents.

IT has long been recognised that the movements of meteor trails can be used as evidence for currents in the upper atmosphere, but the number of observations available for discussion increases but slowly. A useful collection of reports made by Dr. S. Kahlke is published in *Annalen der Hydrographie und Maritimen Meteorologie*, 1921, Heft IX. Dr. Kahlke makes a broad distinction between observations by day and by night. Following Trowbridge (*Physical Review*, 1906, p. 279; 1907, p. 524) he regards the luminous trails seen at night as electrical phenomena to be assigned to the region about the base of the aurora, say from 80 to 100 kilometres above ground, whilst the trails seen by day are probably the actual meteor dust illuminated by sunshine. These daylight trails are, it is supposed, at heights below 80 kilometres.

It is of interest to rearrange the observations collected by Dr. Kahlke so as to show the number in each calendar month. The tabulation brings out the following facts :—

(1) In the daylight-trail layer east winds occur from June to November. For other months the evidence is doubtful.

(2) In the luminous-trail layer the wind is exceedingly variable during the months August to November. For other months there is little evidence.

Directions from which Meteor Trails drifted.

Month.	Daylight Trails.	Luminous Trails.	
	Northern Hemisphere 1741—1916.	Europe 1805—1913.	North America 1865—1901.
January	NW	W	W.
February	—	SE	—
March	S	—	—
April	E/C/W	S	V3Я8 —
May	C	—	WNW.
June	C, C, E, E, C	N	—
July	E, E	N, WNW	—
August	(E, E), NE, E	(W, W), NW, E/W, NW, NE	S, W, NW, NW, (SW, W).
September	E	NW, SSW, W	—
October	—	N, SW, SW/E, S, SSW, (NW, E), SE, E, SW, NNW, E/SW.	NNE.
November	(C, E)	(S, NW, N, WNW, ESE, W, WNW, N, N, W, NW), SE. SW, SW.	(S, S), (S, SE), (NW, NW, NW, NNW, NNW, W, S), (S/N, S, S, N/S, W, S), SW, W, (SW, WSW, SSE, S).
December	E, W	SW	—

Entries enclosed in brackets refer to observations on the same date or consecutive dates; E/SW means E current over SW; C = calm.

The direction from which the air current carrying the trail was blowing is tabulated here; Dr. Kahlke gives the direction to which it was blowing.

Dr. Kahlke makes no suggestion as to further research in this field. It is clear that no detailed knowledge of the variation of upper air currents is to be obtained from casual observations of the few meteors which leave conspicuous trails. The right course is surely that advocated by Prof. R. H. Goddard, of Clark College, Worcester, Mass, the sending up of suitable rockets.

Who will take the initiative in such investigation in this country?

F. J. W. W.

The Abnormal Sequence of Warm and Dry Months in London.

OCTOBER 1921 was the warmest month of that name during 64 years' record at Camden Square, and was actually the fourteenth consecutive month with mean shade temperature in excess of the average of 60 years 1860–1919. Four months (marked * in the following table) during this warm spell have given unprecedentedly high mean temperatures. During the greater part of the fourteen months the deficiency of rainfall has been nearly as remarkable as the excess of warmth, the whole period showing a deficiency from the 60 years' average of 12·06 in. September 1920 was wet, and, taking the thirteen subsequent months, the deficiency was 13·18 in. or 45 per cent. July was the only month with an unprecedentedly low fall.

RAINFALL AND MEAN TEMPERATURE AT CAMDEN SQUARE, LONDON, SEPTEMBER 1920 TO OCTOBER 1921.

Mean Temperature is taken as ½ (Mean Max. + Mean Min.) and refers to a Glaisher stand.

Months.	Rainfall.		Mean Temperature.	
	1920–21.	Diff. from Average 1860–1919.	1920–21.	Diff. from Average 1860–1919.
	in.	in.	° F.	° F.
1920.				
September - - -	3·27	+ 1·12	57·9	+ 0·2
October - - -	1·09	− 1·53	51·9	+ 1·7
November - - -	1·12	− 1·21	43·5	+ 0·1
December - - -	2·36	+ ·04	41·0	+ 0·9
1921.				
January - - -	2·48	+ ·43	46·1*	+ 7·4
February - - -	·19	− 1·50	40·7	+ 0·8
March - - -	1·19	− ·67	46·8*	+ 4·6
April - - - -	1·29	− ·38	49·5	+ 1·5
May - - - -	1·03	− ·82	57·0	+ 2·5
June - - - -	·37	− 1·91	61·8	+ 1·6
July - - -	·13*	− 2·26	69·4*	+ 6·0
August - - -	1·65	− 1·73	63·7	+ 1·3
September - -	2·50	+ ·35	60·5	+ 2·8
October - -	·63	− 1·99	56·2*	+ 6·0

* Unprecedented since 1858.

The High Tide of November 1st, 1921.

A very high tide was experienced along the east coast of the British Isles on November 1st. The Thames at Tilbury Docks rose 2 feet above the normal high-water mark, and in London itself the tramlines on the Victoria Embankment were under water and many wharves in the City were flooded. The Medway, Blackwater, and Colne also overflowed their banks, and in Sheerness Dockyard an increase of 35 inches over normal high-water level was noted. The high water was, no doubt, associated with the wind, which was blowing steadily from the north over the full length and width of the North Sea. Such a wind would produce a flow of water southwards, which would be thrown by geostrophic force on to the east coast of England.

A nice example of the contrast between the northern and southern hemispheres is provided by the remark on p. 312 that floods at Buenos Aires coincided with exceptionally low tide at Montevideo. In that case the wind was blowing the water westwards up the mouth of the La Plata and geostrophic force was throwing it to the left.

Exceptional Visibility.

In the account, which is sold to visitors to the tower on Leith Hill, it is stated that "the Ordnance Surveyors were able on July 15th, 1844, with the aid of a small glass, to see a staff about 4 inches in diameter on Dunstable Downs." The distance from the tower, which is 64 feet high and stands on the highest ground in Surrey, 965 feet above sea level, to Dunstable Downs is about 47 miles. It would be interesting to have the original authority for the statement which we have quoted.

The Aurora Line in the Spectrum of the Night-sky.

Reference has been made in the May number of this magazine to Lord Rayleigh's photographs of the aurora line in England. A letter in *Nature* of October 13th, 1921, gives an interesting account of his further investigation of the phenomenon.

Lord Rayleigh has found that at Terling, in Essex, the aurora line can be photographed on two nights out of three. Exposures were made on 150 nights, irrespective of weather, and the intensity appears to have little or no connection with magnetic disturbance or with the distribution of sun-spots. It is curious, however, that at Beaufront Castle, in Northumberland, about 3° further north, no trace of the line was found, although exposure on the same kind of plate was made on 26 different single nights. Positive results at Terling alternated with negative results at Beaufront, so that the latter cannot be attributed to seasonal variation. On two occasions at Beaufront a plate was exposed for five nights, and on each plate the line was observed.

Lord Rayleigh expresses great surprise at the diminished intensity of the line towards the north, and he hopes to pursue his investigations as opportunity occurs.

Templates for Use in Estimating the Duration of Rainfall.

The convention adopted by the Meteorological Office in estimating the duration of rainfall is that only such rain is to count as falls at a rate of 0·1 mm. per hour or more. To judge when the critical rate is reached a glass or celluloid plate ruled with oblique lines is placed over the record; if the trace is steeper than these lines, then the rainfall is heavy enough to count.

Celluloid templates of two patterns, suitable for use with the Halliwell Gauge and with the Hyetograph respectively, can now be obtained from Messrs Negretti and Zambra and Messrs. Casella & Co. are able to supply similar templates for their self-recording gauges. It is hoped that observers who are interested in measuring the duration of rainfall will appreciate the advantage of the standardized system and will provide themselves with the scales appropriate to their gauges.

British Association for the Advancement of Science.

It is announced that the British Association Research Committee for the Investigation of the Upper Atmosphere for 1921–22 is constituted as follows:—Sir Napier Shaw (*Chairman*), Capt. C. J. P. Cave (*Secretary*), Prof. S. Chapman, Mr. J S. Dines, Mr. W. H. Dines, Sir R. T. Glazebrook, Col. E. Gold, Dr. H. Jeffreys, Sir J. Larmor, Mr. R. G. K. Lempfert, Prof. F. A. Lindemann, Dr. W. Makower, Sir J. E. Petavel, Sir A. Schuster, Dr. G. C. Simpson, Prof. H. H. Turner and Mr. F. J. W. Whipple.

Meteorological Stations.

Lisburn.—Mr. John Ridges, of the Friends School, Prospect Hill, who has been responsible for the observations at Lisburn since 1911, has now resigned his headmastership. Mr. Ridges has been succeeded by Mr. J. Woolman.

The Artificial Production of Rain.

A RECENT article in *The Times* gave an account of the work of Mr. Charles M. Hatfield, who claims to have produced eight inches of rain in three months at Medicine Hat, Alberta. His method is not described in detail, but Mr. Hatfield states that he uses a tank filled with certain unspecified chemicals exposed to the air about 25 feet above the ground, and some 22 miles from Medicine Hat. It is said that this apparatus draws clouds from other parts to Medicine Hat and causes them to precipitate their moisture there.

This article was followed by correspondence. Mr. Carle Salter laid stress on the thermodynamical aspect of the problem, and Captain C. J. P. Cave complained of the vagueness of Mr. Hatfield's "explanations." The conclusion of Captain Cave's letter may be quoted. "The medicine man in Central Africa was, no doubt, busy last night (*i.e.*, Oct. 16th) in warding off the baleful influence that was affecting the moon. He was wonderfully successful, he succeeded in preventing the total obscurity of the moon's disc, and by the end of his endeavours, the moon shone again with its usual brilliancy. I actually witnessed his success, so I know what I am talking about."

Dr. H. Jeffreys compared two of the rain-maker's records with official statistics, with the following result :—

Place.	Date.	Rainfall.		
		From *The Times* Article		From Official Records.
		Guaranteed.	Supplied.	
Los Angeles	Jan.-Apl. 1905 -	18 ins.	29·49 ins.	14·98 ins.
Medicine Hat	May-Aug. -	8 ins.	8 ins.	4· 8 ins.

A further letter from Mr. J. T. Lithgow, of Yukon, is also of interest. It appears that, in 1904, Mr. Hatfied was offered by the local Council a large sum of money to produce good rainfall in the Klondyke district during June, July and August.

In this case, though he tried for six weeks, the rain-maker was not successful, as he himself admitted.

Erratum.—In the note on Unprecedented Drought on p. 264 of the October number the driest periods previously recorded at Chitterne were erroneously given as having occurred in 1858–59. This should read 1857–58 in both cases.

The Argentine Daily Weather Reports.

FROM October 1st, 1921, the isobars on the Daily Weather Charts of the Argentine Meteorological Service have been drawn at larger intervals than hitherto. Formerly they were shown for every 2·5 millimetres of mercury; now they are shown for every 3 millimetres. The change brings the Argentine maps into line with the international section of our own Daily Weather Report, since 3 millimetres are equivalent to 4 millibars. Comparison is facilitated by each isobar bearing a pair of equivalent denominations, *e.g.*, 1,020 mbs. and 765 mm.

The Argentine Meteorological Service is to be congratulated on the wide scope of its report, which covers the whole of South America. Provision is made for daily reports of rainfall for about a thousand stations in the Argentine.

A Meteorological Observatory at Breslau.

AFTER long negotiations with the Entente a few aircraft have been given over to the Krietern Meteorological Observatory, near Breslau, for the purpose of upper-air soundings. According to the *Illustrierte Flugwoche*, September 28th, 1921, the observatory is to undertake researches on the cyclones which follow the track denoted by Von Bebbe as 5 b, since cyclones are said to have become disastrous for Upper Silesia, and to have produced severe floods in the Oder.

The "C.G.S." System.

A CORRESPONDENT calls attention to an order issued at Baghdad at the end of 1918 and including the following recommendations:—

> *Adoptions of Continental Units Advocated.*
>
> Under peace conditions Meteorological Work will be much more in co-operation with Egypt, Turkey and Caucasia than with India, so that the adoption of Continental units is practically essential. Indeed, if Egypt has adopted, or is likely to adopt, the "Chief of the General Staff" system of units with the millibar as the unit of pressure, it would be advisable to go one better than the Continental system and adopt the "Chief of the General Staff" system straight away from the beginning.
>
> *Instruments.*
>
> Instruments graduated for Continental or "Chief of the General Staff" units can be obtained in England.

Readers who are occasionally baffled by the use of unexplained initials in military intelligence will sympathise.

Reviews.

The Rainfall of the British Isles. By M. de Carle S. Salter. 8vo. xiii + 295. London University Press, 1921. Price 8s. 6*d.* net.

THIS volume is such a book as only Dr. Mill or Mr. Salter could have written. It has been long wanted by water-engineers and the general public as well as by meteorologists, and it is extremely satisfactory that the accumulated experience of 62, Camden Square, should at last have been made available in an easily accessible form.

There is perhaps not very much that is new but there is a very great deal that even those interested in the subject do not know. Naturally the volumes of *British Rainfall* have been drawn on, and it is not too much to say that practically everything of importance that has appeared in that long series receives somewhere or other appropriate mention. But that does not imply that in any sense the book is "cauld kail het." It is a serious and coherent presentment of the subject. The purpose of the book is stated in the introduction; it is "to bring together some of the general conclusions so far deduced; to suggest, rather than formulate, a working hypothesis which future students of the subject may build upon or amend, and to draw attention to the economic utility of a more complete knowledge of our resources in respect of one of Nature's greatest gifts." Six chapters are taken up with discussions of methods of obtaining data, and deal with rain gauges and their exposure together with methods of mapping. The remaining eight chapters are occupied with the discussions of results obtained especially with reference to the incidence and frequency of daily rainfall, types of seasonal distribution, the seasonal variation and the fluctuation of annual rainfall and the relation of rainfall to configuration. The book concludes with a chapter on the economic application of rainfall data in which, among other things, we are given a most interesting account of the method of construction of rainfall maps of small areas.

Perhaps the most striking general impression received in reading the chapters dealing with the results and still more after looking at the maps is how wide are the differences in the distribution of rainfall according to whether the time considered is 35 years, 35 months of the same name, a single year, a single month or a single day. Mr. Salter groups rainfall into three types, convectional, cyclonic, and orographical. The maps for the longer periods, 12 months and over, show the orographical effect more or less strongly. The maps for months sometimes show the effect and sometimes do not. Maps showing the amount of rain measured on particular days show the effect only occasionally. When it comes to plotting the areas over which rain is falling at a named hour Mr. Salter can produce maps showing convectional rain and maps showing cyclonic rain, but not one showing even slightly the orographical effect. This may of course result from the fact that orographical rain is not such a striking phenomenon as convectional or cyclonic rain may be, and simply has not been studied, but one rather begins to wonder how often purely orographical rain really does fall. Mr. Salter is careful to warn us that the three types "merge imperceptibly into one another and more often occur in conjunction than not" but from what has been said it is not at all obvious that even that is the whole story.

The curious thing is that when larger areas as well as shorter times are considered the orographical effect again becomes less noticeable. For example, in the monthly maps of rainfall over the continent of Africa one is scarcely conscious at all of any effect of relief. Perhaps this is partly due to the lack of data. The fact that in no country in the world has rainfall been studied in such detail that the effect of relief is known with such accuracy as in Britain encourages the belief that even more detailed results may be forthcoming. There is certainly no one who knows more about the subject than Mr. Salter and he has summarised what is known lucidly and effectively.

J. FAIRGRIEVE.

Record of Bare Facts for the year 1920 (Thirtieth report of the Caradoc and Severn Valley Field Club). The section on Meteorology contains rainfall tables, monthly summaries of weather, a table of extremes for the year, and notes on farm and garden crops. In all the tables the stations are arranged according to heights, and as the heights of the thirty-seven stations vary from 140 feet to 1,400 feet, the contrast between hill and valley climatology is well brought out. The tables should be used with caution, however, as internal evidence suggests that in some cases the returns from individual stations have been utilised without adequate scrutiny.

Obituary.

Julius von Hann.—It is probably the lot of everyone to have had during life a regard for some person which amounts almost to personal and intimate friendship, although one may never have seen or even corresponded with the object of that regard. Sometimes it is an author, sometimes a character in a book and sometimes a historical personage, but in every case the feeling is very real and vivid. The scientist experiences this feeling quite as strongly as those of a more literary turn of mind, and to many of us Faraday, Maxwell, Kelvin are not mere names met with in text-books, but real live men worthy of honour and devotion.

To many meteorologists, certainly to all who can read German, Hann appealed in this way. One knew from his writings, seldom controversial, never militant, that he must be of a quiet retiring nature, a conclusion confirmed by all those who have had the pleasure of his acquaintance. One likes to picture him in his room in the Hohe Warte in Vienna searching, always searching, in likely, and more often in unlikely, places for any reference to weather conditions, which could add to our knowledge of the atmosphere and its ways.

And when Hann had once found a piece of weather information it could never again be lost to the world. Within a month or two of its discovery it was made known to all those whom it might concern in the pages of the *Meteorologische Zeitschrift*, but that was not all, for Hann's encyclopædic mind was able to see its relationship to other factors and like a piece in a puzzle it was fitted into its place to make possible those masterly descriptions of climate found in his *Klimatologie* and those clear accounts of atmospheric processes which make up his *Meteorologie*.

Hann started life as a school teacher, but at the age of twenty-nine his natural love of meteorology led him to enter the Central-Anstalt für Meteorologie in Vienna; six years later, in 1874, he became Director and held that office until 1897, when at the age of fifty-eight he retired. His retirement was only from official duties; from meteorology he could not retire, and did not retire, until the very presence of death made further work impossible. The first fruits of his relief from official duties was his *Lehrbuch der Meteorologie*, which was written between the autumn of 1898 and August 1900 in the Physicalische Institut in Graz. This book, which was so different from any previous text-book of meteorology, became at once the recognised standard book of reference and from 1900 onwards practically no major piece of meteorological work has been published which does not draw upon the Lehrbuch for facts and data.

Hann's *Handbuch der Klimatologie*, which had been written while he was still Director of the Central-Anstalt, is probably better known to British meteorologists than the Lehrbuch, for the only reason that it has been published in an English translation. It is surprising how readable Hann has made this book, dealing, as it does, with little more than a mass of climatological statistics collected from all parts of the world.

But that is one of the great charms of Hann's writing that he is able to present the driest of meteorological facts in a pleasing and enticing manner. In the *Klimatologie* this end has been reached by leaving in so much of the original work from which the information has been extracted. It helps even a meteorologist to enjoy the account of the climate of a place if he knows that the data were provided by a Livingstone, a Franklin or a Scott.

The *Klimatologie* and the *Meteorologie* are Hann's largest individual works, but it is questionable whether the writing of these books is his most valuable contribution to meteorology. Probably science owes more to him for the mass of information he has rescued from oblivion and preserved in the *Meteorologische Zeitschrift*, of which he was the editor, or joint-editor, from 1866 to 1920, the *Zeitschrift* in the meantime undergoing several changes both in name and control.

Hann has received many honours, national and international; probably of all of these, those which he most appreciated were the issue in 1906 of a special volume of the *Zeitschrift* called the *Hann Band* to celebrate his forty years of editorship, and the spontaneous exhibition of esteem which he received on his eightieth birthday from all parts of the world in spite of the disastrous effects of the war on international relationships.

Hann was born on March 23rd, 18~~95,~~39 and died on October 1st, 1921—a long life, a full life, and a life for which every meteorologist has cause to be grateful. G. C. S.

William Speirs Bruce, LL.D., August 1st, 1867–October 29th, 1921.—As a student in Edinburgh 35 years ago W. S. Bruce made many friends by his pleasant disposition and his whole-hearted enthusiasm in the study of natural history. Hence, when surgeons of scientific tastes were required for the four Dundee whalers which proceeded to the Antarctic regions in 1892, he was appointed to the *Balaena* for his scientific rather than his medical qualifications. The voyage drove him far from a medical career, and he returned with meteorology and oceanography added to marine zoology as his chief interests. Opportunities were few at the time in any of these departments, but Bruce was ready to seize all that turned up. Like many Edinburgh students of his time, he had occasionally lent a hand in the Ben Nevis Observatory, where observations of all the instruments were made hourly by day and night, and on two occasions he had been in charge of the observatory in the absence of Mr. R. T. Omond. It was while he was on Ben Nevis in 1896 that I telegraphed to him on

June 5th on behalf of the Jackson-Harmsworth polar expedition offering him a position as naturalist, and on June 9th he left the Thames in the *Windward* for Franz-Josef Land. Never surely were the preparations for an Arctic voyage carried out so promptly.

The year in the Arctic made Bruce a polar explorer, and he seized chance after chance on private expeditions to Novaya Zemlya and Spitsbergen to equip himself for his life-work. He owed much to the encouragement and help of the Prince of Monaco, both afloat in his yachts and ashore at the Monaco laboratories. Bruce yearned after the Antarctic regions and nearly accepted a post on the *Discovery* under Captain Scott, but fortune favoured him with a wealthy supporter in Major Andrew Coats and he was able to fit out an expedition of his own on board the *Scotia.* He left the Clyde in November 1902 with the best equipment for meteorology and oceanography that had yet been provided for any polar ship and with the aid of Mr. R. C. Mossman who was in charge of the meteorological work the expedition to the Weddell Sea was epoch-making. The captain of the *Scotia* was Thomas Robertson of Dundee, one of the ablest ice navigators who ever left that port, but Bruce and his scientific colleagues were in full command of the expedition. The *Scotia* returned in 1904 and from that time onward, apart from some summer visits to Spitsbergen, the main occupation of Bruce's life was the working-up of his collections, and the publication of the results. For this purpose he founded the Scottish Oceanographical Laboratory in Edinburgh and dispite almost crushing financial difficulties he produced a splendid series of volumes.

He was for many years Lecturer on Geography in the Heriot-Watt College, Edinburgh, and he did much to assist the later Antarctic explorers and to advise Government Departments concerned with the southern whale and seal industry.

Bruce received the gold medals of the Royal Geographical Society and of other geographical societies in various countries as well as the Keith Prize of the Royal Society of Edinburgh and he was created LL.D. by the University of Aberdeen. But although recognition and that of a kind which he keenly valued was not lacking he had a tremendous struggle with difficulties which his ardent independence of all external authorities did not tend to diminish. He was never robust and his enthusiastic energy wore him out before his work was finished. He has raised his name to a high position amongst naturalists and explorers and leaves many friends to mourn his loss.

HUGH ROBERT MILL.

News in Brief.

THE 1921–22 session of the Royal Meteorological Society was opened on November 2nd, by a *soirée* held at the new premises, 49, Cromwell Road, S.W. 7.

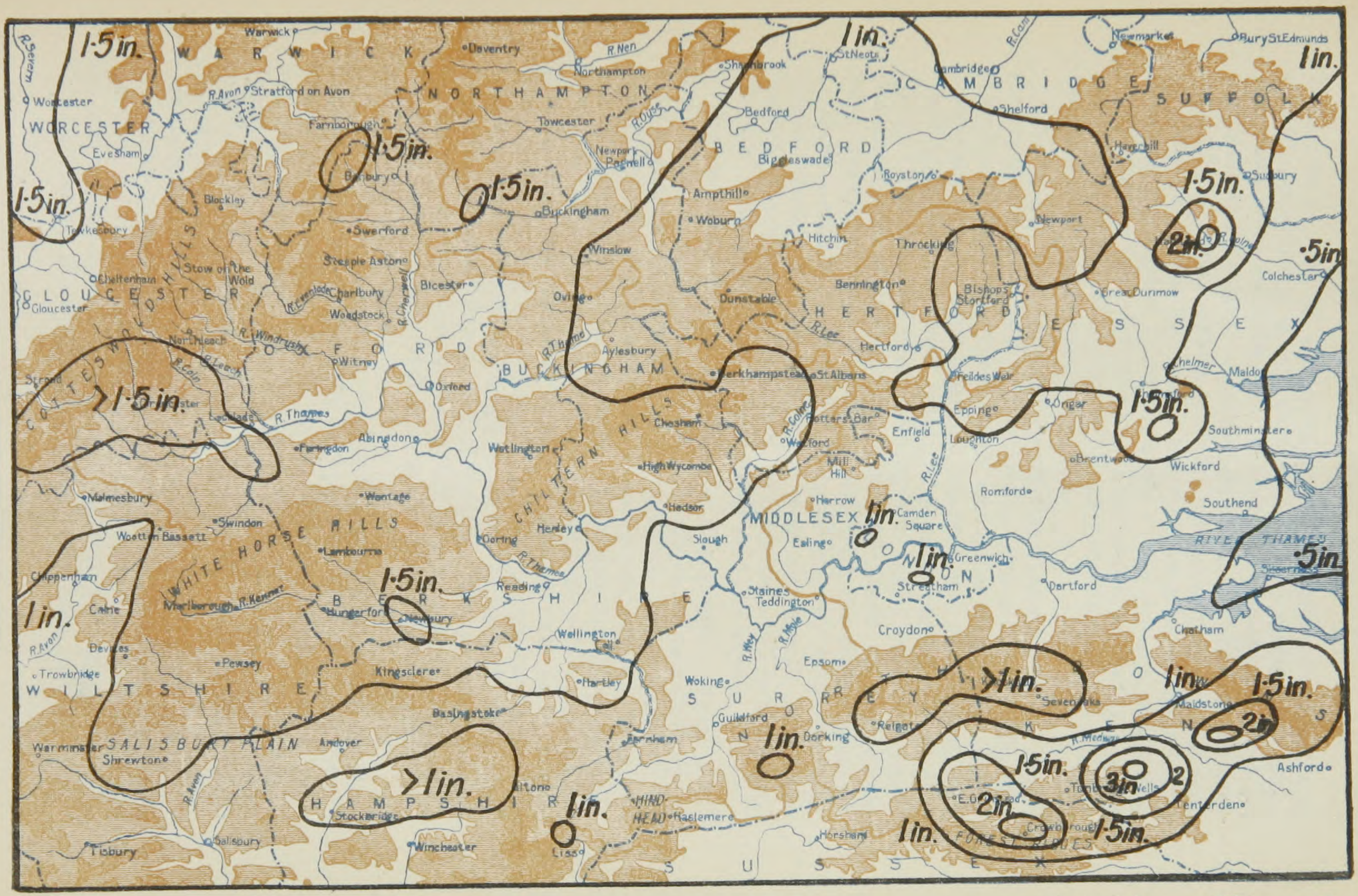
The meeting of the Physical Society on Friday, November 25th, will be devoted to a discussion on Hygrometry. Meteorologists are invited to attend. The meeting will be held at the Imperial College of Science, South Kensington, at 5.0 p.m. An exhibition of hygrometrical apparatus will be open from 3.0 p.m.

The Weather of October, 1921.

DURING the first three weeks of the month pressure was highest over Central and Southern Europe, settled conditions extending over our south-eastern districts, where exceptionally warm weather was experienced. By contrast the weather was very unsettled in the north-west and in Northern Europe. Relatively low pressure between Spain and the Azores was associated with rain almost daily during this period. A change of type occurred on the 22nd, highest pressure becoming established off our south-west coasts. Conditions now became very unsettled in the Mediterranean, and occasional secondaries from northern depressions penetrated Central Europe.

The month opened with a belt of low pressure extending from the Azores along our north-west coasts to Scandinavia. Snow fell in the north of Norway and in Iceland, in a polar current from north-east, but generally cold conditions were limited to these northern regions. On the 2nd a shallow depression moved in from the Atlantic, bringing to the south of England a temporary influx of air from the south-west, interrupting the southerly current which characterised the early weeks of the month. The transition was marked by thunderstorms on both sides of the Channel. Early on the 3rd this depression, growing deeper, passed across Scotland to Scandinavia, where northerly gales and sleet occurred, and an anticyclone moved south-east from Iceland, reaching the Shetlands on the morning of the 4th. Pressure remained low over the Atlantic, and a southerly current was re-established over France and the British Isles. A notable phenomenon which developed out of this distribution was a line of convergence of winds extending from west to east across the Midlands, fed on the south by warm air from France and on the north by cold air from Scandinavia, circulating round the Shetlands anticyclone. This system remained stationary for about 12 hours, producing considerable rainfall on its northern side, 44 mm. being reported at Cranwell, 25 mm. at Notting-

THAMES VALLEY RAINFALL. —— OCTOBER, 1921.



Watershed of River Thames above Teddington and River Lee above Feildes Weir ——

Isohyetals.

ALTITUDE SCALE: Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES: 0 5 10 15 20

H M Stationery Office Press, Kingsway W.C.2

PS.3337/348 Wt.26. D.P15. 1250 11/21.

ham, and 14 mm. at Manchester. The southerly current was drawn, apparently, direct from Africa, and remarkable temperatures were experienced on this and succeeding days in England and France. Biarritz recorded 93° F. on the 4th, while 83° F. was reached at Kew Observatory on the 5th, and at Croydon on the 6th. Minima, too, were abnormally high, Kew registering 62° F. on the night of the 3rd–4th, which is a record for the time of the year. The exceptionally high upper air temperature, exceeding 60° F. at 5,000 feet on the 5th and 6th, favoured high surface maxima.

On the 4th the Atlantic depression commenced to move slowly northwards, and with it the rain-line over the Midlands, which could be identified with the outer extremity of the "steering-line." This rain-line marked the renewed northward progress of mild conditions, and passed across the Arctic Circle on the 6th. During the night of the 5th–6th thunderstorms occurred in the west and north of the British Isles, associated like those of the 2nd, with the replacement of a warm southerly current by a cooler one of more westerly origin, though the veer of wind was only small. At Baldonnel, where a storm occurred, temperature fell in the night about 8° F. at heights up to 5,000 feet and less above.

The morning of the 10th saw a depression centred over Ireland, bringing strong northerly winds in its rear and heavy rain in places in the west and south-west. Some rain fell in the south-east of England, and thunder was reported locally, but the depression filled up without making further progress.

On the 14th the centre of highest pressure was temporarily transferred from Central Europe to the south-west of the British Isles during the passage of a deep depression far north, which caused widespread high winds and gales over the north of Scotland, Scandinavia, and Denmark. Cooler air passing round the anticyclone invaded the south-east of England, resulting in local ground frosts on the mornings of the 15th and the next few days.

A small secondary to a northern depression passed up the English Channel on the 20th, and thunder was again reported locally in the south. A very local rainstorm of great violence, but unaccompanied by thunder or lightning, broke over Shanklin, Isle of Wight, between 6 h. 45 m. and 9 h., and yielded 33 mm. of rain. Low-lying streets were flooded and considerable damage done to roads.

A complete change of type occurred on the 22nd, when a depression passing across this country to Denmark brought the first marked influx of polar air, definitely terminating the exceptionally warm weather of the first three weeks. Penetrating to the south of France, this cold current was felt as the Mistral on the Mediterranean coast, being associated, characteristically, with the formation of a depression south of the Alps. Subsequently, strong winds and heavy falls of rain occurred in the Mediterranean area. On the 24th, 80 mm. was recorded at Sanguinaire and 61 mm. at Rome. The depression, approaching Denmark, developed rapidly, and northerly gales occurred in the North Sea and Baltic in its rear. High pressure, established off the south-west of the British Isles by the 24th, dominated the situation in the southern districts during the remainder of the month, but high winds and gales were frequent in the north of Scotland, as in Northern Europe.

On the London-Continental aerial routes morning mist and fog were prevalent but day visibility was mostly fair or good. Very low cloud was rare. On the other hand there were many days with little or no low cloud at all. Winds at 2,000 feet were mostly under 25 miles per hour. Of 76 observations at Lympne 20 showed speeds at this level under 10 miles per hour, 44 between 10 and 25, 10 between 25 and 45, while on two occasions this was exceeded, on the 3rd and 24th, when 48 miles per hour was registered. M. A. G.

In Western Europe October was characterised by abnormal warmth and dryness, punctuated by occasional heavy falls of rain. In Belgium the drought again became serious, and it was necessary to close factories and limit the consumption of water for domestic purposes. In Beauvais a third crop of hay was cut for the only time within living memory, and near Geneva many fig trees yielded a second crop of fine quality. In the Alps the melting of the glaciers owing to the warm weather caused local floods and high water levels in the lakes. On the 10th, however, there was a severe thunderstorm in the Hérault (Gulf of Lyons), accompanied by heavy rain, causing floods, which did some damage. On the 23rd and 24th, with a deep depression in the southern Baltic, cold stormy weather was experienced, accompanied by blizzards in northern Jutland and southern Sweden and heavy snow in the Alps. Gales on the 24th caused damage to shipping in Holland and Denmark. Between the 24th and 29th a depression in the neighbourhood of Italy caused cold weather, with a severe gale at Florence on the 24th and heavy rain near Naples and over Vesuvius on the 25th and 27th.

In India the month opened with a vigorous monsoon in the Peninsula and rainfall above normal in most places. Early harvest had begun, and the condition of the crops was good generally, except in Baluchistan, where the prospects were very poor. There was some distress in Madras, but good rains had fallen in the affected tracts. A telegram dated October 19th reported good rains generally, and favourable conditions for sowing in all the principal wheat regions. In the Bombay Presidency, after a monsoon period of extreme doubt and anxiety, conditions improved, and the season was on the whole an average one, satisfactory in the north but poor in the south. Cotton crops were good on the whole. A telegram to the Marine Division on October 24th reports one storm in the Bay of Bengal and a weak monsoon over the Peninsula; the last advices, dated the 26th, show fair or scanty rainfall in most places and a weak monsoon.

In North America the month opened with a severe storm in Ontario and Quebec, in which trees were blown down, houses unroofed, and much damage done to electric and telephone services and to orchards. Depressions caused fairly heavy rains in the Great Lakes and St. Lawrence region on the 8th to 12th, and again on the 18th to 21st, but conditions were generally anticyclonic until near the close of the month. On the 26th, however, a violent cyclone visited Florida, causing damage to the extent of several million dollars. Tampa was the chief sufferer, owing to a hurricane wave which swept over the lower parts of the town, wrecking nearly 500 houses, and killing five people. The orange crops in the path of the storm were damaged. Two days later Britannia Beach, a mining town in British Columbia, 25 miles north of Vancouver, was overwhelmed by a flood due to the mountain stream, swollen by two days' steady rain, being temporarily blocked by an avalanche; when the dam gave way under the increasing pressure, a wall of water 70 feet high descended on the town, carrying away 50 houses, some of which were swept into the sea. There were also floods at Port Coquitlam on the Fraser River, east of Vancouver, which injured the Canadian Pacific Railway bridges and did other damage.

On the night of October 3–4 the Argentine was visited by the worst storm experienced for many years. A deep depression, moving eastward, and centred over Entre Rios at 8 h. on the 4th, brought heavy rains over a great part of the country, which caused the rivers to rise alarmingly. At the same time a terrific thunderstorm broke over the province of Buenos Aires. The fall up to 8 h. on the 4th exceeded 75 mm. at many stations and reached 100 mm. at Cerrito. Rain continued with slight intervals during the rest of the day, while the swollen rivers were banked up by easterly or south-easterly gales. By the morning of the 4th a large part of Buenos Aires was flooded, and violent gusts, increasing in fury as the day passed, tore through the streets,

(*Continued on* p. 312.)

Rainfall Table for October 1921.

STATION.	COUNTY.	Aver. 1881–1915.	1921.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days.
		in.	in.	mm.		in.	Date.	
Camden Square	*London*	2·63	·63	16	24	·21	22	8
Tenterden (View Tower)	*Kent*	3·49	·40	10	11	·19	22	6
Arundel (Patching Farm)	*Sussex*	3·96	1·37	35	35	·87	20	6
Fordingbridge (Oaklands)	*Hampshire*	4·15	·86	22	21	·26	18	18
Oxford (Magdalen College)	*Oxfordshire*	2·79	1·18	30	42	·42	18	10
Wellingborough (Swanspool)	*Northampton*	2·52	1·58	40	63	·42	3	8
Hawkedon Rectory	*Suffolk*	2·70	1·30	33	48	·51	10	8
Norwich (Eaton)	*Norfolk*	3·12	1·50	38	48	·54	3	13
Launceston (Polapit Tamar)	*Devon*	4·80	1·56	40	32	·40	23	13
Sidmouth (Sidmount)	„	3·72	1·17	30	31	·27	20	12
Ross (County Observatory)	*Herefordshire*	3·28	1·32	34	40	·30	19	9
Church Stretton (Wolstaston)	*Shropshire*	3·62	1·91	49	53	·65	3	9
Boston (Black Sluice)	*Lincoln*	2·74	2·07	53	76	1·28	3	8
Worksop (Hodsock Priory)	*Nottingham*	2·63	2·37	60	90	·83	11	11
Mickleover Manor	*Derbyshire*	2·69	3·10	79	115	1·24	3	11
Southport (Hesketh Park)	*Lancashire*	3·54	2·87	73	81	·52	22	16
Harrogate (Harlow Moor Ob.)	*York, W. R.*	3·35	1·72	44	51	·46	12	12
Hull (Pearson Park)	„ *E. R.*	2·98	1·22	31	41	·50	22	9
Newcastle (Town Moor)	*North'land*	3·20	2·17	55	68	·94	22	11
Borrowdale (Seathwaite)	*Cumberland*	12·00	6·75	171	56	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	4·80	2·05	52	43	·53	23	14
Haverfordwest (Gram. Sch.)	*Pembroke*	5·41	2·25	57	42	·78	3	10
Aberystwyth (Gogerddan)	*Cardigan*	5·28	3·20	81	61	1·19	3	7
Llandudno	*Carnarvon*	3·59	2·49	63	69	·57	3	12
Dumfries (Cargen)	*Kirkcudbrt.*	4·36	3·35	85	77	·89	21	17
Marchmont House	*Berwick*	3·82	3·04	77	80	1·22	23	13
Girvan (Pinmore)	*Ayr*	5·00	5·01	127	100	1·21	21	25
Glasgow (Queen's Park)	*Renfrew*	3·25	4·92	125	151	1·05	1	21
Islay (Eallabus)	*Argyll*	4·77	5·24	133	110	·91	21	26
Mull (Quinish)	„	5·60	5·51	140	98	·84	17	24
Loch Dhu	*Perth*	7·15	7·90	201	110	1·35	17	26
Dundee (Eastern Necropolis)	*Forfar*	2·66	2·42	61	91	·35	2	19
Braemar (Bank)	*Aberdeen*	3·75	2·10	53	56	·29	31	20
Aberdeen (Cranford)	„	3·25	1·62	41	50	·24	1	16
Gordon Castle	*Moray*	3·16	2·44	62	77	·42	2	21
Fort William (Atholl Bank)	*Inverness*	7·03	10·78	274	153	1·45	31	27
Alness (Ardross Castle)	*Ross*	3·85	2·90	74	75	·71	20	26
Loch Torridon (Bendamph)	„	8·02	10·38	264	129	1·55	17	27
Stornoway	„	5·18	4·78	121	92	·58	9	27
Loch More (Achfary)	*Sutherland*	7·80	11·23	285	144	1·17	18,28	28
Wick	*Caithness*	2·96	2·32	59	78	·28	20	24
Glanmire (Lota Lodge)	*Cork*	4·15	3·08	78	74	1·11	1	14
Killarney (District Asylum)	*Kerry*	5·37	3·79	96	71	·72	9	19
Waterford (Brook Lodge)	*Waterford*	3·91	3·41	87	87	1·06	18	14
Nenagh (Castle Lough)	*Tipperary*	3·39	2·07	53	61	·37	1	20
Ennistymon House	*Clare*	4·40	5·39	137	123	1·61	9	21
Gorey (Courtown House)	*Wexford*	3·54	3·67	93	104	1·17	3	16
Abbey Leix (Blandsfort)	*Queen's Co.*	3·52	2·35	60	67	·43	22	18
Dublin (FitzWilliam Square)	*Dublin*	2·68	1·95	49	73	·43	22	17
Mullingar (Belvedere)	*Westmeath*	3·12	2·31	59	74	·35	1, 3	20
Woodlawn	*Galway*	3·72	2·97	75	80	·55	22	22
Crossmolina (Enniscoe)	*Mayo*	5·18	7·68	195	148	2·17	9	26
Collooney (Markree Obsy.)	*Sligo*	4·06	3·54	90	87	·86	21	25
Seaforde	*Down*	3·56	3·34	85	94	1·04	21	16
Ballymena (Harryville)	*Antrim*	3·69	3·49	89	95	1·18	21	21
Omagh (Edenfel)	*Tyrone*	3·67	4·35	111	119	1·20	21	23

Supplementary Rainfall, October 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	·97	25	XII.	Langholm, Drove Rd.	4·14	105
„	Sevenoaks, Speldhurst	1·41	36	XIII.	Ettrick Manse	4·65	118
„	Hailsham Vicarage...	·89	23	„	North Berwick Res....	3·43	87
„	Totland Bay, Aston ..	1·11	28	„	Edinburgh, Royal Ob.	3·80	97
„	Ashley, Old Manor Ho.	·98	25	XIV.	Biggar...............	3·13	79
„	Grayshott...........	·83	21	„	Leadhills	4·38	111
„	Ufton Nervet........	1·13	29	„	Maybole, Knockdon ...	4·03	102
III.	Harrow Weald, Hill Ho.	·82	21	XV.	Dougarie Lodge.......	5·25	133
„	Pitsford, Sedgebrook..	1·02	26	„	Inveraray Castle......	11·83	301
„	Chatteris, The Priory.	1·75	44	„	Holy Loch, Ardnadam	7·62	193
IV.	Elsenham, Gaunts End	·91	23	„	Tiree, Cornaigmore....	4·43	113
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„	Bolton, Queen's Park.	3·15	80	„	Darrynane Abbey	4·69	119
„	Lancaster, Strathspey.	2·66	68	„	Clonmel, Bruce Villa ..	2·39	61
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„	Bradford, Lister Park.	1·98	50	„	Roscrea, Timoney Pk..	2·06	52
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„	Lligwy	3·61	92	„	Milford, The Manse ..	4·19	106
XII.	Stoneykirk,ArdwellHo.	4·28	109	„	Narin, Kiltoorish	..	..
„	Carsphairn, Shiel.....	5·80	147	„	Killybegs, Rockmount .	8·19	208

Fortrose for September 0·67 in.

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	° F.		° F.		° F.	° F.	° F.	° F.
London, Kew Observatory	1014·8	−1·1	75	24	36	5	64·4	45·7	55·1	+1·7
Gibraltar	1014·6	−0·3	78	31	54	18	71·6	57·8	64·7	−0·6
Malta	1013·5	−0·2	77	16	51	6, 10	70·6	60·5	65·5	+0·4
Sierra Leone	1010·5	−1·2	92	1, 2, 17	65	31	87·7	70·0	78·9	−3·0
Lagos, Nigeria	1011·8	+0·8	99	4	72	17	84·5	75·6	80·1	−1·1
Kaduna, Nigeria	1013·2	+3·6	97	12	66	9,29,30	88·2	70·2	79·2	+0·1
Zomba, Nyasaland	1014·5	+0·2	81	3	51	17, 21, 22	73·4	55·9	64·7	−1·0
Salisbury, Rhodesia	1015·2	−2·9	81	1	41	30	71·2	49·5	60·3	−0·2
Cape Town	1019·7	+1·8	88	4	42	28	71·3	53·4	62·3	+3·7
Johannesburg	1020·4	0·0	67	14	35	28	61·2	43·8	52·5	−1·9
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	71	14	29	31	63·8	40·2	52·0	−0·7
Calcutta, Alipore Obsy.	1000·4	−3·1	102	24	72	4	97·1	81·3	89·2	+3·2
Bombay	1006·3	−1·4	94	12	79	9	92·5	81·5	87·0	+1·3
Madras	1002·8	−2·6	111	25	77	1	104·4	83·2	93·8	+3·9
Colombo, Ceylon	1008·2	0·0	90	23	71	26	88·2	79·4	83·8	+1·0
Hong Kong	1007·3	−2·1	87	4	70	28	81·3	74·1	77·7	+0·3
Sandakan	..	..	92	14	74	1	88·4	76·3	82·3	−0·3
Sydney	1017·7	−0·9	77	2	41	27	68·1	55·3	61·7	+3·2
Melbourne	1018·0	−1·2	81	5	39	29	63·5	48·3	55·9	+1·9
Adelaide	1016·4	−3·7	89	4	45	8	71·3	55·4	63·3	+5·6
Perth, Western Australia	1010·3	−8·4	80	2	47	18	69·1	55·8	62·5	+2·1
Coolgardie	1012·4	−7·4	85	3	41	19	68·5	52·6	60·5	+2·9
Brisbane	1017·5	−1·4	80	19	46	27	75·2	57·2	66·2	+1·8
Hobart, Tasmania	1017·1	+1·8	78	5	33	26	58·3	44·1	51·2	+0·8
Wellington, N.Z.	1019·6	+4·4	64	27	37	9	57·4	47·7	52·5	−0·3
Suva, Fiji	1013·5	+0·7	88	Sev.	67	19	87·3	72·0	79·7	+3·2
Kingston, Jamaica	1012·8	−0·5	91	10	70	7	86·8	72·2	79·5	−0·2
Grenada, W.I.	1012·3	−0·3	88	24	71	3	84·8	73·8	79·3	−0·2
Toronto	1016·6	+1·8	87	21	33	17	70·3	49·7	60·0	+7·3
Winnipeg	1016·7	+2·4	85	27	23	14	66·9	41·6	54·3	+2·7
St. John, N.B.	1015·6	+1·6	79	22	30	6	60·1	41·2	50·7	+3·0
Victoria, B.C.	1016·4	0·0	72	30	39	3	59·3	44·6	51·9	−1·2

LONDON, KEW OBSERVATORY.—Mean speed of wind 7·1 mi/hr, 2 days with hail, 3 days with thunder heard, 1 day with fog.

GIBRALTAR.—3 days with thunder heard.

MALTA.—Prevailing wind direction E, 1 day with fog.

SIERRA LEONE.—Prevailing wind direction SW, 9 days with thunder heard.

COLOMBO, CEYLON.—Prevailing wind direction SW; mean speed 7·2 mi/hr; 6 days with thunder heard.

	Mean M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
BRISBANE:—										
December 1920	1010·2	−1·6	97	17	64	10	87·0	69·1	78·1	+1·8
Year 1920	1015·9	+0·2	97	Dec.17	41	July13	77·3	60·1	68·7	−0·2
Corrected values for Suva, Fiji, Jan.–Apl. 1921. Jan.	1005·9	−1·8	90	5	71	2	86·3	73·1	79·7	−0·2
Feb.	1009·3	+1·6	90	9, 11	70	23	87·0	74·4	80·7	+0·2
Mar.	1008·6	+0·1	91	19	70	30	87·5	72·8	80·1	0·0
Apl.	1009·3	−1·3	89	17	68	16	85·8	71·6	78·7	0·0

Brisbane.—Max. temp. in sun:—Dec., 156; Year, 156.

British Empire, May 1921.

TEMPERATURE Mean Wet Bulb °F.	TEMPERATURE Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	PRECIPITATION Amount mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible	STATIONS
51·5	26	67	5·5	0·98	25	– 19	16	7·4	48	London, Kew Observatory.
59·7	49	75	3·8	1·39	35	– 10	5	..	..	Gibraltar.
62·1	50	74	4·1	0·56	14	+ 4	5	9·2	66	Malta.
75·5	..	71	5·6	6·21	158	–128	13	..	..	Sierra Leone.
78·5	68	94	6·8	21·55	547	+284	21	..	..	Lagos, Nigeria.
74·7	..	91	..	5·81	148	– 38	11	..	..	Kaduna, Nigeria.
..	..	87	4·7	1·47	37	+ 12	6	..	..	Zomba, Nyasaland.
54·5	39	67	4·5	2·52	64	+ 52	8	..	..	Salisbury, Rhodesia.
56·9	..	65	3·1	0·34	9	– 92	2	..	..	Cape Town.
44·7	32	69	3·5	1·15	29	+ 11	7	7·6	70	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
45·3	..	82	2·2	2·91	74	+ 44	5	..	..	Bloemfontein.
81·9	71	56	3·5	3·01	76	– 70	3	..	..	Calcutta, Alipore Obsy.
78·2	75	63	2·3	0·00	0	– 18	0	..	..	Bombay.
77·8	..	70	3·2	0·00	0	– 27	0	..	..	Madras.
79·8	70	72	7·8	5·09	129	–182	21	..	..	Colombo, Ceylon.
74·5	..	86	8·8	33·79	858	+561	25	2·9	22	Hong Kong.
77·3	..	80	..	4·61	117	– 35	8	..	..	Sandakan.
57·9	32	76	6·0	7·28	185	+ 59	20	4·1	39	Sydney.
53·2	35	77	5·9	2·73	69	+ 14	14	..	..	Melbourne.
55·5	35	59	6·0	4·57	116	+ 47	11	4·3	42	Adelaide.
58·9	38	78	7·0	10·56	268	+148	25	..	..	Perth, Western Australia.
57·4	38	69	6·6	3·98	101	+ 66	15	..	..	Coolgardie.
62·2	39	72	4·8	0·75	19	– 55	11	..	..	Brisbane.
46·8	29	76	5·7	1·23	31	– 16	14	..	..	Hobart, Tasmania.
..	29	82	8·3	2·62	67	– 53	20	3·3	33	Wellington, N.Z.
72·4	..	88	..	8·86	225	– 33	19	..	..	Suva, Fiji.
..	..	71	5·5	5·61	142	+ 32	13	..	..	Kingston, Jamaica.
74·1	..	71	4·0	3·26	83	– 35	15	..	..	Grenada, W.I.
51·9	28	72	4·8	1·88	48	– 28	12	..	..	Toronto.
49·0	..	66	3·7	1·76	45	– 12	9	..	..	Winnipeg.
46·0	27	74	5·2	1·80	46	– 48	10	..	..	St. John, N.B.
46·8	32	76	4·2	1·47	37	+ 4	7	..	..	Victoria, B.C.

HONG KONG.—Prevailing wind direction ESE; mean speed 9·7 mi/hr; 15 days with thunder heard.

ADELAIDE.—Max. temp. and mean max. and min. temp., highest on record.

PERTH, W. AUSTRALIA.—Heaviest rainfall for May since 1879.

COOLGARDIE.—Heaviest rainfall on record for May.

WELLINGTON, N.Z.—1 day with thunder heard.

GRENADA.—Prevailing wind direction E.

										BRISBANE:—
..	56	59	3·8	2·57	65	– 63	5	..	..	December 1920.
..	34	64	4·7	39·74	1009	–170	122	..	..	Year 1920.
77·7	..	87	6·2	20·49	520	+248	23	..	..	Jan. } Corrected values for Suva, Fiji, Jan.–Apr. 1921.
79·0	..	83	5·1	11·38	289	+ 32	23	..	..	Feb.
76·5	..	80	..	17·12	435	+ 62	24	..	..	Mar.
73·3	..	85	..	27·02	686	+399	20	..	..	Apl.

SUVA.—Days with thunder heard: January, 14, February, 7, March, 5.

causing the water to break in waves against the houses. The velocity of the wind recorded at the Oficina Meteorologica Argentina was 40 miles per hour at 8 h., 45 miles per hour at 14 h., and reached 47 miles per hour at 20 h. The damage done was immense; many houses collapsed, and loss of life was narrowly averted; the docks were completely flooded and new works largely destroyed, and there has been much damage to shipping. It is stated that at the time of the flood in Buenos Aires there was an exceptionally low tide in Montevideo, near the mouth of the estuary.

In Eastern Australia satisfactory rains have fallen, and crop and pasture prospects are good.

The rainfall of the month was below the average generally in the south-eastern half of the British Isles, the areas with more than the average lying mainly in the north-west of Ireland and west of Scotland. As much as 50 per cent. in excess was reached locally in these regions. Less than half the average fell generally south of a line from the Bristol Channel to the Wash, and only about 10 per cent. of the average fell in the south of Kent. Less than 25 mm. (1 in.) was confined to the south of England, less than 12 mm. (0·5 in.) falling along the coasts of Kent and Essex. More than 100 mm. (4 ins.) fell over considerable areas in north and central Wales, the English Lake District, the west and north of Ireland, and more widely in the west of Scotland. More than 250 mm. (10 ins.) occurred in Snowdonia, Connemara, and over a large part of the Western Highlands of Scotland. At Loan, near Loch Quoich, as much as 546 mm. (21·50 ins.) was recorded. On the 20th heavy rain fell during a thunderstorm in isolated areas in the south-east of England, when 62 mm. (2·54 ins.) was recorded at Horsmonden, near Tunbridge Wells.

For the nine months, February to October, a considerable area in the south of England has had less than half the average rainfall. The area concerned lies south of a line from the Bristol Channel to the Wash, and roughly coincides with the area which had less than half the average rainfall in October.

The general rainfall for October, expressed as a percentage of the average, was:—England and Wales, 51; Scotland, 105; Ireland, 92; British Isles, 80.

In London (Camden Square) the mean temperature was 56·2° F. or 6·0° F. above the average and the highest for October in the 64 years' record. Duration of rainfall, 8·5 hours; evaporation, 0·72 inch.

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The Sun and the Weather.

By R. M. DEELEY.

MANY writers on meteorology have tried to show that there is an intimate relation between the activities of the sun, such as are exhibited by sun-spots, &c., and the variations of the weather which take place on the earth's surface, the favourite line of attack being through periodicity. Most of the attempts to correlate sun-spot activity with weather-changes have been directed to the question of temperature and rainfall changes, and it would appear that sun-spot activity is in some places associated with cold, and in some with warm conditions, in some with increased, in some with decreased rainfall.

Our meteorological charts show us the changes of atmospheric pressure which occur on the earth's surface from month to month, and also, to some extent, the anomalous conditions of pressure which obtain when the climatic conditions of particular areas are unusual, but although very great attention has been paid to the daily and hourly variations of pressure which occur, there is no agreement among meteorologists as to how the conditions obtaining at any one time are brought about.

I have attempted* to show that if the winds be considered as resulting from the heating of the upper portion of the

* *Phil. Mag.*, July 1915, April 1916, and March 1918.

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stratosphere, as well as the lower portion of the troposphere, it is possible to account for the general pressure distribution and wind directions being as they are; but to do this it must be assumed that the stratosphere is mainly heated over the poles and the lower troposphere over the equator. Now the earth's atmosphere is warmed in two ways. The heat and light waves mainly pass through the upper atmosphere and heat the earth's surface and lower troposphere, whilst the electrons shot out by the sun are, as explained by Arrhenius, directed by the earth's magnetic field towards the poles, where they heat the upper atmosphere and cause the aurora. If such be the case the climate of the earth will be affected both by variations in the intensity of the heat rays emitted by the sun as well as by variation in the number of electrons shot out.

One way to detect changes in the number of electrons emitted from the sun from time to time would be by a study of auroral changes; for great auroral displays resulting from the sun's electrical activities should, theoretically, be accompanied by greater heating of the upper atmosphere over the poles* than over the equator.

From a study of barometric changes I shall attempt to show that the conditions in Great Britain during the long spell of dry hot weather in 1921 have been such as may be expected when the electronic bombardment is a mild one.

Encircling the earth along the equatorial regions is a belt of low pressure towards which the winds blow from easterly directions. This low pressure belt oscillates about the equator, following the sun as it moves north and south. The circulation of the atmosphere in this region appears to be caused mainly by the heat of the vertical sun acting upon the earth's surface and the lower atmosphere. If the winds

* Even as far south as lat. 35° N. Slipher has seen the green auroral line (λ5578). Lord Rayleigh remarks "I have succeeded in photographing the line on many nights for the past month. I do not always get it, and one of the failures has been on a fairly clear night. On the other hand, many of the successes have been on cloudy, though not, of course, extremely dark nights."

"At the present time sun-spot minimum is much nearer than during Slipher's experiments, and for this and other reasons I am inclined to think that I have been dealing with fainter auroras than he did."

"The programme in view is a systematic comparison of the auroral intensity with sun-spots and magnetic disturbances, and also a comparison of its intensities in different localities in Great Britain and elsewhere. So far as I have been able to learn, the auroral spectrum has not previously been photographed in this country." *Nature*, March 31st, 1921, p. 137.

It is to be hoped that all those who are in a position to do so will second Lord Rayleigh's efforts to obtain as complete a record as possible of auroral intensities, especially over Northern Europe, Asia and North America.—R. M. D.

[An account of Lord Rayleigh's further work in this direction is given on p. 295 of the issue for November.—ED. *Met. Mag.*]

of the earth were entirely due to the sun's heat acting in this way on the lower atmosphere and earth, the polar regions, not being so greatly affected by the sun's heat rays in summer, and being entirely in the shade during winter, would be areas of high pressure and intense cold, and the air would descend and blow towards the equator from easterly directions. But this does not take place, for over the polar areas there are great low pressure cyclones, towards which westerly winds blow. Over the Arctic regions the cyclone has what may be regarded as two low pressure eyes, one over the North Atlantic and the other over the Behring Sea, the warm seas probably assisting to cause an updraught, especially in winter. Between the polar low pressure areas and the low pressure equatorial belt, therefore, we have high pressure belts (anticyclonic), broken to some extent by reason of the varying temperatures of the ocean, as compared with the land. The two polar cyclones seems to be due to the heating of the upper atmosphere over the polar areas, such heating more than compensating for the comparatively thin cold layer near the ground. Now the positions of the two high pressure belts depend upon the diameters of the two polar cyclones, and if they decreased in diameter and strength the two high pressure belts would approach the poles. If this occurred in the summer, anticyclonic hot and dry conditions would travel towards the poles, but if in winter, anticyclonic and probably cold surface conditions would result. Thus decreased electrical activity on the part of the sun results in England in cold winters and warm dry summers.

During 1921 the high pressure belt covering western Europe has been much further north than usual, and consequently, over France and southern England particularly we have had exceptionally hot weather. The south-westerly winds which generally blow from the Atlantic during both winter and summer, and give us our cool summers and warm winters, are thrown far to the north, whilst France and southern England have dry warm easterly, southerly, or northerly winds. We thus have a continental summer instead of an oceanic one.

The actual climatic conditions produced by the shifting of the high pressure belts depends upon the position of the areas affected. Generally speaking, the result of decreased electrical activity is to move the hot weather and desert conditions nearer the poles in summer, but the distribution of the land areas and especially of mountain ranges exercises a considerable effect. Not only is this the case, but changes in the direction of the winds, caused by movements of the high pressure belts, modify very considerably the directions taken by the ocean currents and thereby modify the temperature and humidity of the air.

The more general rains, however, are the result of secondary or travelling cyclones causing currents of air to rise, the one over the other, and throw down moisture. Such cyclones seem to be fewer in number and of less strength when pressure is generally high and when there is a deficiency of electrical activity on the part of the sun, the chain of events in the northern hemisphere being (*a*) reduced activity of solar electronic bombardment, (*b*) increase of pressure near the pole, and northern march of the high pressure belt, (*c*) reduced frequency of westerly winds and cyclones crossing Western Europe, (*d*) reduced rainfall and hot weather especially in the northern portion of the British Isles.

Is the Propagation of Waves affected by the Rotation of the Earth?

By F. J. W. Whipple, M.A.

To most people who have not had occasion to study meteorology the dynamical influence of the rotation of the earth is a scientific curiosity which is illustrated by Foucault's pendulum and by the gyrostatic compass. To the meteorologist, the tendency of moving air to bear to the right in the northern hemisphere, to the left in the southern, under the influence of "geostrophic force," is familiar, but it is only recently that the like property of moving water has been fully realised. G. I. Taylor's investigations on the tides of the Irish Sea show that it is owing to geostrophic force that the range of the tide on the Welsh coast is much greater than that on the opposite Irish coast. As the flood-tide moves northward the water is piled up on the east of the Irish Channel, and during the ebb it is thrown away from the same coast. More recently Taylor has explained the movement of the tide in the North Sea, where the tidal wave as it comes in from the north hugs the British coast and sweeps round the Low Countries to Scandinavia.

The behaviour of Ocean currents is also explained by the action of geostrophic force. Currents in deep water are only appreciable near the surface; they are due to the dragging power of the wind, but as Walfrid Ekman predicted and as has been verified by Jeffreys, the currents do not flow with the wind. Under steady conditions the direction of motion of the water close to the surface is inclined 45° to the right of the direction of motion of the air. Theory indicates that at increasing depths the direction of motion of the water bears more and more to the right. The resultant drift is at right angles to the wind, this being the condition that the resultant geostrophic force may just balance the drag of the wind.

The action of the wind in producing high water in the narrow seas has not yet been fully investigated, but instances in which the action of geostrophic force is to be detected can be found without difficulty when once the clue is given. Two recent examples were mentioned in the last issue of this Magazine. Another will be found in the *Meteorological Office Circular* No. 31, where it is stated that the highest tides at Richborough were found with northerly winds.

The question whether the propagation of ordinary waves on the surface of the water is affected by the rotation of the earth does not seem to have been discussed, in fact speculation as to the origin of the "swell" observed either on the coast or in mid-ocean is always based on the idea that waves once started will be propagated in straight lines, or rather in the great circles which are the nearest possible approach to straight lines on a globe.

In view, however, of the acknowledged importance of the rotation of the earth in the theories of the tides and of ocean currents, it may be asked whether surface waves are not also affected.

If the motion of a wave on the sea were comparable with that of a particle on a smooth rotating globe its course would be very nearly a circle; in latitude L the wave-front would rotate through two right angles in a fraction $\frac{1}{2}$ cosec L of a day. Thus, near latitude 50° waves created by a west wind and moving at 40 knots from the west would be met 15 hours later and 400 nautical miles to the south as a swell from the east. Such a notable rotation, if it took place at all, would surely be well known to seamen. It is understood that the identification of the origin of "swell" is not always easy even when daily synoptic weather charts are available, and that some smaller rotation of the direction of movement might be admitted, but nothing like a complete reversal in 15 hours.

An examination of the problem from the mathematical point of view shows, however, that no such rotation is to be expected. The analysis given below indicates that the wave-fronts move straight ahead in spite of the movements of the individual particles in the water not being confined to planes at right angles to the wave-fronts. At the crest the particles are running with the wave, and owing to the geostrophic force they will have a slight acceleration to the right. In the trough there is a like acceleration in the opposite direction.

In the ordinary theory of long waves it is shown that the individual particles move in vertical circles in planes at right angles to the wave-fronts. When allowance is made for geostrophic force it is found that the circles described by the particles are inclined to the vertical; the tip is so small, however, that there is no possibility of detecting it by observation. We may therefore conclude that there is at present no reason to suspect any appreciable influence of the rotation of the earth on the propagation of swell.

It may not be irrelevant to mention, in conclusion, that with sound waves, where the period of oscillation of a particle is infinitesimal compared with the period of rotation of the earth, no effect of that rotation is to be expected. On the other hand, as Margules has realised, any theory of such waves as are shown in the regular diurnal changes of barometric pressure must be largely devoted to the consideration of this rotation.

Analysis.—Confining attention to the case of waves in a polar basin and taking the axes of x and y horizontal, that of z vertically downwards, the equations of motion are

$$\frac{du}{dt} - 2nv = -\frac{1}{\rho}\frac{\delta p}{\delta x}$$

$$\frac{dv}{dt} + 2nu = -\frac{1}{\rho}\frac{\delta p}{\delta y}$$

$$\frac{dw}{dt} = -\frac{1}{\rho}\frac{\delta p}{\delta z} + g$$

and the equation of continuity is

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0$$

where u, v, w are the components of the velocity, p is the pressure, n the angular velocity of the earth, g the acceleration due to gravity and ρ the density of the water.

A solution of these equations is

$$u = Ae^{-mz}\cos(kx - \sigma t)$$

$$v = \frac{2n}{\sigma}Ae^{-mz}\sin(kx - \sigma t)$$

$$w = -\frac{k}{m}Ae^{-mz}\sin(kx - \sigma t)$$

$$\frac{p}{\rho} = gz + \frac{k\sigma}{m^2}Ae^{-mz}\cos(kx - \sigma t)$$

with the condition $\sigma^2 (\sigma^2 - 4n^2) = k^2g^2$

An additional condition $\sigma^2 = mg$ is determined by the agreement between the upward velocity of the free surface with that of the water near the surface.

The existence of such a solution of the equation indicates that a series of waves can be propagated without change of direction. Moreover, since n is very small in comparison with σ the velocity of the waves is not appreciably affected by the rotation of the earth.

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OFFICIAL NOTICES.

Meteorological Office. Changes in Codes for Reports.

FROM 1st January 1922, the hourly reports issued by wireless telegraphy from the Air Ministry, primarily for the London-Continental Air Services, will be sent in the revised code adopted by the International Commissions for Weather Telegraphy and for the Application of Meteorology to Aerial Navigation at meetings held in London last September. The code will be brought into use from the same date by the French and Belgian Meteorological Services.

The revised code is shorter than the code at present in use; the specifications of the different code figures remain practically unchanged, but in the case of visibility the code has been modified to include a figure for distances of 50 kilometres and upwards. This modified code for visibility will be adopted in all British meteorological reports from 1st January.

Copies of the code and full particulars of the reports referred to may be obtained on application to the *Director, Meteorological Office, Air Ministry, W.C. 2.*

Official Publications.

British Rainfall, 1920. 9 × 6. pp. xxviii + 285. 2 plates. Fully illustrated. Price 12s. 6*d*. net.

THE sixtieth annual volume of *British Rainfall*, dealing with the records of the year 1920, gives evidence that the transfer of the work of the British Rainfall Organization from private to public control, a task attended with many difficulties, may now be regarded as having been successfully accomplished. The number of complete records available for the year was 5,452, an increase of 54 over 1919; this increase appears to put a period to the gradual decline in numbers which had been the natural result of the war.

An innovation introduced into the volume is the addition of a column to the general tables of rainfall, giving the number of days in the year on which ·04 in. (1·0 mm.) of rain fell at each station. This step has been taken as a result of the enquiry instituted in the volume for 1919 on the advisability of regarding ·04 in. as the unit for computing frequency of days with rain instead of ·01 in. as hitherto. The tabulation of dry and wet periods based upon the new unit has again been given side by side with the results by the older method. The advantages of the new definitions set out in 1919 have been confirmed. It is proposed, however, not to discontinue the use of the old definitions until a few years' comparative data are available.

The section dealing with Heavy Falls of Rain in 1920 contains an account of the disastrous storm at Louth on May 29th, 1920, when 22 lives were lost and damage to the extent of 100,000*l*. was done.

The statistical basis of the work has been greatly strengthened by the introduction, for the first time, of the recently computed rainfall averages for the period 1881–1915. In addition to bringing the tables into line with those published in this Magazine and in the *Monthly Weather Report*, the use of the new averages greatly improves the choice of stations for comparison with average conditions and enables the number to be increased. This affects the sections dealing with monthly and seasonal rainfall and with that of the year as a whole, and enables the maps illustrating these sections to be improved. The publication of a map showing the distribution of total rainfall during the year, on a scale of 80 miles to 1 inch, has again been possible.

The special articles include an account of the revised rainfall averages and the regional distribution which they indicate, illustrated by examples of the monthly average rainfall maps referred to in this Magazine for March 1921, p. 37, and comparing also the values for individual stations with those given by the average 1875–1909 previously used.

Another article deals with recent experiments by Mr. Wilfred Irwin on the salt-content of rain in the British Isles, suggesting a geographical distribution of considerable range and pointing out the economic bearing of the observations.

An account is also given of the development of the Nipher rain gauge shield in America and on the Continent of Europe, with suggestions for its adaptation for use in the British Isles.

British Meteorological and Magnetic Year Book, 1914, *Part V. Réseau Mondial.* Price 18s. net.

THE first volume of the Réseau Mondial to be prepared was that for 1911. Volumes for 1912 and 1913 followed and then 1910. With the resumption of international communication, it became possible to proceed with the preparation of later volumes, and that for 1914 has now been issued. For this volume the whole of the normals have been revised and a number of new values computed; it is hoped to publish these revised normals at a later date. Complete observations over Russia were unobtainable at the time, but it is hoped that they will be published eventually.

The Fernley Observatory, Southport. Report and Results of Observations for the Year 1920. By Joseph Baxendell.

IN addition to the usual full account of the weather at Southport the report of the Fernley Observatory for 1920 contains an account by Mr. Baxendell of an examination of a long series of mean winter-temperatures for London. The temperatures adopted are based on observations at various places in London with various exposures and various hours of observation, but they have been adjusted to be comparable with the means for the present exposure at the Royal Observatory, Greenwich. Mr. Baxendell finds that the five-year periodicity is well marked in these data, and that its length during the last 125 years lies nearly midway between 5·0 and 5·1 years with a slight lengthening tendency. The next minimum is due about 1921. The amplitude is nearly double that obtained by Capt. D. Brunt from whole-year temperatures, the reason being that easterly winds and clear anticyclonic weather increase the surface temperature in the summer. It is hoped that more detailed results of Mr. Baxendell's work will soon be available for publication.

Royal Meteorological Society.

THE first meeting of the session was held on Wednesday, November 16th, at the Society's new house, 49, Cromwell Road, S. Kensington.

Dr. Harold Jeffreys.—On the Dynamics of Wind.—The first paper was by Dr. Harold Jeffreys "On the Dynamics of Wind." Dr. Jeffreys sets down the general equation of motion of a fluid on a rotating globe and considers the order of magnitude of the various terms. This analysis leads to the division of winds into three main groups, according as the pressure differences between places at the same level are mainly occupied in producing acceleration relative to the ground, in guiding the wind under the influence of the earth's rotation, or in overcoming friction. In the ideal cases when these several causes predominate the winds are to be called "Eulerian," "geostrophic" and "antitriptic" respectively. The name Eulerian is in honour of Euler who was the first to give the equations of fluid motion; the word geostrophic, meaning in tune with the earth's motion, was coined by Sir Napier Shaw and has been generally adopted; the denomination antitriptic, *i.e.*, opposed to friction, has been invented by Dr. Jeffreys for the present paper. It appears that tropical cyclones and tornadoes are Eulerian; all winds of wide extent, including the winds of the travelling cyclone of temperate regions as well as the great air-currents like the monsoons and trades, are approximately geostrophic whilst sea and land breezes, mountain and valley winds are mainly antitriptic.

The part played by temperature differences in producing wind is analysed with special reference to the alternation of high and low pressure in winter and summer in central Asia, and to the production of land and sea breezes.

In the discussion on this paper Mr. Whipple insisted that though mountain-breezes directing the drainage of cold air into the valleys at night were common there was no reverse movement of the air by day; the winds that blew in the day time in the valleys were the more general currents. Mr. Whipple also pointed out that sea breezes were affected by the rotation of the earth. Observations at Aberdeen showed that the sea breeze was nearly perpendicular to the shore at first, but by sunset it was nearly parallel to the shore.

N. K. Johnson, B.Sc.—The Behaviour of Pilot Balloons at Great Heights.—Wind structure in the upper atmosphere is almost invariably determined by following a pilot balloon with a single theodolite. At a few stations the balloon is followed by two theodolites, but in the great majority of the determinations only a single theodolite is used. The reduction of observations with a single theodolite rests upon the assumption that the rate of ascent of the balloon is uniform, and therefore any departure from uniformity in the rate of ascent will give rise to errors in the computed wind velocity and direction. In the case of a pilot balloon observed with two theodolites at the ends of a base line, the actual height of the balloon is calculated from minute to minute, and no assumption is therefore needed as to the constancy of the rate of ascent. On the contrary this method affords a means of testing the accuracy of the assumption which has to be made in the single theodolite method. Evidence bearing on this point is given by observations made at Shoeburyness during 1920, and examples are given which illustrate the untrustworthy nature of the single theodolite method of observation at great heights. Balloons which had risen steadily to considerable heights developed leaks, and either drifted horizontally or began to fall. Experiments on the leakage of pilot balloons are detailed, and from these the author re-affirms that the results of single theodolite pilot balloon ascents which are carried to great heights must always be received with great caution.

In the discussion on this paper Captain Cave expressed the opinion that the leakage of gas from a balloon was sometimes intermittent, the hole through which the gas had escaped closing when the balloon reached a lower level. Mr. Corless emphasized the importance of the highest accuracy in the construction and use of theodolites for observing balloons at great distances, especially when two theodolites were used.

C. J. P. Cave, M.A.—The Cloud Phenomenon of November 29th, 1920.—As was mentioned in the *Meteorological Magazine*, December 1920, p. 256, a cloud with a sharp-cut edge passed across the east of England on November 29th of that year. Captain Cave presented to the Society an account of this phenomenon. The cloud was observed as far north as Worksop, Notts, and as far south as Hawkhurst, Kent. It moved from the west with clear sky in front, overcast sky behind, but the maps prepared by Captain Cave show that the progress of the edge was not regular. The cloud seems to have been built up more or less continually by air rising in front of the cloud and streaming nearly parallel to the edge from north to south. A fascinating riddle!

Discussions at the Meteorological Office.

Nov. 14th. *Is the Atmosphere Warmed by Convection from the Earth's Surface?* By W. Schmidt. Meteorologisch Zeitschrift. September 1921.

THE heating and cooling of the atmosphere depend on the balance of several causes, radiation, convection, evaporation and condensation all playing their part, as well as compression and rarefaction. It is widely believed that, on the average, the direct contact of air with the ground heats the air more than it cools it. In this paper by Dr. Schmidt (which was introduced by Capt. Brunt) the results of some numerical investigations of the convective transference of heat, based on observations in India, Germany, and Hungary are discussed. Dr. Schmidt concludes that the resultant flow is downwards and averages 50 gram-calories per square centimetre per day. Objection to this conclusion, which is opposed to that of Mr. W. H. Dines* was raised by several speakers. The rate of transference of heat depends on both the eddy conductivity and on the difference between the adiabatic and actual lapse-rates of temperature. When the lapse-rate exceeds the adiabatic, the vertical exchange of mass is a much more vigorous process than when it is less. Consequently, Schmidt's use of mean values of the lapse-rate may have led him to underestimate the transference of heat upwards very considerably. On the other hand, the absence of a diurnal variation of temperature at heights of two or three kilometres indicates that these layers are not warmed appreciably from the ground.

Nov. 28th. *The Origin of Continents and Oceans.* By A. Wegener. Die Wissenschaft, Bd. 66, 1920.

THE problem of the origin of continents and oceans has received much attention but most theorists have worked with the idea that the present land masses have occupied similar relative positions since their first solidification. Dr. Wegener, whose work was explained by Dr. G. C. Simpson, allows the continents to slide over the globe, and finds evidence that parts which were in contact in past ages are now widely separated. Perhaps the best example of this separation is the case of South America and Africa. It is obvious, on the map, that these continents would fit together pretty well, and the fit becomes better if the edges of the continental shelves are considered rather than the shore-lines. Moreover, bringing the continents together brings into juxtaposition rocks of like character. The striking Glossopteris flora of Carboniferous

* *Q. J. R. Met. Soc.*, Vol. XLIII., 1917, p. 155.

age is found only in South Africa, South America, Madagascar, India and the Antarctic. Wegener suggests that the land masses of the globe were formerly all connected so that these countries were close together, and that the single continent of that period has broken up into several fragments which have separated and moved over the semi-fluid interior of the earth into their present positions. The theory avoids the assumption of several vanished continents, which is generally adopted as an explanation of the distribution of the Glossopteris flora Moreover, a shifting of the continents relative to the pole gives a possible explanation of glacial periods. A general westward movement of the land-masses is postulated, whilst resistance to this movement accounts for the curvature of the extreme south of South America and the neighbouring part of Antarctica.

So startling a theory naturally gave rise to vigorous discussion, various speakers criticising it in its dynamical, geodetic, astronomical and geological aspects. It was agreed, however, that the theory did co-ordinate a large number of facts which were not otherwise explained except by many *ad hoc* assumptions, and opened up a wide field for closer investigation.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

The Loss of the R. 38.

None of the orthodox meteorologists having endeavoured to explain the reason of the destruction of the R. 38 in very thundery weather at the mouth of the Humber, permit me to give what was most probably the cause, viz.:—The airship running into a small circular storm or whirlwind. The five shocks spoken of by one of the survivors of the disaster would thus be accounted for, as the airship would have been struck fore and aft in different directions.

I have been within a few yards of one of these storms in the summer of 1893 which struck an oak tree in front of me, stripping it of twigs and leaves, the whirlwind breaking at the bank of a river 100 yards or so away from me.

I should further like to state that during the past two or three years I have been able to locate many of the big storms, and I believe the track of these storms is ascertainable beforehand.

I have been able to follow the course of one or two of these and if they start in a certain district seem to have an inclination to disperse or break up in the same place time after time. W. M. ROBERTSON.

The Longacre, Cheltenham, Oct. 28th, 1921.

[The R. 38 was the airship finished by the Air Ministry for the American Government; she crashed on August 24th, 1921, during her trial trip and fell in the Humber about 17 h. 40 m. The catastrophe has not generally been attributed to meteorological conditions but the final report of the Committee of Inquiry has not yet been issued.—ED. M.M.]

Meteor Trails and Upper Air Currents.

WITH reference to the remarks on this subject in your November issue, I believe that the relative scarcity of effective observations is due more to a lack of observers than to a lack of meteors. For every fireball whose path is well determined there are hundreds of thousands which pass unrecorded over some region of the earth's surface, but perhaps not more than one tenth of these would leave durable trails.

It is frequently the case that a large fireball travels over England, without attracting more than one person to record its flight, and some pass without any notice. If astronomers and meteorologists generally were sufficiently interested to keep careful watch and to report such objects whenever they appear we should soon accumulate a large amount of new data. At the present time there are only five or six habitual meteoric observers in the Kingdom, and in other countries there is hardly any practical attention given to the subject of meteoric drifts, so that year after year there is very little addition to our knowledge.

In *Symons's Meteorological Magazine* for March 1913, I gave some results of calculation of the velocities and directions of meteor-drifts, but most of the computations were based on incomplete or rather rough data, so that exact or detailed conclusions could not be reached with safety.

There are hundreds of descriptions of long-enduring meteor trails (streaks or trains) in the reports of the Luminous Meteor Committee of the British Association for the years 1848 to 1881, but nearly all these descriptions lack essential details and few are sufficiently accurate for critical purposes.

If by a system of rocket-firing any vaporous or gaseous clouds can be visibly formed in the higher atmosphere and enable details of the upper drifts to be suitably determined it is to be hoped that this method will soon be realised, as it will avoid the delays in awaiting natural occurrences. But the cosmic clouds generated by meteoric fireballs should also afford useful evidence, and especially if a more widespread endeavour were made to deal with them in an effective manner.

W. F. DENNING.

Bristol, Nov. 17th, 1921.

The Measurement of Snow.

THE principle that practice is better than theory applies most aptly to taking meteorological observations. I venture, as an observer for more than half a century, to offer a few remarks on "The Measurement of Snow" dealt with in the *Meteorological Magazine* for October. I have had no experience of the hot water chamber which is fitted in some gauges, although, offhand, it seems feasible. Casella refers to such a gauge with a jacketed funnel in a recent catalogue of instruments. In course of experience I have carried the funnel and inner reception can indoors, although I do not like this method.

There is no occasion to lose any of the snow, for the outer body of the gauge, which is practically the same diameter as the funnel, will serve to catch what falls while the melting is in progress, and this extra snow may be transferred finally into the inner reception can.

The method of pouring a measured quantity of hot or boiling water into the funnel of an all-metal gauge to melt the snow is, in my judgment, the best method to be adopted by an ordinary observer. I have done this for more than half a century, using generally a graduated metal milk measure to gauge the amount of water added, and subtracting an equal quantity before measuring the precipitation. I first adopted this method from a suggestion made by Mr. G. J. Symons, who was my colleague in the Meteorological Department in the early sixties. I should, personally, strongly object to applying a hot cloth to the funnel or can, as this method seems too troublesome, at any rate in a snowstorm, even if efficacious, though in fairness I may say I have never tried it.

I have seen it suggested that an allowance should be made by measuring the depth of snow as it has fallen and estimating that a foot of snow yields about an inch of rain; this is far too rough an approximation, owing to the great range in the density of the snow at different times of occurrence.

CHAS. HARDING.

2, *Bakewell Road, Eastbourne, Nov.* 1921.

Long-Range Forecasting.

WILL you permit me to comment very shortly on Mr. E. V. Newnham's article on "Long-Range Forecasting"?

As the originator of the system of Periodic Weather Forecasting I might mention that in 1916, when Mr. Newnham lectured on "Rainfall and Periodicity," I called his attention to the fact that all weather in this country was periodic, both as regards drought, heat and cold. At that time I had never kept a note or attempted long-range forecasting. It was only after an interview with Lieut. Grant at the Admiralty on October 2nd, 1917, and at his request, that I first issued long-range forecasts, and finding that my forecasts were generally fairly accurate, after enlisting the services of Mr. D. W. Horner, we recently published in *Simple Weather Forecasting*,* the methods we pursue. I have not the slightest doubt that if meteorologists, or even laymen, will study our theory they will find that generally accurate forecasts can be made without using any instruments. As regards the long-range forecast issued by the Meteorological Office, I wrote early on Sunday, September 25th, an article for the *Dundee Courier* pointing out that an Indian Summer was probable as wind was light north-west. This wind shifted to north-east on 26th and in that district this shift of wind usually causes some trouble and frequently denotes changes further south later on, so that I was able to warn a past President of the Royal Meteorological Society of the depression off Ireland of October 2nd, twenty-four hours beforehand. If meteorologists will purchase our book and will send me descriptions of their thunderstorms during the summer I believe that the actual direction in which these are likely to travel may be traceable, but it would be far better if the Meteorological Office would lend its assistance, as I find playing a lone hand entails an enormous amount of correspondence.

In conclusion I should like to add that the gale which proved so disastrous to the German Zeppelins was forecasted to Lieut. Grant some days beforehand for twenty-four hours later than it arrived, but warning was sent to him midday of its coming within a few hours and every airman should be instructed in my system. Certain districts in the North Sea and round our coasts in certain weather might be death traps to any novice. W. M. ROBERTSON.

The Longacre, Cheltenham, Nov. 28th, 1921.

* *Simple Weather Forecasting for Everyone*, by Donald W. Horner and W. MacDonald Robertson. 8vo, *illus.* Tunbridge Wells: The Courier Printing and Publishing Co., Ltd., 1921.

Exceptional Visibility.

My attention has been called to a note in the *Meteorological Magazine* with reference to a statement that "the Ordnance "Surveyors were able on July 15th, 1844, with the aid of a "small glass, to see a staff about 4 inches in diameter on "Dunstable Downs," from Leith Hill 47 miles away. It is the case that observations were taken from Leith Hill in 1844, with the 36-inch theodolite; but there is no mention in the Ordnance Survey records of any staff being observed. As a fact heliostats were used; and I think that a staff "4 inches in diameter" would have been quite invisible at the distance named, through "a small glass."

C. F. Close, Colonel, Director-General, O.S.

Ordnance Survey Office, Southampton, Nov. 30th, 1921.

The Early Frost.

As evidence of the severity of the frost in this district, I may mention that on November 11th—Armistice Day—I walked across a brook 13 feet wide on ice which never even cracked. There was not much current, the stream being very low, but about a foot deep just above a weir. This is the earliest date on which I have ever known ice to bear a man, the fact that it was running water makes it still more remarkable. The exposed thermometer had been as low as 11° F. and the highest temperature reached was only 35°, there being no perceptible thaw in the shade. R. P. Dansey.

Kentchurch Rectory, Hereford, Nov. 12th, 1921.

NOTES AND QUERIES.

A Rate of Rainfall Recorder.

An interesting attempt to solve the problem of constructing an efficient instrument for recording the instantaneous rate at which rainfall occurs has been made recently by Messrs. Negretti and Zambra.

The principle adopted is that of recording the weight of water passing down an inclined surface at any given moment, the weight varying with the rate of flow. The inclined surface takes the form of a tube in the shape of a spiral, and is delicately suspended at one end of a balanced lever, the other end of which carries the pen. The angular fall of the coil is about 18° and is a compromise between a steep incline that would empty rapidly but hold too little water to work the pen, and a gradual one that would hold a lot of water and take a long time to empty, but which would bring the pen to zero after the rain had ceased. The rain is collected in a funnel 16 inches in diameter.

This instrument is a decided advance towards the desired end, and, though it has several defects which render it of little value for statistical purposes, its records are very interesting.

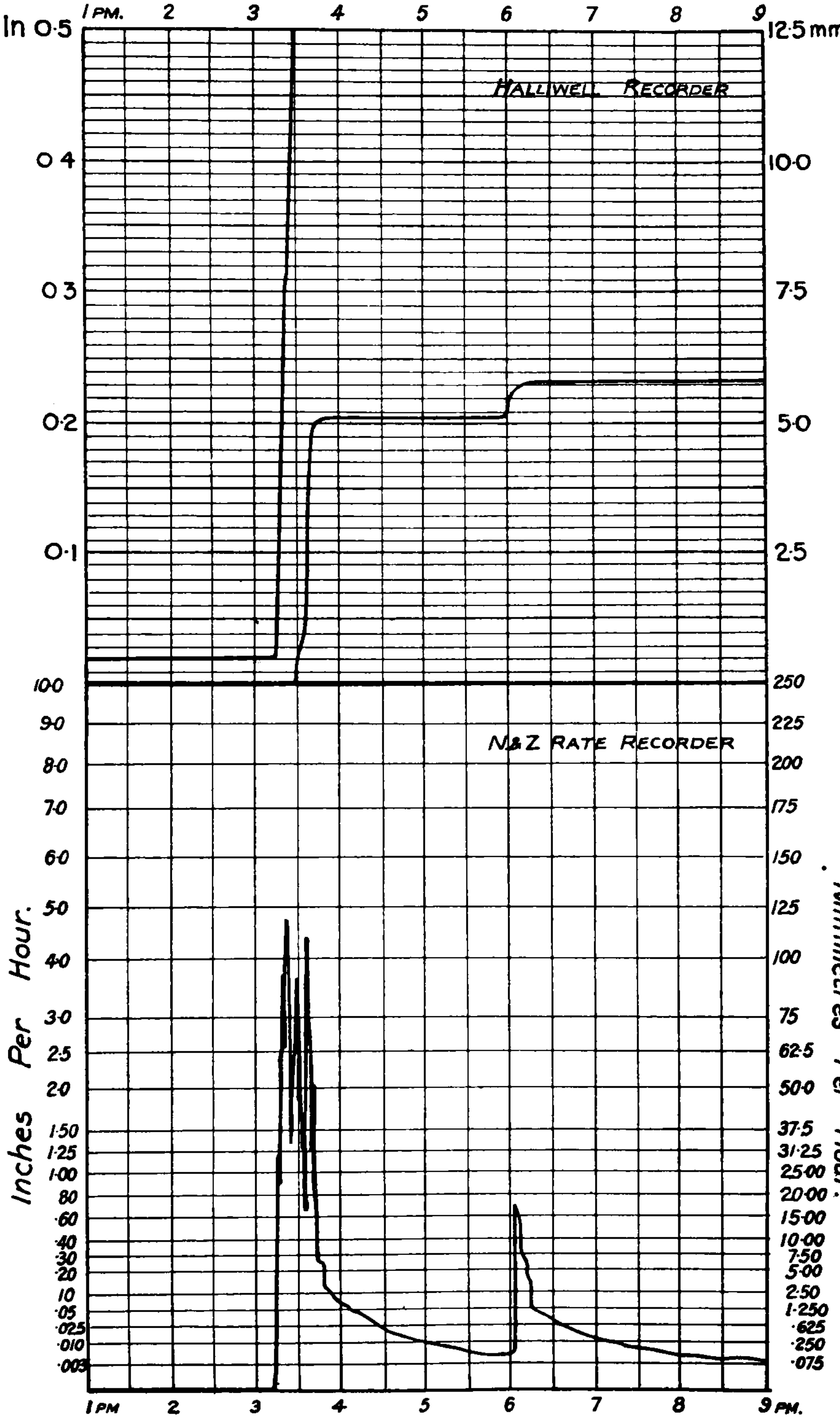
Perhaps the first criticism one may make is that the scale of the chart is not linear. For low rates of fall the scale is very open, decreasing to a minimum for falls of about 10 inches per hour. This lack of uniformity of the scale makes it almost impossible to check the records in the only really satisfactory manner, namely, by integrating the curve and comparing the result with the total fall recorded during the same period by an ordinary rain-gauge. If one knew that the record given by the instrument was a true one, uniformity of the scale value would not be so important, but unfortunately there are only too many indications that the record itself is untrue. The contraction of the scale value at the higher rates has, however, the important advantage that information as to heavy rates can be obtained without risk of the pen passing off the record sheet.

So far as the actual working of the recorder is concerned it has been noted that whenever the funnel and spiral tube are wet, the commencement of rain is marked, as one would expect, by a sharp rise of the pen until the actual rainfall rate is reached, followed by a steady or jerky trace according to the varying intensity of the rainfall. This is quite satisfactory; but if, on the other hand, the funnel and tube are dry when rain commences, the water is held up by surface tension, firstly in the funnel, and secondly, in the tube itself. The result is that until this surface tension effect is broken down by a sufficient head of water at the top of the tube, the pen is rising above the height indicating the true rate of rainfall. In the case of a gentle, steady rain this effect, although often very considerable, is perfectly obvious judging by the trace, but in showery weather in which funnel and tube have time to dry between the showers it is not always possible to tell whether the record is true or not.

Another obvious defect shown by the records depends on the fact that the draining process after the cessation of rain takes a considerable time, and, although on the average it does not appear obvious on the chart until the pen drops to the ·003 inch per hour mark, there are occasions when this process commences as high as the ·10 inch per hour mark.

Rain Gauge Records at 62 Camden Square.

Tuesday 23rd August 1921.



The distortion of the trace thus produced is a characteristic of the instrument, and one cannot be sure to what extent this process goes on whilst rain is falling as well as after its cessation. Any checking by comparison with an ordinary gauge is also effectively prevented by this distortion.

The extreme sensitiveness of the balance of the lever, brought about by the special design of its fulcrum, to some extent defeats its own object. It makes the instrument so liable to accidental errors in registration that their magnitude is often greater than the variations which it is trying to record. Apart from the enormous effect of initial hold-up, smoothing out of variations in the process of draining, and of final draining, the slightest jar to the instrument, such as opening the lid, or sometimes only walking past it, will produce a jump on the trace which, if the chart were examined by anyone not familiar with the facts, or at a later date than the time of occurrence, would be quite indistinguishable from an actual shower trace. In practice such a disability is serious.

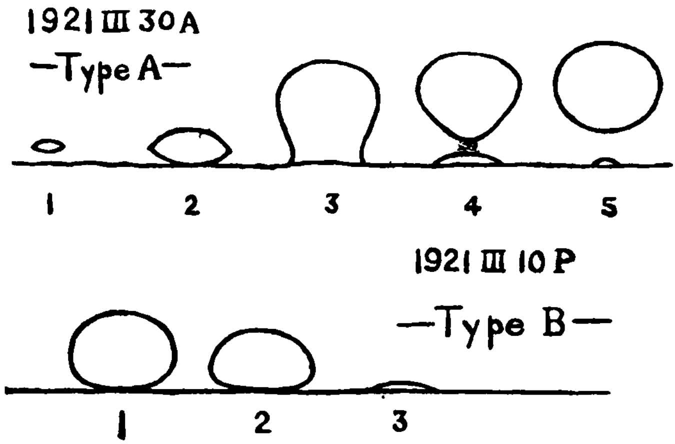
The records reproduced on p. 331 were obtained at Camden Square on the occasion of the thunderstorm of August 23rd. The initial rise in this record appears to be a true one, although no confirmatory evidence can be given that the rate of 4·5 inches per hour was actually reached. The fall between 3 and 4 p.m. is officially quoted as ·68 inch (17·3 mm.) in 26 minutes, that is, the mean rate of fall was 1·57 inches per hour. At South Kensington the total fall was 12 mm. (·47 inch), and careful measurements of the Halliwell Recorder trace gave the fastest mean rates of fall for 1 mm. as 60 mm. (2·36 inches) per hour, and for 5 mm. as 50 mm. (1·97 inches) per hour. From these results it therefore seems quite possible that the rate of rainfall did actually attain the value 4·50 inches per hour for short periods. It appears probable that in this instance the rate was high enough to mask any initial hold-up which may have occurred. The draining process is clearly marked at the cessation of both downpours, commencing just above the ·10-inch line in the first case and at the ·05-inch line in the second. It will be noted from the record that the pen did not reach the base line even after two to three hours draining.

In conclusion, one may say that the instrument will probably record faithfully rainfall rates exceeding ·10 inch per hour, but below that limit, the draining process and the initial hold-up are sufficiently marked to vitiate the records. In justice to the makers it must be pointed out that in producing this instrument they are doing valuable pioneer work. The only rate of rainfall recorders in use hitherto appear to be those described (in Japanese) in the Journal of the Meteorological Society of Japan, Vol. 24, June 1905 and Vol. 28, May 1909, and the new instrument aims at much greater precision.

N. H. SMITH.

The Duration of Sunrise and Sunset.

Nature of October 13th, 1921, contains an interesting letter by Mr. Willard J. Fisher of Cambridge, Mass., on the duration of sunrise and sunset. The observations were made with



a view to comparing observed and computed duration. The observed duration is the interval between the time at which the lower edge of the sun appears to be in contact with the horizon and the time at which the upper edge is just seen. The computed duration is determined on the hypothesis that refraction may be ignored* entirely. Seventy-nine observations were taken, mostly with marine horizons, the viewpoint varying from the sea-beach up to an elevation of 1512 metres. There seem to be two types of marine sunrise and sunset. With type A., which is about twice as frequent as the other and which is accompanied by horizon mirage, there is a slight excess of observed duration over the computed duration, amounting in 44 cases to 0·55 per cent.; a few cases give small deficiencies. Type B., however, always gives excess, sometimes even as large as 2 mins., or 68 per cent., with an average excess for 22 cases of 12·3 per cent.

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* In the *International Meteorological Tables* the times of sunrise and sunset are determined as the times at which the centre of the sun appears to be on the horizon, the centre being raised 34 minutes of a degree by refraction.

Mr. Fisher points out that such observations are almost non-existent and that amateur observers in as many places as possible are desirable. The subject is meteorological not astronomical, since the duration of sunrise and sunset depends on temperature distribution in the atmosphere.

A useful table of the duration of sunset for 1922 has been computed by Mr. Fisher and is published in *Nature* of December 1st.

Meteorology in Brazil.

We learn from *Auto-Propulsão* of September 1st, 1921, that the National Observatory of Morro do Castello, at present the headquarters of the Brazilian Meteorological Department,* has initiated an ambitious programme under the leadership of Dr. Sampaio Ferraz. The first aerological soundings to be made in Brazil were carried out with some ceremony in the presence of the Minister for Agriculture. They reached 21,760 metres (wind, north), and 8,000 metres (wind, north-west), respectively. Three kite-balloon stations and 18 pilot-balloon stations are to be established within a year. The new Meteorological Department will continue the climatological work instituted in 1909, standardising the methods of all the meteorological institutions throughout Brazil, and publishing the results of the last ten years. A Forecast Service will also be established for the whole of Southern Brazil, and an Agricultural Meteorological Service will study the influence of weather on crops, a Maritime Service will be established with a special section for rain and floods, and provision has been made for research, including long-range forecasting.

We are glad to be able to announce that Dr. Sampaio Ferraz has arranged to telegraph each month for publication in this Magazine an official summary of the weather in Brazil.

The summary for October, which was received too late for inclusion in the November Magazine is as follows :—

> The pressure distribution over the Southern States was generally irregular during October ; the weather was rather cooler than usual over the South and Centre, and abnormal cloudiness was experienced over the whole country. Rainfall was deficient in the north, especially in Ceara, Pernambuco and Parahyba, and the rains in Central Brazil were so much retarded that the coffee plantations in Spaulo were sensibly affected, and agriculture and dairy work in general suffered.

The summary for November will be found on p. 339.

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* *Meteorological Magazine*, Sept. 1921, p. 225.

Meteorology in Russia.

METEOROLOGISTS will learn with interest that steps have been taken to re-organise the Russian Meteorological Services. All independent services have been absorbed in the organization based on the Central Physical Observatory, a return to pre-war conditions. In order to co-ordinate the work of different organizations carrying out meteorological or geophysical research, a committee has been formed consisting of representatives of the government departments interested, the Director of the Central Observatory being president.

Regional and provincial meteorological bureaus are to be established so that all districts in the Republic may receive forecasts in good time. A radio-station for receiving messages from meteorological stations in western Europe and in Russia is to be established at headquarters; meteorological messages are to take precedence of all others at telegraph offices and the Central Observatory is to be allowed the use of the telephone line from Petrograd to Moscow for ten minutes daily. Moreover a legal liability is to be imposed on any one who fails to take the necessary steps for the urgent transmission of meteorological information. The Supreme Council of Public Economy is to transform the workshops of the Central Observatory into a fully-equipped factory for the manufacture of meteorological instruments and to provide for the printing and publishing of reports and other literature.

Meteorological Stations.

Weston, Newtownbarry.—A climatological station has been instituted at Weston, Newtownbarry, co. Wexford, by Mr. G. T. Lewis, and a summary of the first return of the observations has been published in the *Monthly Weather Report* for October. This station fills a gap in an otherwise unrepresented district in south-east Ireland.

The Symons Medal.

THE Council of the Royal Meteorological Society has awarded the Symons Memorial Gold Medal for 1922 to Col. Henry George Lyons, F.R.S., for distinguished work in connection with meteorological science.

The medal, which is awarded biennially, will be presented at the Annual General Meeting on January 18th, next.

Shall Climatological Data be published for a "Climatic" rather than a Calendar Year?

THE United States Weather Bureau has instituted an inquiry into the desirability of publishing climatological data for a year beginning on September 1st or October 1st instead of or in addition to the calendar year. The chief argument for the change is that the transition from one year to the next would take place at a time of minimum precipitation, at any rate for California, the state from which the proposal originates. It has already been adopted by the Water Resources Branch of the U.S. Geological Survey. A *questionnaire* is being circulated on the subject, and all users of the precipitation data of the Weather Bureau are invited to communicate their views.

The Seasonal Aneroid.

IN the *Meteorological Magazine* for January, 1921, Vol. 55, page 279, reference was made to Dr. Chapman's "Seasonal Aneroid." We learn that the maker of this instrument is Mr. F. Darton, of 142, St. John Street, E.C. 1, who is issuing a pamphlet dealing with it.

News in Brief.

The *Journal of Hygiene*, Vol. 20, p. 248, contains a paper by Dr. Matthew Young on the "Regional Distribution of Rheumatic Fever." Dr. Young states that acute rheumatic infection is more common in the north and west of England than in other districts and that it is associated with high rainfall and low temperature. He finds a positive correlation between the death-rate from rheumatic fever and the mean annual rainfall, and a negative correlation between this death-rate and the mean annual temperature.

"Everyone is interested in the weather" is one of the mottoes of Messrs. Negretti and Zambra's price list "for December 25th." Among other suggestions for gifts are shewn aneroids, barographs, and the patent forecaster. According to a statement in a recent number of this Magazine "instrument makers report a steadily increasing demand for barometers with the millibar graduation," but the Philistines will rejoice to find that all the barometers and all the barograph charts shewn in this list shew inches only.

THAMES VALLEY RAINFALL — NOVEMBER, 1921.

ALTITUDE SCALE

Below 250 feet	250 to 500 feet	500 to 1000 feet	Above 1000 feet

SCALE OF MILES

0 5 10 15 20

Watershed of River Thames above Teddington and River Lea above Feildes Weir.

Isohyetals.

H.M.Stationery Office Press, Kingsway W.C.2.

On December 2nd, a "Geophysical Discussion" was held in the rooms of the Royal Astronomical Society. The discussion, which was opened by Dr. H. Jeffreys was on "Certain Geological Consequences of the Cooling of the Earth." Dr. Jeffreys elaborated the hypotheses set out in his recent paper in the *Proceedings of the Royal Society*, A. Vol. 100, 1921. Sir Jethro Teall was in the chair, and Dr. J. W. Evans, Col. E. H. Grove-Hills, Mr. R. D. Oldham, Prof. W. G. Duffield, and Dr. G. C. Simpson took part in the discussion.

On November 18th the Association of Economic Biologists held a discussion on "Meteorological Conditions and Diseases" which was opened by Dr. E. J. Butler.

On December 5th, Col. E. Gold lectured on "The Application of Meteorology to Aviation" before the Scottish Branch of the Royal Aeronautical Society, at the Royal Technical College, Glasgow.

On December 6th, Sir David Wilson-Barker read a paper on "Weather at Sea, including Clouds, Waves, &c.," before the Institute of Marine Engineers.

On December 12th, Dr. Owens gave a demonstration on "Dust in Expired Air" before the Medical Society of London.

The Weather of November, 1921.

After the first week in November, which was unsettled everywhere with high winds and considerable precipitation, the weather of north-western Europe with the exception of the extreme western districts can be summarized as quiet, cold, generally frosty and dry. The absence of wind together with the cold produced somewhat frequent fogs especially near industrial centres. Sunshine was above the average amount in eastern and southern England.

The extreme western districts, Ireland for most of the month and the west coast of Norway at times, were within a warm equatorial current. Temperature and rainfall were distinctly above and sunshine below the normals for the month in Ireland.

On the first day of the month a deep depression was centred over Scandinavia causing north-westerly gales on the Norwegian and Danish coasts and in the north of Scotland. The effect of these gales in causing high tides in the Thames was mentioned in the last issue of the *Meteorological Magazine.* From Bornholm there was reported a wind of force 11 on the Beaufort scale blowing continuously for 12 hours. Wrecks with accompanying loss of life occurred in the North Sea. Rain fell heavily in the wake of this depression and local showers of sleet or hail occurred in Scotland. As this depression moved away in an easterly direction a complex, rapidly varying, pressure distribution took its place over north-western Europe with generally unsettled weather.

A depression which appeared off the coast of Ireland on Saturday evening (the 5th) crossed the centre of England deepening very considerably as it moved and causing gales and heavy continous rain over England during Sunday. Cross-Channel services were delayed, telegraphic communication was cut, and a number of wrecks occurred in the North Sea and the English Channel. A minor effect of these high winds noticeable in the London area was the stripping of the trees which up to November 5th had lost very few of their leaves. On the 7th and 8th the disturbance with its violent cyclonic weather passed over the North Sea and the south of Denmark to north Germany. Behind this depression the temperature fell considerably and sleet or snow showers occurred throughout Scandinavia, Scotland and eastern England. The somewhat early immigration of wild geese to our northern and eastern shores during this period was hailed as an infallible sign of a hard bitter winter to come. In the frost which followed there was quoted (probably by the same prophets)—

> "Ice in November to carry a duck,"
> "Will bring nothing after but slush and muck."

The morning of the eighth saw an elongated area of high pressure off the west of Scotland. The movements and meanderings of this system have been the determining factor in the weather of north-western Europe throughout the rest of the month. On the evening of Tuesday, the 8th, the central region lay over England and severe frosts with local falls of snow were experienced. During the next two or three days the "high" extended from south-east England in a north-easterly direction so that the south-east of England, France, Belgium and Germany were getting their air supply from the north-east, chilled also by its passage over the radiation-cooled land, resulting in fine, frosty, wintry weather. Heavy snow to a depth of a foot fell in Switzerland. Skating was enjoyed in many parts of England.

On the other hand the west of the British Isles was getting air from a southern region. This caused a typical winter distribution of isotherms over the British Isles with the lines of equal temperature running north and south—a complete and sudden change from the typically summer distribution of isotherms of the middle of October.

By the 13th the highest pressure had moved to northern Russia and from the 13th to 17th a series of small disturbances caused considerable rain and strong winds in the south-west of the British Isles. The anticyclone then became very intense and extended its influence to the whole of the British Isles causing an easterly type of weather, cold, with a good deal of cloud and rain on our east coasts.

On the 21st a depression over the Azores began to influence the western districts, causing a south wind and higher temperature while the "high" over northern Europe began to move south and decrease in intensity. These changes, however, were very slow and very constant weather conditions prevailed from the 21st to the end of the month. Over central Europe and eastern England quiet, dry, cold but generally fair weather prevailed with thick fogs locally especially in places where smoke is poured into the atmosphere. London suffered severely, particularly on Sunday 27th and Monday 28th. In the western parts of the British Isles a southerly current brought warmer weather with a moderate rainfall. A succession of depressions passing from Iceland to the north of Scandinavia caused unsettled weather with strong winds and much snow in these parts. R. A. W.

On the night of the 17th two tornadoes occurred in different parts of Arkansas, probably in the south-east quadrant of a depression which passed across Texas on that day. Twelve persons were killed and over thirty injured. On the 24th a storm over Lake Ontario caused the wreck of the cargo-steamer *City of New York* off Stoney Point, Lake Ontario, with the loss of nine lives. A telegram dated the 11th states that timely rains have somewhat checked the bush fires in New South Wales, which have been very serious during the drought.

The special message from Brazil states that during November unusual frequency of high pressure was associated with cold winds from the south over the Southern States. Drought affected seriously the crops in the centre and south, especially cotton, rice, sugar, and maize, and reduced sensibly the estimates of the coffee crop for next year.

(*Continued on* p. 344.)

Rainfall Table for November 1921.

STATION.	COUNTY.	Aver. 1881—1915.	1921.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days.
		in.	in.	mm.		in.	Date.	
Camden Square	*London*	2·36	2·01	51	85	·51	2	10
Tenterden (View Tower)	*Kent*	3·02	1·91	49	63	·43	5	11
Arundel (Patching Farm)	*Sussex*	3·56	2·20	56	62	·64	16	11
Fordingbridge (Oaklands)	*Hampshire*	3·42	2·27	58	66	·85	16	14
Oxford (Magdalen College)	*Oxfordshire*	2·21	2·02	51	91	·48	2	13
Wellingborough (Swanspool)	*Northampton*	2·15	1·56	40	73	·47	2	11
Hawkedon Rectory	*Suffolk*	2·27	1·55	39	68	·48	2	7
Norwich (Eaton)	*Norfolk*	2·57	1·84	47	72	·41	5, 6	12
Launceston (Polapit Tamar)	*Devon*	4·24	3·67	93	87	·93	13	18
Sidmouth (Sidmount)	"	3·12	3·65	93	117	·95	30	19
Ross (County Observatory)	*Herefordshire*	2·53	1·81	46	72	·39	16	14
Church Stretton (Wolstaston)	*Shropshire*	2·94	3·04	77	113	·74	5	16
Boston (Black Sluice)	*Lincoln*	2·00	1·30	33	65	·32	2	12
Worksop (Hodsock Priory)	*Nottingham*	1·96	1·63	41	83	·46	2	10
Mickleover Manor	*Derbyshire*	2·23	1·85	47	83	·77	2	11
Southport (Hesketh Park)	*Lancashire*	3·14	2·61	66	83	·76	2	13
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·70	2·49	63	92	1·25	5	15
Hull (Pearson Park)	" *E. R.*	2·19	1·74	44	79	·56	5	19
Newcastle (Town Moor)	*North'land*	2·42	2·52	64	104	1·02	5	13
Borrowdale (Seathwaite)	*Cumberland*	13·58	5·65	143	42	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	4·17	3·38	86	81	·54	13	22
Haverfordwest (Gram. Sch.)	*Pembroke*	5·02	5·32	135	106	1·72	14	15
Aberystwyth (Gogerddan)	*Cardigan*	4·72	2·80	71	59	·98	2	10
Llandudno	*Carnarvon*	3·09	2·39	61	77	·61	2	13
Dumfries (Cargen)	*Kirkcudbrt.*	4·52	3·05	77	67	·80	5	16
Marchmont House	*Berwick*	3·00	2·19	56	73	·52	18	14
Girvan (Pinmore)	*Ayr*	5·32	3·96	101	74	·91	5	17
Glasgow (Queen's Park)	*Renfrew*	3·73	2·49	63	67	·47	16	14
Islay (Eallabus)	*Argyll*	5·38	4·30	109	80	·68	22	18
Mull (Quinish)	"	6·17	2·90	74	47	·78	13	13
Loch Dhu	*Perth*	8·69	6·30	160	72	1·70	13	15
Dundee (Eastern Necropolis)	*Forfar*	2·44	2·09	53	86	·39	22	14
Braemar (Bank)	*Aberdeen*	3·89	2·60	66	67	·48	18	15
Aberdeen (Cranford)	"	3·22	2·03	52	63	·24	7	17
Gordon Castle	*Moray*	2·88	1·65	42	57	·35	3	15
Fort William (Atholl Bank)	*Inverness*	8·07	2·85	72	35	·75	22	15
Alness (Ardross Castle)	*Ross*	4·02	1·62	41	40	·40	4	13
Loch Torridon (Bendamph)	"	9·27	2·79	71	30	·56	4	15
Stornoway	"	5·83	3·23	82	55	·67	4	21
Loch More (Achfary)	*Sutherland*	8·55	2·87	73	34	·80	3	16
Wick	*Caithness*	3·14	1·95	50	62	·45	4	14
Glanmire (Lota Lodge)	*Cork*	4·30	5·21	132	121	·80	15	24
Killarney (District Asylum)	*Kerry*	5·61	4·35	111	78	·52	22	27
Waterford (Brook Lodge)	*Waterford*	3·78	5·53	141	146	1·34	15	17
Nenagh (Castle Lough)	*Tipperary*	4·02	4·04	103	101	·75	15	19
Ennistymon House	*Clare*	4·65	..	..	..	..	..	..
Gorey (Courtown House)	*Wexford*	3·49	4·28	109	123	·94	13	17
Abbey Leix (Blandsfort)	*Queen's Co.*	3·34	3·91	99	117	·63	15	18
Dublin (FitzWilliam Square)	*Dublin*	2·67	2·57	65	96	·47	1	18
Mullingar (Belvedere)	*Westmeath*	3·41	3·71	94	109	·80	15	20
Woodlawn	*Galway*	4·01	3·67	93	92	·55	1	23
Crossmolina (Enniscoe)	*Mayo*	5·86	4·46	113	76	1·17	1	23
Collooney (Markree Obsy.)	*Sligo*	4·23	3·75	95	89	·58	1	20
Seaforde	*Down*	3·79	6·15	156	162	1·12	13	19
Ballymena (Harryville)	*Antrim*	4·05	4·14	105	102	·88	5	23
Omagh (Edenfel)	*Tyrone*	3·80	3·80	97	100	·83	5	22

Supplementary Rainfall, November 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	1·74	44	XII.	Langholm, Drove Rd.	2·97	75
,,	Sevenoaks, Speldhurst	1·91	49	XIII.	Ettrick Manse	2·65	67
,,	Hailsham Vicarage	1·96	50	,,	North Berwick Res.	1·96	50
,,	Totland Bay, Aston	1·97	50	,,	Edinburgh, Royal Ob.	2·55	65
,,	Ashley, Old Manor Ho.	1·86	47	XIV.	Biggar	1·29	33
,,	Grayshott	2·45	62	,,	Leadhills	3·29	84
,,	Ufton Nervet	2·37	60	,,	Maybole, Knockdon	2·49	63
III.	Harrow Weald, Hill Ho.	1·62	41	XV.	Dougarie Lodge	3·94	100
,,	Pitsford, Sedgebrook	1·83	47	,,	Inveraray Castle	4·25	108
,,	Chatteris, The Priory	1·26	32	,,	Holy Loch, Ardnadam	6·32	161
IV.	Elsenham, Gaunts End	1·87	47	,,	Tiree, Cornaigmore	..	..
,,	Lexden, Hill House	1·37	35	XVI.	Loch Venachar	4·85	123
,,	Aylsham, Rippon Hall	2·09	53	,,	Glenquey Reservoir	3·20	81
,,	Swaffham	1·41	36	,,	Loch Rannoch, Dall	2·33	59
V.	Devizes, Highclere	2·01	51	,,	Blair Castle	2·49	63
,,	Weymouth	2·35	60	,,	Coupar Angus	2·42	61
,,	Ashburton, Druid Ho.	5·58	142	,,	Montrose Asylum	2·52	64
,,	Cullompton	4·31	109	XVII.	LogieColdstone,Loanh'd	2·48	63
,,	Hartland Abbey	4·04	103	,,	Fyvie Castle	3·17	81
,,	St. Austell, Trevarna	5·55	141	,,	Grantown-on-Spey	1·30	33
,,	Crewkerne Merefield Ho	3·05	77	XVIII.	Cluny Castle	1·82	46
,,	Cutcombe,Wheddon Cr.	3·28	83	,,	Loch Quoich, Loan	3·90	99
VI.	Clifton, Stoke Bishop.	2·05	52	,,	Fortrose	·76	19
,,	Ledbury, Underdown.	1·91	49	,,	Faire-na Squir	1·75	44
,,	Shifnal,HattonGrange	2·13	54	,,	Skye, Dunvegan	5·23	133
,,	Ashbourne, Mayfield	1·85	47	,,	Glencarron Lodge	2·86	73
,,	Barnt Green, Upwood	1·80	46	,,	Dunrobin Castle	2·02	51
,,	Blockley, Upton Wold	2·03	52	XIX.	Tongue Manse	2·14	54
VII.	Grantham, Saltersford	1·30	33	,,	Melvich Schoolhouse	2·28	58
,,	Louth, Westgate	1·69	43	XX.	Dunmanway Rectory	8·09	205
,,	Mansfield, West Bank	1·81	46	,,	Mitchelstown Castle	4·06	103
VIII.	Nantwich, Dorfold Hall	1·93	49	,,	Gearahameen	9·50	241
,,	Bolton, Queen's Park.	3·76	95	,,	Darrynane Abbey	6·22	158
,,	Lancaster, Strathspey.	2·16	55	,,	Clonmel, Bruce Villa	4·73	120
IX.	Rotherham, Moorgate.	1·86	47	,,	Cashel, Ballinamona	4·33	110
,,	Bradford, Lister Park.	2·36	60	,,	Roscrea, Timoney Pk.	3·27	83
,,	West Witton	2·42	61	,,	Foynes	3·60	91
,,	Scarborough, Scalby	3·44	87	,,	Broadford, Hurdlesto'n	4·67	119
,,	Middlesbro', Albert Pk.	2·09	53	XXI.	Kilkenny Castle	3·44	87
,,	Mickleton	1·90	48	,,	Rathnew, Clonmannon	4·70	119
X.	Bellingham	2·23	57	,,	Hacketstown Rectory	4·63	118
,,	Ilderton, Lilburn	2·05	52	,,	Balbriggan, Ardgillan	3·73	95
,,	Orton	2·46	63	,,	Drogheda	3·27	83
XI.	Llanfrechfa Grange	2·12	54	,,	Athlone, Twyford	3·78	96
,,	Treherbert,Tyn-y-waun	6·91	175	XXII.	Castle Forbes Gdns.	3·91	99
,,	Carmarthen Friary	4·66	118	,,	Ballynahinch Castle	7·23	184
,,	Llanwrda, Dolaucothy	4·19	106	,,	Galway Grammar Sch.	2·69	68
,,	Lampeter, Falcondale	3·86	98	XXIII.	Westport House	4·63	118
,,	Cray Station	4·90	125	,,	Enniskillen, Portora	3·85	98
,,	B'ham W.W.,Tyrmyndd	5·10	129	,,	Armagh Observatory	2·81	71
,,	Lake Vyrnwy	5·32	135	,,	Warrenpoint	3·99	101
,,	Llangynhafal, P. Drâw	2·67	68	,,	Belfast, Cave Hill Rd.	4·09	104
,,	Oakley Quarries	4·83	123	,,	Glenarm Castle	5·81	148
,,	Dolgelly, Bryntirion	5·04	128	,,	Londonderry, Creggan.	3·48	88
,,	Snowdon, L. Llydaw.	9·47	241	,,	Sion Mills	3·24	82
,,	Lligwy	2·11	54	,,	Milford, The Manse	4·32	110
XII.	Stoneykirk,ArdwellHo.	4·24	108	,,	Narin, Kiltoorish	4·69	119
,,	Carsphairn, Shiel	5·94	151	,,	Killybegs, Rockmount	5·08	129

Climatological Table for the

STATIONS	PRESSURE: Mean M.S.L. (mb.)	PRESSURE: Diff. from Normal (mb.)	TEMPERATURE: Absolute: Max. (° F.)	Date	Min. (° F.)	Date	Mean Values: Max. (° F.)	Min. (° F.)	½ max. and min. (° F.)	Diff. from Normal (° F.)
London, Kew Observatory	1021·8	+5·6	85	25	42	19	69·8	50·5	60·2	+1·0
Gibraltar	1017·0	+1·2	85	29	56	5	77·5	62·4	69·9	−0·4
Malta	1014·6	0·0	80	3, 28	62	25	75·7	65·0	70·3	−1·7
Sierra Leone	1011·8	−0·9	89	6, 12	65	2, 8, 18	85·7	68·5	77·1	−3·3
Lagos, Nigeria	1012·4	−0·5	88	5	70	23	85·7	75·5	80·6	+2·0
Kaduna, Nigeria	1013·8	+2·5	90	5	61	2	84·3	66·9	75·6	−0·4
Zomba, Nyasaland	1015·6	−1·8	82	11, 12	48	26	75·1	53·8	64·5	+2·0
Salisbury, Rhodesia	1016·5	−3·7	80	13	36	27	72·9	42·9	57·9	+1·5
Cape Town	1014·3	−6·0	77	3	39	12	61·7	50·1	55·9	+0·1
Johannesburg	1020·5	−2·6	70	28	30	23	61·8	41·8	51·8	+1·1
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	69	29	21	23	60·7	32·4	46·5	−1·1
Calcutta, Alipore Obsy.	998·3	−1·4	96	8	73	25	90·8	79·6	85·2	+0·1
Bombay	1003·4	−0·8	94	7	74	20	89·0	80·5	84·7	+0·8
Madras	1002·5	−1·4	107	1	78	13	100·5	82·1	91·3	+1·4
Colombo, Ceylon	1008·1	−0·2	88	13	75	27	87·0	78·9	82·9	+1·0
Hong Kong	1004·5	−1·6	89	23	72	3	85·2	77·8	81·5	0·0
Sandakan	..	..	91	6, 8, 14	73	28	88·7	75·2	81·9	+0·2
Sydney	1020·4	+2·5	75	10	43	21	66·2	49·0	57·6	+3·3
Melbourne	1020·1	+1·8	65	11	33	27	57·7	46·3	52·0	+1·6
Adelaide	1019·9	+0·8	69	13	37	27	62·9	47·9	55·4	+2·0
Perth, Western Australia	1018·1	+0·1	71	8	40	29	66·5	51·7	59·1	+2·7
Coolgardie	1019·1	0·0	72	12	35	30	65·0	45·0	55·0	+2·3
Brisbane	1020·1	+2·1	80	1	46	19	71·2	56·6	63·9	+3·9
Hobart, Tasmania	1014·9	+0·6	61	21	36	8	55·9	43·9	49·9	+3·1
Wellington, N.Z.	1016·6	+2·3	62	18	31	29	55·6	45·6	50·6	+0·9
Suva, Fiji	1014·3	+0·7	89	6	63	28	83·9	69·1	76·5	+1·6
Kingston, Jamaica	1013·1	−0·9	93	22	72	3	87·9	73·3	80·6	−0·7
Grenada, W.I.	1012·7	−0·6	87	7	70	2	83·4	74·0	78·7	−0·1
Toronto	1015·4	+1·1	91	23	45	6	79·9	57·1	68·5	+5·9
Winnipeg	1011·9	−0·6	94	30	32	3	78·9	56·6	67·7	+5·5
St. John, N.B.	1011·6	−2·4	80	24	42	5	63·9	48·3	56·1	−0·4
Victoria, B.C.	1015·1	−1·8	70	25	46	15	63·2	49·6	56·4	−0·6

LONDON, KEW OBSERVATORY.—Mean speed of wind 7·9 mi/hr; 2 days with thunder heard.

MALTA.—Prevailing wind direction NW. Hours of observation from this month are 7 h. and 16 h. 1 day with thunder heard, 1 day with fog.

SIERRA LEONE.—Prevailing wind direction morning NE, evening SW; 8 days with thunder heard.

MADRAS.—13 days with thunder heard.

British Empire, June 1921.

TEMPERATURE Mean Wet Bulb. °F.	Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	mm.	Diff. from Normal mm.	Days	BRIGHT SUNSHINE Hours per day	Percentage of possible	STATIONS
54·5	? 29	60	6·1	0·22	6	− 49	3	7·4	45	London, Kew Observatory.
63·9	51	73	1·8	0·20	5	− 7	2	..	..	Gibraltar.
64·6	56	65	2·8	0·00	0	− 2	0	11·1	77	Malta.
75·3	..	75	6·0	15·31	389	−104	22	..	..	Sierra Leone.
78·4	68	87	5·7	15·34	390	− 93	18	..	..	Lagos, Nigeria.
71·9	..	90	..	5·59	142	− 83	13	..	..	Kaduna, Nigeria.
..	..	80	2·9	0·08	2	− 13	1	..	..	Zomba, Nyasaland.
51·6	30	57	2·5	0·00	0	− 1	0	..	..	Salisbury, Rhodesia.
51·9	..	74	7·1	7·93	201	+ 88	17	..	..	Cape Town.
39·8	28	54	1·1	0·00	0	− 3	0	9·3	89	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
36·6	..	71	2·2	0·00	0	− 12	0	..	..	Bloemfontein.
81·4	72	75	8·1	14·27	362	+ 72	14	..	..	Calcutta, Alipore Obsy.
78·8	72	74	6·8	26·79	680	+211	16	..	..	Bombay.
76·4	..	58	6·1	0·65	17	− 31	5	..	..	Madras.
78·4	72	73	8·3	1·50	38	−154	13	..	..	Colombo, Ceylon.
77·2	..	81	8·0	14·74	374	− 24	25	5·2	39	Hong Kong.
76·4	..	82	..	7·39	188	+ 3	14	..	..	Sandakan.
53·8	36	74	3·9	0·89	23	−107	8	6·2	63	Sydney.
49·2	31	78	6·9	1·56	40	− 14	15	..	..	Melbourne.
51·1	27	74	5·5	2·05	52	− 27	11	5·0	52	Adelaide.
55·8	30	77	6·1	6·51	165	− 5	19	..	..	Perth, Western Australia.
52·3	32	63	3·5	1·31	33	+ 2	8	..	..	Coolgardie.
60·6	42	77	6·2	7·98	203	+136	15	..	..	Brisbane.
46·5	29	76	6·4	1·55	39	− 17	14	..	..	Hobart, Tasmania.
47·6	22	79	7·4	3·36	85	− 36	17	3·5	37	Wellington, N.Z.
72·5	..	89	..	5·03	128	− 28	14	..	..	Suva, Fiji.
..	..	73	7·3	2·21	56	− 49	6	..	..	Kingston, Jamaica.
75·6	..	79	6·2	9·81	249	+ 30	27	..	..	Grenada, W.I.
60·1	41	66	3·4	2·15	55	− 15	7	..	..	Toronto.
64·0	..	73	4·0	1·56	40	− 43	10	..	..	Winnipeg.
51·6	32	78	6·0	1·46	37	− 46	14	..	..	St. John, N.B.
51·9	39	82	6·9	1·24	31	+ 7	12	..	..	Victoria, B.C.

Colombo, Ceylon.—Prevailing wind direction WSW ; mean speed 7·0 mi/hr.

Hong Kong.—Prevailing wind direction SE ; mean speed 10·7 mi/hr ; 10 days with thunder heard.

Sydney.—Mean max. temp. highest on record.

Brisbane.—Mean temp. highest on record for June.

Grenada, W.I.—Prevailing wind direction E ; 2 days with thunder heard.

The rainfall of the month was in excess of the average (1881–1915) over four distinct areas lying across the centre of the British Isles, viz., locally along the coast of Durham and Northumberland, a narrow strip from Cheshire to Worcestershire, near Sidmouth, and over the whole of the eastern half of Ireland extending to the extreme west of South Wales. The amount in excess was usually not large, although in co. Down more than 50 per cent. above the average was recorded. The areas with deficiency were much wider, and in Scotland less than half the average fell generally north of a line from about Mull to Elgin, the greater part of the area receiving less than 40 per cent. of the average. In England less than 60 per cent. fell locally along the south-east coast and in Cumberland, where Seathwaite recorded only 42 per cent. of the average. Less than 25 mm. (1 in.) for the month occurred locally in the neighbourhood of the Wash and the Moray Firth, while the area over which more than 200 mm. (8 in.) fell was much smaller than usual and confined entirely to Kerry and Connemara.

The general rainfall for November, expressed as a percentage of the average, was:—England and Wales, 75; Scotland, 55; Ireland, 106; British Isles, 75.

November adds yet another month to the series of consecutive months since January with rainfall less than the average in the south of England. The dryness of November in the north of Scotland has helped to counterbalance the wetness of March and May, so that for the period February to November the only district with as much as the average rainfall was a very small area in Argyll. In these 10 months less than half the average rainfall has fallen over considerable areas along the south and east coasts from about Weymouth to Canterbury, less than 60 per cent. of the average being confined to the south of a line from about the Bristol Channel to the Wash. The only considerable area in England and Wales with more than 80 per cent. of the average lies in the neighbourhood of Newcastle-on-Tyne. In Scotland less than 60 per cent. has occurred in eastern Aberdeenshire, but the Western Highlands have mainly received over 90 per cent. of the average. In Ireland the percentage varies from a little over 70 per cent. in the centre to rather more than 90 per cent. in Wexford and Down.

In London, Camden Square, the mean temperature for November was 39·4° F. or 4·0° F. below the average. Duration of rainfall, 43·5 hours; evaporation, 0·19 inch.

Errata.—On p. 292 of the issue for November, in the last line of the note on Mr. Dansey's letter: *for* 13 h. *read* 18 h.

On p. 294, in the paragraph immediately preceding the table: *for* $\frac{1}{2}$ (Mean Max. + Mean Min.) *read* $\frac{1}{4}$ (Mean Max. + Mean Min. + 9 h. + 21 h.)

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The Rainfall of 1921.

THE completion of the rainfall records for 1921 has been awaited with unusual interest, less because the end of the year puts any natural period to the dry spell which has been so prominent a feature in the south and east of the country, than because it affords a convenient opportunity of carrying out a comparison between the conditions during the year and those during previous years.

It is not, of course, possible within a few days of the end of December to give any comprehensive summary of the year's records, but by making a selection from the 3,000 returns so far received we are able to give a preliminary idea of the distribution in relation to the average.

The year has undoubtedly been one of very unusual shortage of rainfall, but the area affected in an extreme degree was not very large. In the western half of Scotland, largely owing to the heavy rains of January, March, and December the total was above the average at all stations, and over a large part of the Western Highlands there was an excess of more than 10 per cent. reaching 20 per cent. in places. A small area in the northern Pennines and isolated spots in Ireland also had more than their average rainfall, but with these exceptions the year's fall was apparently everywhere defective. The deficiency increased in a marked manner towards the east and south. In the north-east it culminated in a rainfall of 40 per cent. below the average around Aberdeen, and in the south of Ireland in a deficiency of more than 30 per cent. to the east

O (64)16799—1 Wt105—P35 1250 1/22 E & S A of Cork, but these were local dry centres. In England, and part of South Wales the whole country south-east of an irregular line from the Bristol Channel to Yorkshire experienced a deficiency of more than 30 per cent. and nearly all the district beyond a line from Plymouth to Yarmouth a deficiency of more than 40 per cent., whilst the east of Kent exhibited the quite unprecedented phenomenon of a rainfall less than half its average.

The conditions in the south-east of England so far transcend any records within the period over which trustworthy observations extend that it will be necessary to revise the empirical law hitherto found to hold good for this country as well as for most parts of the world with an annual average rainfall exceeding about 20 inches, namely, that the fall of the driest year will not fall appreciably below 60 per cent. of the normal. The driest years hitherto recorded in the British Isles were probably 1854, 1864, 1870, and 1887. In all these years considerable areas had less than 70 per cent. of the average and in 1887 nearly the whole of England and Wales, as well as more than half the area of Scotland and Ireland, had less than 80 per cent., but so far as we are able to ascertain the deficiency nowhere reached 40, much less 50 per cent. The general percentage of the average rainfall in these four dry years is given in the following table for comparison with 1921. In the case of 1854 the data were insufficient to establish values for Scotland and Ireland, but these districts were probably wet.

——	1854.	1864.	1870.	1887.	1921.
England and Wales -	77	78	82	74	71
Scotland - -	..	94	80	80	99
Ireland - -	..	86	95	77	88
British Isles - - -	..	85	84	77	82

The area covered by the map of the Thames Valley, published in each number of this magazine, includes so large a part of the district with an unprecedentedly low rainfall that we gladly acquiesce in the suggestion of a reader to publish a supplementary map showing the total fall for the year. This map shows that the highest rainfall in the Thames Valley was barely 20 inches (500 mm.), and this only in one or two spots, and that over nearly the whole valley it was less than 17·5 inches (450 mm.). Along a broad belt on both sides of the main river below Lechlade, interrupted where the high land approaches closely between Goring and Reading, there

THAMES VALLEY RAINFALL —— YEAR, 1921.

*Watershed of River Thames above Teddington and River Lee above Feildes Weir.

Isohyetals.

ALTITUDE SCALE: Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES 0 5 10 15 20

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M.O.D. 8862/464. 1250. 1/22.

was less than 15 inches (380 mm.) during the year, and in the north-east of the area included the fall was everywhere less than this amount. The most remarkable totals were observed in the Thames Estuary and the southern Fen District, where considerable areas had less than 12 inches. These were undoubtedly the driest places in England during this remarkable year.

The following table gives the general rainfall of each

Monthly General Rainfall as Percentage of Average.

1921.	England and Wales.	Scotland.	Ireland.	British Isles.
January	146	168	119	145
February	15	39	51	34
March	101	170	129	133
April	59	61	46	56
May	79	108	90	91
June	17	40	24	26
July	40	105	130	87
August	115	106	108	110
September	64	81	53	64
October	51	105	92	80
November	75	55	106	75
December	83	133	80	101

month in the great divisions of the British Isles, as a percentage of the average of the 35 years 1881–1915. It will be observed that January, March and August were the only months with appreciable general excess, though July was wet in Ireland and December in Scotland. The most noteworthy months of the year were February and June for the British Isles as a whole and more locally July and October. February had less than a quarter of its average practically everywhere in England and Wales as well as in the east of Scotland and part of the centre of Ireland. It was driest in South Wales where less than 5 per cent. of the average fell. The only Februaries, for which comparable data exist, which appear to have been drier were in 1891 and 1895, but the difference was not great. June was beyond doubt the driest of which any record exists, having less than a quarter of the average practically everywhere except in the north of Scotland and less than 5 per cent. of the average along the whole of the south coasts of England, Wales and Ireland with no rain at all in parts of Sussex and of Pembrokeshire. The drought of June was continued throughout July in the south-east of England where that month was not much less dry than its

A 2

predecessor, but to the north-west considerably more rain fell, and in Ireland and the western Highlands the month definitely terminated any tendency to rain shortage. The dryness of October was also local, a deficiency of 50 per cent. being confined to the south of England and Wales and parts of the East Coast. In the extreme south less than 25 per cent. of the average fell, and in places the month was the driest October known to have occurred. The remarkable features of the rainfall of 1921 are more vividly brought out by study of groups of months. It will be observed that in some part of the south-east of England every month of the year was dry and several of them very dry indeed. The cumulative effect was probably most pronounced in the period February to July inclusive. During these six months the whole of the south-east of England and Wales experienced less than half the average rainfall and a large tract extending from Monmouthshire to Lincolnshire, as well as other local areas, less than two-fifths of the average. In the notably dry year 1887 the six months, February to July, had less than half the average rainfall in the south-east of Ireland, the south-west of England, and part of Yorkshire, with less than 40 per cent. in Cornwall and South Devon; and in the great winter drought of 1879–80 less than half the average fell over the south coast of England during a period as long as eight months, but these are probably the only comparable periods. Equally remarkable was the period February to October 1921: during these nine months less than half the average rainfall fell to the south-east of a line drawn roughly from Plymouth to Cromer and less than 40 per cent. over a narrow strip in the south of Dorset, Hampshire, Sussex, and Kent. The driest nine months in 1887, also from February to October, fell below 50 per cent. only in a small patch in the south-east of Ireland, and for the most part had more than 60 per cent. of the average fall.

It is as yet too early to speak definitely as to the effects of a year of such remarkable deficiency. There is no question that great want of water has been experienced in rural districts where local supplies are depended upon, and although the greater municipal supplies have mostly held out well there has been, in many cases, keen anxiety as to their adequacy. Most of the water supplies of the south-east of England are drawn from underground sources, and it may well be that well-supplies are being used up in a manner analogous to living on capital. It is known that the underground water in the chalk formations depends intimately upon the rainfall for its maintenance, and in particular the winter rains percolate freely into the fissures of chalk and compensate for the draft made during the summer. It is an ominous fact that percolation records made during the year in the south of England show that no water has reached the chalk since May, and that the quantity since February 1st has been not more than the equivalent of 1·75 inch of rain. Unless, therefore, an unusually rainy period intervenes between this and the early summer the outlook for the summer of 1922 from the point of view of water supply is not very promising.

OFFICIAL NOTICES.

Meteorological Stations.

Falmouth Observatory.—Meteorological observations have been carried on at Falmouth since the founding of the Royal Cornwall Polytechnic Society in 1833. In 1867 the Meteorological Committee of the Royal Society recognised Falmouth as one of the seven observatories of their network and provided the necessary equipment. The first site of the observatory was in the town at 200 feet above sea-level. From 1885 a house with less urban surroundings (167 feet above M.S.L.) has been used. The situation is charming as may be gathered from the illustration in the official list of stations (001 J, 1919). Since 1902 there has been a Dines anemometer at Pendennis Castle on an exposed headland a mile from the observatory, and the comparison of wind-records from the two stations has been of great interest.

Mr. J. Lovell Squire was the first superintendent of the observatory; he was succeeded in 1882 by Mr. Edward Kitto, who held the position until 1913. On Mr. Kitto's retirement it was arranged that the society should lend the observatory premises to the Meteorological Committee, who should be responsible for the staff, equipment, and work. Up to this time the preparation of hourly values from the autographic records had been the principal part of the meteorological work, but under the new plan the observatory became a telegraphic reporting station. The photographic barograph and thermograph were dismantled and magnetic observations ceased, it being intended to develop the station as a centre for upper-air observations.

At the end of the year 1921 the Meteorological Office gave up its tenancy of the observatory, and observations for the daily weather service are now being made at the coastguard station at Pendennis Castle. The Royal Cornwall Polytechnic Society propose, with the assistance of the Town Council, to carry on climatological observations at the observatory, for the present year at least, and these will be published in the *Daily Weather Report* under the heading "Health Resorts." Mr. J. B. Phillips, who has been acting as meteorologist in charge of the station for some time, has been so good as to volunteer to take charge of this work.

Huddersfield.—The Meteorological Station at Huddersfield is to be transferred from Edgerton Cemetery to Ravensknowle, where it will be in close connection with the Tolson Memorial Museum. The Edgerton station was founded in 1876 by Mr. James Firth on his appointment as Registrar of the Cemetery. He had, previously to this, taken much interest in the weather and had supplied summaries to the local press. In 1895, his son, Mr. Joe Firth, succeeded him and the station was reorganised to meet the needs of the Meteorological Office. Mr. Firth has now retired after twenty-seven years' service for meteorology and his place as observer will be taken by Mr. C. Mosley, Assistant Curator of the Museum. The Tolson Memorial Museum is being designed to show the relation of human activity in the West Riding to the natural environment and the local climatology is therefore recognised as of fundamental importance.

Sheepstor.—The Rev. H. H. Breton is leaving Sheepstor, Devon, this month for a new living at Alfriston, near Eastbourne, and the meteorological station which he has maintained since 1907 will therefore lapse.

Torquay.—Mr. G. E. Body has succeeded the late Mr. P. C. Steventon as Borough Meteorologist to Torquay.

A list of the Distributive Stations of the Meteorological Office and their Auxiliary Reporting Stations as at present established is given below.

The Station at Howden and the Auxiliary Station at Goswick were closed on December 22nd, 1921, and November 30th, respectively, and the Station at Manchester was transferred to Shotwick on October 24th, 1921.

This list supersedes that given in the *Meteorological Magazine*, April 1920, p. 41.

The various types of stations are indicated by the letters in the first column.

Type	County.	Station.	Lat.	Long.	Height in feet above M.S.L.	Officer in Charge.
			N. ° ′	° ′		
R	Dublin	Baldonnell	53 16	6 23 W	280	A. Walters
R	Fifeshire	Leuchars	56 23	2 52 W	40	W. Gillon.
C	Renfrewshire	Renfrew	55 52	4 24 W	48	J. J. Somerville.
U	Yorkshire	Flamborough Head.	54 7	0 5 W	150	Coastguard.
A	Anglesey	Holyhead	53 18	4 39 W	15	S. T. A. Mirrlees.
R	Cheshire	Shotwick	53 13	3 0 W	16	H. F. Jackson.
RI	Lincolnshire	Cranwell	53 2	0 31 W	236	W. H. Pick.
R	Devonshire	Cattewater	50 22	4 8 W	58	G. H. L. Douglas-Lane.
RI	Hampshire	Andover	51 13	1 31 W	295	C. D. Stewart.
RI	Hampshire	Calshot	50 49	1 17 W	10	H. W. L. Absalom.
RR	Hampshire	South Farnborough.	51 17	0 45 W	234	R. M. Stanhope.
C	Norfolk	Pulham	52 24	1 14 E	122	G. Harris.
R	Suffolk	Felixstowe	51 56	1 19 E	21	D. F. Bowering.
C	Surrey	Croydon	51 21	0 7 W	244	G. R. Hay.
U	Kent	Biggin Hill	51 19	0 3 E	610	T. H. Applegate.
RR	Kent	Isle of Grain	51 27	0 43 E	20	H. St. S. Dyke-Marsh.
C	Kent	Lympne	51 5	1 1 E	350	R. S. Read.
U	Kent	Hythe	51 3	1 5 E	5	Coastguard.
U	Sussex	Beachy Head	50 44	0 15 E	525	Coastguard.

C.—Civil Aerodrome or Civil Airship Station.
R.—Royal Air Force Station.
RI.—Royal Air Force Station (Regular Lectures and Instruction given in Meteorology.)
RR.—Royal Air Force Station (Associated with Research or Design.)
A.—Experimental Anemometrical Station.
U.—Auxiliary Observing Station.

Official Publications.

Geophysical Memoirs, No. 18. *Observations on Radiation from the Sky and an Attempt to Determine the Atmospheric Constant of Radiation.* By W. H. Dines, F.R.S. Price 1s. 3*d.* net.

In this Memoir Mr. W. H. Dines gives some of the results of observations made with the apparatus described in the *Meteorological Magazine* for October 1920, and with the earlier instruments which served the same purpose. The memoir will serve to explain the significance of the tables which have been appearing in the Magazine during the last year, one of which will be found on p. 366 of this issue. Thus under Zone I. in Table II. of the memoir we have the monthly values for 1920 of what is here called π I, a measure of the atmospheric radiation from the zenith on cloudless days. We see that for July 1920, π I only reached 543 cal/cm²/day. Whereas with the hotter air of July 1921 the value (*Meteorological Magazine*, p. 262) was 647 cal/cm²/day. At the end of the memoir the method of computing J, the total radiation from the sky, is given and the result that the net radiation from the ground on clear days in 1920 had a mean value rather over 200 cal/cm²/day, is stated. In the notation of this Magazine this estimate may be written $X - J = 200$ in 1912 whereas for 1921 the corresponding result is $X - J = 708 - 538 = 170$; the latter figure is perhaps the more reliable as the method of averaging is more thorough.

It appears from the memoir that as contrasted with diffuse solar radiation the radiation received from the atmosphere itself comes almost exclusively from the lower layers. Using η to represent the ratio of the radiation emitted by a layer of air equivalent to one-tenth of the atmosphere (*i.e.*, with gravitance 100 mb.) to that of a black body at the same temperature Mr. Dines finds his data are concordant with the assumptions $\eta = \cdot 5$ for two-thirds of the heat energy and $\eta = \cdot 05$ for the remaining third. It is curious that although the greater part of the radiation is generally attributed to the presence of water vapour the relative humidity at the time does not make much appreciable difference in the radiation; it is the temperature that is all important.* No doubt the reason is that even when the air is at its driest there is enough moisture present to supply the radiation of the characteristic type; if there is not as much moisture as usual in the lowest thousand feet then that layer will supply less than its usual amount, but it will also be less effective in cutting off radiation from higher layers.

Discussions at the Meteorological Office.

Dec. 12th, 1921. *Atmospheric Stirring Measured by Precipitation, by L. F. Richardson.* (Proc. Roy. Soc., Vol. 96A, pp. 9–18). Opener.—Mr. N. K. Johnson.

G. I. Taylor in his paper† on "Eddy-motion in the atmosphere" made a successful attempt to deal with the phenomena of atmospheric turbulence.

On certain assumptions as to the general uniformity of the eddy-motion Taylor showed that heat and also momentum would be conveyed through the atmosphere in much the same way as heat is conducted through a solid. The equations at which Taylor arrived were of the same form as those used by earlier authors who had not considered the mechanism in such detail.

In the paper under consideration Richardson reverts to the

* *See* Q.J.R. Met. Soc., Vol. XLVII., 1921, p. 260.

† *Phil. Trans.*, A. 215, p. 1, 1914.

more general method—he is concerned with the power of eddies to convey heat or moisture or momentum from one horizontal layer to another rather than with the size and constitution of the eddies.

The type of equation which is adopted as most satisfactory for expressing results in comparable form is:—

$$\frac{\partial \chi}{\partial t} = \frac{\partial}{\partial p}\left(\xi \frac{\partial \chi}{\partial p}\right)$$

where χ represents any measurable "entity" capable of transfer according to the prescribed rules, p is the pressure at the level under consideration, and ξ is the measure of turbulence.

It is the object of the paper to evaluate ξ by the consideration of the relation between the ascent of water in the form of vapour and its descent as rain or snow. The processes which take the water upwards may all be pooled together as turbulence in the widest sense.

Taking Hann's values for the mean rate of precipitation and for the mean variation of water-vapour with height in the first kilometre the author obtains a value of $\xi = 1\cdot4 \times 10^5$ C.G.S. units.* Considering next the precipitation at 8·5 km., which consists of the slow descent of cirrus, cirro-stratus, and cirro-cumulus, he decides that ξ at that height must be between 3 and 180 C.G.S. units. The results depend on mean values taken over the whole earth over a long interval of time.

Comparison of the values of Richardson's results with those of other investigators is of interest. The values of ξ obtained from such methods as the variation of diurnal range of temperature, change of wind direction between the top and bottom of the Eiffel Tower, and the height at which the wind attains the gradient velocity and direction all give values of ξ between $1\cdot1 \times 10^5$ and $1\cdot45 \times 10^5$, while for the rate of vertical diffusion of temperature-inversions over the sea Taylor obtained the value $\xi = 3\cdot6 \times 10^3$.

The variation of turbulence with height is of especial interest. The evidence of the results of different writers is that the turbulence increases rapidly near the ground, reaches a maximum, and then falls off more slowly with increasing height, Richardson's values at 8·5 km. receive some confirmation from Schmidt's value of the "Austausch" at 10 km. which would give a value of 0·5 for ξ at that height.

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* The dimensions of ξ are those of [pressure]^2 [time]$^{-1}$ and since the millibar is 10^3 C.G.S. units of pressure, $1\cdot4 \times 10^5$ C.G.S. units of $\xi = 0\cdot14$ [millibar]^2/second. Near the ground a millibar is the difference of presence for about 8 metres, and the given value of ξ corresponds with the moment of velocity of a particle moving with speed $0\cdot14 \times 8$ metres a second in a circle of radius 8 metres.

The Royal Meteorological Society.

THE December meeting of the Royal Meteorological Society was devoted to a discussion on visibility. The discussion was opened by Mr. F. J. W. Whipple who mentioned some of the earlier work on the subject, emphasizing the importance of the researches of Robert Aitken. In Meteorological practice "visibility" was synonymous with "horizontal range of vision." To obtain comparable results from observations at different places there should be the same sort of contrast between the objects which were to be looked for, and their backgrounds. The best way to satisfy this condition was to select black objects standing against the skyline.

The recent adoption of observations of range of vision as part of the routine at telegraphic stations had made comparisons between atmospheric conditions at different places possible. From tabulations of the data for certain periods during 1921 and 1922, the following conclusions had been drawn :—

(*a*) The system gives reasonably consistent results in contrast with the old vague definitions of fog, &c., which did not.

(*b*) The standards adopted by day and by night are in general agreement. No deduction as to diurnal variation of the opacity of the atmosphere can be made from the figures, however, as the methods of observing by day and by night are different.

(*c*) The improvement in visibility during the day in summer is general, being most marked in urban districts and almost disappearing at Eskdalemuir and Valencia.

(*d*) Visibility was generally better in summer 1921 than in 1920. Shoeburyness and Howden were exceptional in this respect, however.

(*e*) In winter the Atlantic seaboard, represented by Valencia Observatory, shows to advantage, but in summer there is little to choose between that region and south-east England.

Captain Sir David Wilson-Barker criticised the Visibility Scale set out in the *Marine Observer's Handbook*, pointing out that at sea objects are not scattered about at convenient distances and expressed the opinion that for marine purposes the division of atmospheric opacity into fog, mist, and haze would be sufficient. He would define a fog as of the same density throughout, with a clearly marked boundary, a mist as thinner and of variable density. Snow, fine rain and dust also interfered with visibility at sea. He thought that some form of screen or Nicol prism might improve the visibility in mist.

Wing-Commander M. G. Christie said that aviators attached the greatest importance to meteorological reports and especially to reports of visibility. Fog was one of the last remaining weather-enemies of flying, and even that was not insuperable. Once you are in the air it is easy enough to fly in fog, and certain devices, such as the Noakes landing-gear, now make it possible to land in fog. The amount of fog near any place depends very largely on the amount and class of manufacturing that goes on. Mist is a great danger to flying at night, especially as lights rapidly become invisible. The slightest quantity of mist makes landing difficult, however well the ground is lit up. In Mesopotamia the shimmering of the air makes landing difficult at midday. In utilising reports it is desirable to take altitude into consideration, as the visibility from a high observation post may differ from that at a low-lying aerodrome in the neighbourhood. The altitude of the stations should therefore be mentioned in the reports. Mr. Whipple had suggested that when the range of visibility differed according to direction the observer should report the greatest range, but he (Wing-Commander Christie) considered that the pilot would prefer to have the mean of all directions, or perhaps even the worst visibility. It should also be noted that the pilot does not always require the visibility of solid objects against a sky-line —he also requires the visibility from the air of objects on the ground.

Dr. J. S. Owens discussed the conditions of visibility, physical and physiological; the physical conditions include illumination, the contrast of light and shade, colour, and finally the effect of the medium, but the physiological conditions are of equal importance.

There is a definite percentage difference in illumination between an object and background which must be exceeded before any contrast becomes visible; this contrast varies from about one-half to ten per cent. He pointed out that there was a close relation between the emission of smoke and the amount of haze or fog in London, with a regular 24-hourly cycle. He described the manner in which the smoke from chimneys was distributed about the country.

Mr. J. E. Clark gave an account of his visibility observations at Purley and in London, and then Sir Napier Shaw, as chairman, summarised the discussion, pointing out that there were evidently two distinct phases of the subject, visibility from the ground of solid objects against the skyline, and visibility from the air.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

A Comparison between the Double Theodolite and Tail Methods of obtaining the Height of Pilot Balloons.

CAPT. DURWARD has undertaken a useful piece of work in making a comparison between the height of pilot balloons as deduced from two-theodolite observations and from the tail method of measurement. Both these methods have been in use for many years past, but users of each system have generally been too confident each in the advantages of his own method to undertake a comparison between the two.

The difference of 5 per cent. which Capt. Durward finds in your October number between the heights measured by the two methods seems to point to a systematic error and certainly needs further investigation. The suggested unravelling of the cotton might be either assisted or hindered by the spin of the tail. Were all tails constructed to spin in the same way? It might be better to use fine wire of a single strand which should be more constant in length. The value of the results given in the note would be increased if a frequency table were included showing the number of cases where the heights deduced by the two methods differed by various percentages.

It is noticeable that the heights reached by Capt. Durward's balloons in specified times were consistently low compared with the "height from formula" values. Probably the weight of the tail was not included with that of the balloon in the "W" of the formula when working out the speed of ascent. If it was included one would expect the actual heights to exceed those by formula as the steadying effect of the tail should lead to increased rate of ascent. It would be interesting to know whether such was the case.

J. S. DINES.

December 1921.

With regard to the points raised by Mr. J. S. Dines, I may mention that all the tails were constructed to spin the same way, and by their spinning they tended to unravel the thread. In further experiments in which two threads have been used for the tails the average error in the "tail method" height has been considerably less than 5 per cent. The error has been still less (usually between 0 and 2 per cent. up to 4,500 ft. for a 30-ft. tail) when the apparent length of the tail has been measured by means of a graticule instead of by a moving cross-wire and a micrometer.

A frequency table showing the number of occasions in which the height computed by the tail method differed from the height computed by the double theodolite method by 0–2 per cent., &c., is given below. The figures found from the ascents in which a double thread was used are in *italics.*

Table showing the Number of Occasions in which the Height measured by the Tail Method differed by 0–2 per cent., &c., from the Height obtained by Two Theodolites.

Figures in Roman refer to tail ascents with single thread.
„ „ *italics* „ „ „ double „

Minute.	0-2 per cent.		2-4 per cent.		4-6 per cent.		6-10 per cent.		>10 per cent.		No. of Cases.
	+	−	+	−	+	−	+	−	+	−	
1	1	1	..	..	..	..	3	0	3	2	10
	..	..	..	..	..	..	..	..	..	..	..
2	3	1	0	1	1	4	3	3	0	6	22
	0	*2*	*0*	*1*	*1*	*1*	*0*	*2*	*1*	*0*	*8*
5	2	3	3	4	0	3	0	4	0	2	21
	2	*1*	*1*	*1*	*1*	*4*	*0*	*2*	*0*	*1*	*13*
9	1	6	0	2	0	2	0	4	0	1	16
	1	*2*	*0*	*1*	*0*	*3*	*0*	*3*	..	..	*10*
13	..	..	0	1	1	1	0	4	..	..	7
	0	*3*	*0*	*1*	..	..	*0*	*2*	*1*	*0*	*7*

As to the significance of the theoretical rate of ascent of the balloons, it should be stated that the free-lift was adjusted in each case with a view to a rate of ascent of 500 feet per minute. The balloon balance was adjusted so as to give a free-lift L'_0, such that $L'_0 = L_0 + w$, L_0 being the free-lift appropriate to a balloon of the assigned weight W when without a tail, and w the weight of the tail.

On the theory that the eddy resistance of the tail can be neglected though the effect of the weight on the resultant buoyancy must be allowed for, the formula* for determining the free-lift L′ to be given to the balloon before the tail is attached is—

$$v = \frac{q\,(L' - w)^{\frac{1}{2}}}{(W + L')^{\frac{1}{3}}} \qquad (1)$$

* Computer's Handbook, Sec. II. 1. Second Edition, p. 4, Footnote $(L' = L + w)$.

Whilst my L'_0 was virtually derived from the equation—

$$v = \frac{q\,(L'_0 - w)}{(W + L'_0 - w)^{\frac{1}{3}}} \quad - \quad - \quad - \quad (2)$$

If the rate of ascent v is in feet per minute and the weights are in grammes, then the value adopted for the factor q is 276.*

My L'_0 was chosen so as to give $v = 500$ in formula (2). Substituting my L'_0 for the L' of formula (1) would give $v = 488$, so that the discrepancy amounts to only 2 per cent.

The fact that balloons rise very slowly during the first few minutes of their ascent has been very noticeable here during the summer months. Perhaps the balloons are caught in descending currents for which the topography of the surrounding country is in some way responsible.

J. DURWARD.

Larkhill, Nov. 24th, 1921.

The Sun and the Weather.

IN his interesting article under the above heading Mr. R. M. Deeley writes: "From a study of barometric changes I shall attempt to show that the conditions in Great Britain during the long spell of dry hot weather in 1921 have been such as may be expected when the electronic bombardment (from the sun) is a mild one."

On the contrary, the auroral and magnetic phenomena of the present year would indicate not a mild, but a severe electronic bombardment. The series of magnetic disturbances, from May 12th to May 21st, constituted a storm of the very first magnitude, and a storm too, which in its protracted nature, has not been equalled since that of November 1882. This storm has been succeeded by magnetic disturbances, at each synodical rotation of the sun, even to the month of November. (*cf. Nature*, Oct. 27th, 1921.)

The storm of May was accompanied by a very remarkable aurora, both in the northern and southern hemispheres. According to the *Monthly Weather Review*, U.S.A., for July 1921, pp. 406–409, the aurora was witnessed from northern and central Europe, westward over the Atlantic, across the the United States, and far over the Pacific, reaching as far south as Apia, Samoa. One remarkable character about

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* See *M.O. Circular* No. 27.

this auroral display was that it was seen in extreme south latitudes with all the brilliancy usually observed in the north. The natural inference is that such a display denoted a very severe electronic solar bombardment. Even after five synodic rotations of the sun Major Lockyer observed an aurora, on September 28th–29th, which was connected with that of May 14th–15th. (*Nature*, October 6th, 1921.)

Finally, to judge from the horizontal component, the general magnetic field of the earth was more intense in 1921 than in 1920. A. L. CORTIE, S.J.

Stonyhurst College Observatory, December 30th, 1921.

Units for Meteorological Work.

IN the discussion of the value of new units in meteorological work, Mr. L. C. W. Bonacina* touches one point of vital interest to climatologists; namely, that the Fahrenheit degree is preferable to the Centigrade, "because one can disregard fractions in many instances where it would not be justifiable to do so with Centigrade degrees." This is correct; and climatologists have long felt the need of a smaller scale division than the Centigrade, and for that matter, even the Fahrenheit.

It may interest your readers to know that for six years we have been using at Blue Hill the Kelvin-kilograd scale. This scale has all the merits of the Absolute-Centigrade, plus the advantage of smaller scale divisions; oKk is the absolute zero, and the freezing point is 1,000 Kk. The temperature of water boiling under the pressure of 760 mm. in Lat. 45° comes out to be 1,367 Kk, whilst for the pressure 1 megadyne per square centimetre the boiling point is 1,365 Kk. The scale ratios are 1 Kk = 0°·491 F. = 0°·273 C.

On the new scale the thermal coefficient of expansion of air is 0·001, which replaces the awkward values 0·00367 or 0·002039 appropriate to the Centigrade and Fahrenheit scales. For example, if the velocity of sound in dry air at a specified temperature is required, and it is known that the velocity in dry air at the freezing point of water is 332·9 metres per second, the velocity at the specified temperature, say 1,043 Kk, is $332{\cdot}9 \times 1{\cdot}043^{\frac{1}{2}}$ or 340·0 metres per second. On the other hand, if the Fahrenheit scale had been used, the corresponding expression for the velocity of sound at 52°·6 F. would have given us $332{\cdot}9 \times (1 + 20{\cdot}6 \times {\cdot}002039)^{\frac{1}{2}}$ and brought us to the same answer but by a longer route.

* *Meteorological Magazine*, 1921, p. 255.

Much more could be written, but I realise the limits of your space.

Let me, however, as the one who in 1908 first proposed the decimalisation of pressure, add, that the prime reasons for changing are economy of time and space, and greater accuracy.

ALEXANDER McADIE.

Blue Hill Observatory, Readville, Mass., Nov. 3rd, 1921.

[In the list of "References for the Historical Development of the Question of Units for Meteorological Measurements," in the *Observer's Handbook*, 1915, p. 162, there are six references preceding that to Prof. McAdie's paper of 1908. The "bar" and its sub-multiples were used by Bjerknes and Sandström in working up balloon observations made on the "International Days" 1900–1903.—ED. M.M.]

Grounds for Forecasting a Mild Winter.

THERE is a curious relation between Rothesay rainfall (annual) and the Greenwich winter; after a very mild winter, high rainfall; after a very high rainfall, a mild winter. Thus, taking the latter case, I find that if the Rothesay rainfall reaches 55 in. or more, the Greenwich winter temperature is rarely under 38° F. (only one case in sixteen and that close to 38° F.). In the sixteen cases there were twelve warm winters to four cold. The rainfall this year, I think, will come into the category of 55 in. or over, so that a mild winter would seem likely.

[The average rainfall of Rothesay is about 48·6 in.; the mean temperature of the Greenwich winter, 39°·3 F.]

ALEX. B. MACDOWALL.

Bellevue, Bridge of Allan, Dec. 31st, 1921.

NOTES AND QUERIES.

The Effect of Vertical Currents on Gun-ranging.

IN a recent paper communicated to the Royal Meteorological Society, Mr. N. K. Johnson draws attention to the fact that, when convection currents are strong, single theodolite pilot balloon ascents give erroneous values of wind velocity and direction in the first few thousand feet.

During gunnery trials it is exceedingly important, if vertical currents be present, that their strength should be known. At Shoeburyness, the double theodolite method of pilot balloon observation is always used, as this advantage is secured as well as the greatest possible accuracy with regard to wind values. When firing at low elevations, the displacement of the point of fall of a shell due to a given vertical wind is much greater than that due to a following or head wind of the same velocity. I have worked out some typical examples. In the case of a gun firing with muzzle velocity of 2,400 feet per second and "quadrant elevation" of 5°, *i.e.*, with a range of about 5 miles, a following wind of 10 feet per second increases the range by 8·1 yards whereas an ascending current of the same velocity increases the range by 48·5 yards, an effect nearly six times as great. For a quadrant elevation of 3°, the vertical wind displacement is more than 10 times as great as that due to a horizontal following wind of the same velocity.

In summer anticyclonic weather, vertical currents of 10 feet per second are by no means uncommon and the horizontal component of the wind may be of the order of 5 feet per second. If single theodolite pilot balloon observations are used the calculated displacement of the point of fall of the shell would be quite erroneous not only on account of the false wind velocity deduced from the observations, but because the presence of the vertical wind component would be ignored. Irregular increases in range are found when strong vertical currents are present, but it is always difficult to say over what area convection extends. For this reason vertical winds cannot be allowed for by the artilleryman in the same systematic way as the horizontal winds which do not vary greatly from point to point over a small area.

This irregularity of the vertical current makes the verification of the "small arc computation" a matter of much difficulty. Even after head wind, density, and elasticity effects have been allowed for, it cannot be said that the residuum of the displacement represents a vertical wind effect since there are small indefinite errors due to such factors as slight differences in the lapse rate of temperature, to yaw and to the wear of the gun.

The figures given above were arrived at by the usual step-by-step integration of the equations of motion of a projectile moving under the given conditions. They represent the values of the displacement under ideal conditions which, perhaps, do not often arise in actual practice. They indicate, however, how unexpected over-ranging may be accounted for by the presence of vertical current, and hence the importance of detecting the presence of such currents during artillery trials by the double theodolite method of pilot balloon observation.

C. E. BRITTON.

The Estimation of Cloud Height from Observations of Humidity.

WITH reference to Mr. L. H. G. Dines's note in the September number of this magazine on the estimation of cloud height from humidity observations, some observations made some time ago on Salisbury Plain by Captain J. Durward are of interest. Mr. Dines's observations were mostly of the stratified clouds formed in winds blowing from the Atlantic. Captain Durward's refer to a single occasion when cumulus cloud was forming over the heated land. The day in question, August 12th, 1919, was very hot; four pilot balloon ascents were made at 8 h. 45 m., 10 h., 11 h., and 11 h. 45 m., G.M.T., the two-theodolite method being used.

The growth of convection currents during the morning was well marked, the rates of ascent of the four balloons being 550, 505, 655, and 700 feet per minute.

The sky was cloudless up to 11 h., but about 11 h. 15 m. cumulus began to form, and by 12 h. the sky was half covered, the cloud height as measured was 5,000 feet, and the temperature reported for that level was 52° F.

The temperature in the Stevenson screen at the time was 77·3° F., the dew point (determined by the strong-wind formula which was deemed appropriate to the circumstances), 56·7° F. Using a rule equivalent to that given by Mr. Dines for a well-stirred atmosphere, Captain Durward estimated the level of condensation as 4,750 feet and the corresponding temperature as 52° F. The agreement with observation is satisfactory.

Dust-raising Winds.

DR. E. H. Hankin, whose observations of the flight of birds are well known, has contributed to the *Memoirs of the Indian Meteorological Department* a study of dust-raising winds which should be consulted by all who are interested in the nature of turbulent motion in the atmosphere. The principal point made by Dr. Hankin is that the raising of dust in considerable quantities requires vigorous descending currents to dig into the ground and disturb it violently. Once the dust has been lifted it can be carried to great distances and may form large clouds with comparatively dust-free air beneath. Dr. Hankin classifies the manifestations of the dust-raising power, and discusses *seriatim* dust-devils, large dust columns, dust-curtains, primary dust-storms (in which the dust is raised locally), and derived dust-storms (in which the dust has been brought from a distance). A curious feature of the dust-devils, which are vertical whirls in which the dust is concentrated in the centre, is that in the initial stages the central column is sometimes seen to be falling. It may be suggested that in such cases the whirling motion near the ground is more vigorous than at greater heights so that centrifugal force reduces the pressure in the core of the whirl at low levels more than is appropriate to allow for convectional ascent of air in the central column, and there is therefore a tendency for this central column to fall and for the air immediately surrounding it to gain in digging power. On the other hand, when the dust-devil is well established the bottom of the dust column is maintained at a considerable height—50 metres or more—above the ground. Dr. Hankin's observations of smoke show that the ascending current associated with a dust-devil may have a radius of 6 miles. Within this radius all dust-raising by the wind ceases.

If we may legitimately generalise these observations we arrive at the paradox that a whirlwind marks the stabilising of convection over a considerable area and reduces the turbulence of the motion by substituting steady flow for irregular eddies.

Evaporation from Large Expanses of Water.

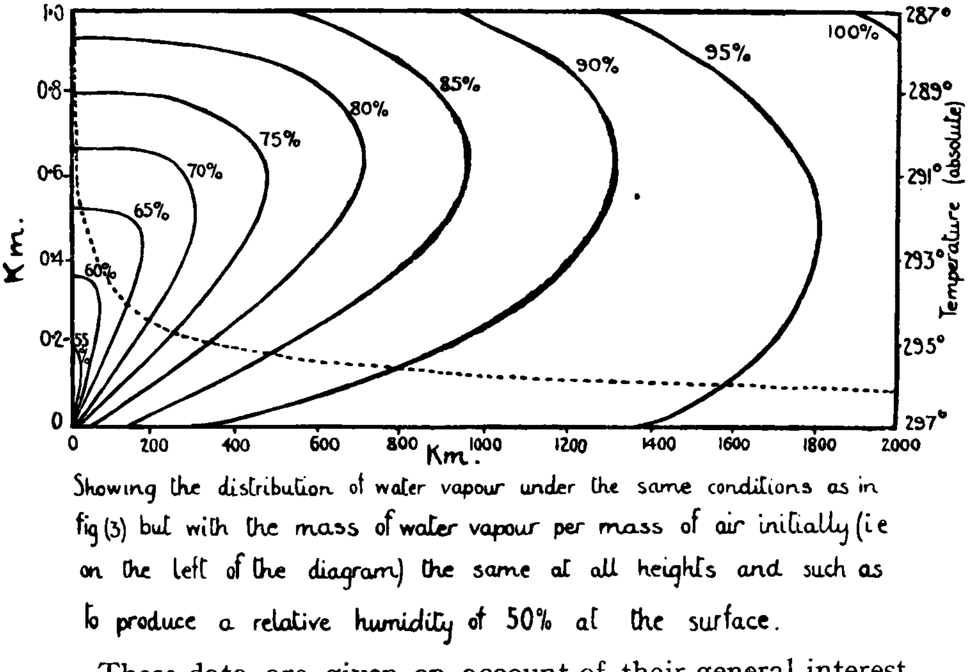
The fact that the air over the continents obtains its supply of water vapour from the oceans is one of the commonplaces of meteorology, but our knowledge of the process by which the vapour works its way up from the surface of the sea, gradually producing a state of saturation, has been too vague hitherto. Dr. H. Jeffreys submitted the problem to mathematical analysis in 1918, and the work of Mr. M. A. Giblett, which has been recently published,* marks a further advance. Dr. Jeffreys adopted the simple hypothesis that the rate of evaporation depended only on difference of vapour pressure, whilst Mr. Giblett allows for the strength of the wind.

The figure reproduced on p. 364 illustrates one of Mr. Giblett's examples.

The wind is blowing from left to right, and on the left of the diagram it reaches the ocean as a current with such water vapour as it contains thoroughly mixed with the air and with the relative humidity, at the surface, 50 per cent. The wind is 5 metres per second, *i.e.* Force 3 on the Beaufort Scale and the sea-temperature 75° F. It will be seen that

* *Some Problems connected with Evaporation from Large Expanses of Water.* By M. A. Giblett, M.Sc. *Proc. Roy. Soc.* A. Vol. 99, 1921.

according to the analysis, which is based on the experimental data of Dalton, Bigelow, and Richardson, the air near the sea reaches 90 per cent. humidity in about 300 kilometres (180 miles), but that evaporation then becomes slower and 95 per cent. humidity is not reached until nearly 1,400 kilometres (800 miles) have been covered; by that time all the air up to 3,000 feet has a relative humidity exceeding 90 per cent., and since the stirring of the air is never uniform, conditions are very favourable for the formation of low cloud.



Showing the distribution of water vapour under the same conditions as in fig (3) but with the mass of water vapour per mass of air initially (i e on the left of the diagram) the same at all heights and such as to produce a relative humidity of 50% at the surface.

These data are given on account of their general interest, but in connection with them two criticisms must be emphasized. These are that the effects of radiation are ignored, and that the lapse-rate of temperature is assumed to be 1° C. per 100 metres. Such a high lapse-rate, connoting thorough stirring of the atmosphere, is the rule over the land in the middle of a summer day. It is not generally appropriate for air over the sea.

The paper provides valuable information as to the total amount of evaporation under various conditions. It is interesting to notice that the same amount of air picks up less moisture if it crosses the ocean quickly than if it goes slowly; the more vigorous evaporation does not make up for the shorter time of passage.

The Smoke Veil.

An interesting example of atmospheric pollution is noted in *Nature* of December 15th by Mr. W. Lawrence Balls, of Bollington Cross, near Macclesfield. On November 26th Mr. Balls was walking from Hayfield to Edale across the Peak of Derbyshire. Below 1,550 feet on the western side he noted hazy sunshine with rime, but at 1,500 feet there was a thin cloud, with a temperature scarcely below freezing point, formed by a steady easterly wind blowing over the Peak plateau from the east. These conditions had obtained since the morning of the previous day, and hoar-frost of peculiar formation had resulted. The stream-lines of air-flow round stones was clearly shown by curling lines of ice, and the deposits of ice-crystals on grass, leaves, and stems took the form of knife-blades with the edges pointing up-wind. The largest ice-knife, which was nearly an inch in width, showed, even at a distance of 2 or 3 yards, a regular striped pattern, and on closer inspection the stripes were found on all the knives. The stripes were three in number, pale grey near the leaf and towards the edge of the knife, and clear or yellowish in between. The grey stripes were evidently due to the presence of smoke in the cloud-mist during the day on November 25th and 26th, while the clear zone had been formed during the night when the wind was cleaner. At Edale Cross, 1,750 feet above sea level, the knives pointed their edges directly to the centre of Sheffield—the intervening distance is more than 16 miles, the first 14 of which are wild moorland.

An Exhibition of Scientific Instruments.

At the annual exhibition of scientific apparatus organised by the Physical Society and the Optical Society, Messrs. Negretti and Zambra and Messrs. Casella exhibited various instruments of interest to meteorologists. Messrs. Negretti and Zambra showed several forms of "transmitting thermometers," thermometers actuated by the expansion of mercury in steel. The thermographs constructed on this principle should prove of great value, as the thermometer bulb can be exposed in a screen out of doors whilst the chart is in view in the house. Messrs. Casella exhibited a weathercock with a vane of the Meteorological Office pattern and the Owens autographic air filter. Both these firms exhibited self-recording rain gauges. Kew unifilar magnetometers were shown by Casella and by the Cambridge and Paul Instrument Company. The latter company also exhibited a Dip Circle of the Kew pattern.

Display of Meteorological Information for the London-Continental Aerial Routes at Lympne Aerodrome.

PILOTS on the London-Continental Air Routes when flying towards London, can obtain information as to the existing weather conditions at their destination by means of a system of ground signals which has been established at Lympne Aerodrome. These consist of large white letters and figures placed in a convenient position and denoting, according to fixed scales, the cloud height and visibility (and also, when reported, adverse weather such as snow or gales) at Biggin Hill and Croydon. These signals will shortly be extended to include the weather conditions at St. Inglevert for the information of pilots proceeding from England to the Continent.

Radiation from the Sky.

RADIATION MEASURED AT BENSON, OXON, 1921.

Unit: one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays).

Averages for Readings about time of Sunset.

		Oct.	Nov.	Dec.	Year.
Cloudless days :—					
Number of readings - -	n	12	13	13	*†
Radiation from sky in zenith -	πI	517	436	468	499
Total radiation from sky - -	J	549	457	509	538
Total radiation from horizontal black surface on earth.	X	717	601	656	708
Net radiation from earth -	X—J	168	144	147	170

DIFFUSE SOLAR RADIATION (luminous rays).

Averages for Readings between 9 h. and 15 h. G.M.T.

		Oct.	Nov.	Dec.	Year.
Cloudless days :—					
Number of readings - -	n_0	8	4	3	*
Radiation from sky in zenith - -	πI_0	24	22	18	44
Total radiation from sky - -	J_0	28	27	28	50
Cloudy days :—					
Number of readings - -	n_1	4	9	11	*
Radiation from sky in zenith	πI_1	91	50	28	138
Total radiation from sky - -	J_1	73	43	23	126

* Mean of 12 monthly values.
† June interpolated (565, 600, 770, 170).

"Fine" or "Fair."

FOR many years the Meteorological Office has adopted conventional meanings for the words "fine" and "fair" as applied to weather, but it is not certain that the same meanings are attached to the words by the public. The Director would be glad to receive from readers of the Magazine definitions of the words in question as understood by the general public.

Obituary.

The Rev. John Smith Begg, M.A., Rector of St. Olaf's Church, Kirkwall, Orkney, who died on 14th December 1921, at the age of 46, had rendered considerable services to meteorology in Scotland. A native of Perth, he was educated mainly at Edinburgh where he entered the University with the high distinction of "First Bursar," and graduated with honours in mathematics and natural philosophy. From his student days onwards he took a keen interest in meteorology and on many vacations he acted as a voluntary observer on Ben Nevis. Mr. Begg's career as a clergyman of the Episcopal Church in Scotland took him successively to West Linton (1907–1913) and to Kirkcaldy (1913–1918); at each place he established a climatological station and secured its continuance, whilst at West Linton a small research grant enabled him to carry out an investigation into the question of temperature gradients with different types of weather. He resigned his charge at Kirkcaldy in order to accept a commission in the Royal Air Force in 1918, and after a period of training was posted as Meteorological Officer at Longside Airship Station. On demobilization in September 1919 and election to his charge at Kirkwall, he took over the duties of climatological observer at that place.

Mr. Begg was not a physically robust man; but his eager spirit was never daunted, and he will be remembered as representing the best type of the voluntary worker to whom this country has owed so much.

Mr. P. C. Steventon.—We note with regret the death of Mr. P. C. Steventon, meteorologist to the Borough of Torquay, at the early age of twenty-nine. Mr. Steventon succeeded Mr. F. March who retired from the position of Borough Meteorologist in December 1919, and proved an enthusiastic and conscientious worker. His health had been affected, however, by the strain of military service, and he succumbed to a short illness.

News in Brief.

CASES for binding the Meteorological Magazine, 1921, will be available shortly. They are to be obtained for one shilling (plus postage 2*d.*) from H.M. Stationery Office, Imperial House, Kingsway, W.C. 2.

In the programme of the Royal Institution two lectures by Sir Napier Shaw, F.R.S., on "Droughts and Floods" are announced. These lectures will be delivered on Thursdays, February 2nd and 9th, at 3 p.m.

A discussion on "The Use of Light as an Aid to Aerial Navigation" will be opened by Lt.-Col. L. F. Blandy at the next meeting of the Illuminating Engineering Society, which is to be held at 8 p.m. on January 31st at the house of the Royal Society of Arts, John Street, Adelphi. The chair will be taken by Maj.-Gen. Sir Frederick Sykes, the Controller-General of Civil Aviation.

There was an unusually large number of earthquake shocks during December. They occurred in the Eastern Alps, Lake Bolsena (north of Rome), in the Andes, and at Tokyo. The latter, which occurred on the night of the 8th, was the severest for twenty years. No deaths are reported, but several injuries and much material damage. The water-main was broken, and the entire city was without water for two days.

The Weather of December, 1921.

December 1921 was a typically unsettled month throughout the greater part of western Europe. At the beginning, pressure was high over Scandinavia, and depressions from the Atlantic moved south-eastwards across the Bay of Biscay to Spain and the Mediterranean, causing heavy rainfall in those regions: 79 mm. fell at Brest and 80 mm. at Sanguinaire, in Corsica, on the 1st, 42 mm. at Rome on the 2nd, while another 70 mm. were measured at Sanguinaire during the 2nd and 3rd.

By the 4th the anticyclone over Scandinavia had begun to withdraw towards central Europe, and depressions near Iceland and Spitzbergen extended their influence to Norway and the north-west districts of the British Isles; varying quantities of rain (or snow in the Arctic circle) fell on many days in succession, but the measurements were generally well under 15 mm. although that figure was exceeded occasionally, *e.g.*, 24 mm. at Eskdalemuir and 22 mm. at Skudesnaes, both on the 6th. Meanwhile the barometer had been falling in central Europe and there was but a comparatively narrow wedge over France and Austria extending from the anticyclone near the Azores. This favoured the development of a small secondary depression over southern Norway which caused rainfall in the neighbourhood of the Baltic on the 7th. For the next few days pressure remained high near the

White Sea and "lows" prevailed north-westwards from the Mediterranean and Poland to Spitzbergen and thence south-westwards a thousand miles or so beyond Iceland. Snow fell in Norway and Sweden and rain at times in most parts with the exception of a small area in the extreme south-west which was dominated by the anticyclonic ridge extending from the Azores. The main flow of air on the northern side of this ridge brought mild, damp weather to the British Isles with night temperatures ranging generally between 40° F. and 50° F. Rainfall, however, was scanty in most districts.

Gradually the anticyclone from the north of Russia moved southwards and uniting with the extension of the Azores system formed an irregular belt of high pressure across the centre of the continent. In eastern and central Europe there was a marked drop in temperature about the 11th or 12th, the thermometer falling several degrees below zero at night both at Prague and Lemberg. Light north-westerly winds in the rear of shallow secondary depressions near the English Channel caused perceptibly colder weather in many parts of England also; frost occurred locally in the screen on the 12th, 13th, and 14th and there was some fog as also in Denmark and the Netherlands where it developed frequently during this period.

After the middle of the month pressure was high near Spitzbergen for about a week and depressions from the Icelandic region therefore tended to pass east or south-east to southern Scandinavia causing frequent gales over a large area, including the British Isles, the North Sea, Denmark, and the Baltic. With the increased gradient for westerly winds temperature rose, especially in the southern districts, and there was little or no frost in the British Isles from the 17th to 20th. Throughout the night of the 18th–19th the thermometer never fell below 50° F. in many parts of south-eastern and southern England and remained two or three degrees above that figure in some localities including Kew.

Gales were reported between Iceland and the Hebrides on the 16th and subsequently, as the depression deepened over southern Norway, the circulation became very strong near Denmark and the southern Baltic and did not subside until the 19th by which time Atlantic liners approaching our coasts were encountering fresh westerly gales as another depression passed south of Iceland. Rough weather was renewed in north-western Europe and strong gales experienced near the Shetlands and Skagerrak. Precipitation associated with these depressions was not, generally speaking, particularly heavy although on the morning of the 17th, 43 mm.

was reported as falling at Floro in southern Norway.

Troughs of low pressure secondary to the main system in the north developed off our south-west coasts and caused steep gradients in the neighbourhood of the English Channel with gales locally on the 22nd and 23rd. Rain fell over a very wide area but seldom much exceeded 10 mm. except in the Mediterranean where a shallow depression yielded 54 mm. at Sanguinaire on the 23rd–24th.

On Christmas Eve there was a temporary drop in temperature in England and many parts of western Europe as the result of cold north-westerly winds associated with a ridge of high pressure which had spread up from the Azores. Ground frost was fairly general, but there was little or none in the screen except in Sweden and the extreme north. Before night the winds had backed again with the approach of a minor disturbance which caused temperature to rise again to 50° F. or above in southern England on Christmas Day, but in its rear a wedge of high pressure spread over the English Channel and northern France occasioning local fog and sharp frost inland the next morning.

Cyclonic conditions, however, prevailed again almost immediately with rain at times in most districts. In the north and west heavy falls were recorded; 43 mm. at Eskdalemuir, 31 mm. at Oxo and over 20 mm. at Floro and Valencia. The last few days of the month were characterised by renewed high winds and gales near the Bristol Channel, English Channel, southern North Sea and south-western Baltic. At 1 h. on the 28th the westerly current attained the force of a whole gale (over 55 miles per hour) at Plymouth and the general strength of the wind was such as to reach gale force, in gusts at least, at inland stations also. On the 30th the passage of a depression across the north of Scotland to southern Norway was accompanied by violent gales which swept across the British Isles during the day and night. Gusts between 55 and 60 miles per hour were recorded at Kew Observatory, between 60 and 70 miles per hour at Benson and Scilly and over 75 miles per hour at Holyhead. As regards the British Isles as a whole this was probably the roughest day of the month and was the occasion of considerable damage to property. During this period there was more heavy rain, snow and hail in south-west Scotland, about 25 mm. being recorded at Eskdalemuir on three days in succession. On the Continent measurements occasionally exceeded 10 mm. but precipitation was more generally light. L. D. S.

In central and southern Europe the drought of the preceding months continued, and the level of the Rhine was unusually low. In Switzerland the weather was fine and mild and the snow-cover thin until about the 24th, when heavy falls of snow enabled winter sports to begin. On the 29th rain fell for a time, with remarkably high temperatures for the time of year, even at high levels. In the Italian Alps and the northern half of Italy the drought has now become very severe. The electric plants, which are worked by water power, have had to close down. In Genoa, on the 19th, water was being sold at *2d.* a gallon, and there have been several forest fires. In the Trentino the water of a lake has fallen so much that a small island has appeared which has not been seen since the great drought of 1806. This year, however, has exceeded the conditions of 1806, and Father Gaddoni, of Imola, is reported as saying that one must go back to 1621 to find another drought in the Po Valley similar to the present one.

The southern parts of Italy were, however, well supplied with rain, and at Bari, in Apulia, damage has been done by the heavy rainfall.

There was heavy snowfall in Asia Minor, and towards the end of the month a gale in the Black Sea, but it appears that in most parts of Russia the drought continues. Welcome winter rains have fallen over wide areas in Baluchistan and North-west India.

In North America a severe gale occurred on the Newfoundland coast on the 7th, in connection with a depression which moved north-eastward across the Maritime Provinces. Several vessels were wrecked, two with loss of life. Another deep depression which moved westward across Canada lay off Nova Scotia on the 12th, causing gales, though hitherto no damage has been reported.

A violent tornado was experienced in the northern parts of Arkansas and Mississippi on the 23rd, followed by a severe frost. The death-roll numbered thirty-six. A gale occurred at San Francisco on the 25th, also causing loss of life.

A message from Australia on December 28th reports extremely heavy rains, ranging from 6 to 12 inches, in New South Wales and Queensland. Flooded rivers and wash-aways seriously interfered with traffic, but the rain will be very beneficial to agriculture.

A telegram from Dr. Sampaio Ferraz, of Brazil, states that during December the rainfall was deficient in the centre and south of Brazil, and the temperature was generally above normal but no excessive heat was experienced, and there was an unusual lack of thunderstorms over the country. The

(*Continued on* p. 376.)

Rainfall Table for December 1921.

STATION.	COUNTY.	Aver. 1881—1915. in.	1921. in.	1921. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days.
Camden Square	*London*	2·39	1·13	29	47	·21	14	15
Tenterden (View Tower)	*Kent*	3·11	1·96	50	63	·37	14	19
Arundel (Patching Farm)	*Sussex*	3·36	2·28	58	68	·56	22	15
Fordingbridge (Oaklands)	*Hampshire*	3·96	2·01	51	51	·35	30	19
Oxford (Magdalen College)	*Oxfordshire*	2·32	1·28	33	55	·25	22	16
Wellingborough (Swanspool)	*Northampton*	2·35	1·60	41	68	·28	26	16
Hawkedon Rectory	*Suffolk*	2·42	1·46	37	60	·25	26	16
Norwich (Eaton)	*Norfolk*	2·61	1·96	50	75	·37	23	15
Launceston (Polapit Tamar)	*Devon*	5·12	3·41	87	67	·75	22	27
Sidmouth (Sidmount)	,,	3·93	1·60	41	41	·31	22	18
Ross (County Observatory)	*Herefordshire*	2·97	1·59	41	54	·40	26	14
Church Stretton (Wolstaston)	*Shropshire*	3·36	2·97	75	88	·53	30	19
Boston (Black Sluice)	*Lincoln*	2·15	1·36	35	63	·40	24	16
Worksop (Hodsock Priory)	*Nottingham*	2·36	1·80	46	77	·34	24	19
Mickleover (Clyd House)	*Derbyshire*	2·63	2·03	52	77	·40	27	20
Southport (Hesketh Park)	*Lancashire*	3·23	3·84	98	119	1·06	27	25
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·92	3·83	97	131	·37	24	25
Hull (Pearson Park)	,, *E. R.*	2·41	2·28	58	95	·77	27	18
Newcastle (Town Moor)	*North'land*	2·41	1·56	40	65	·21	18	15
Borrowdale (Seathwaite)	*Cumberland*	16·34	22·10	561	135	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	5·11	2·70	69	53	·51	26	26
Haverfordwest (Gram. Sch.)	*Pembroke*	5·70	3·00	76	53	·58	26	24
Aberystwyth (Gogerddan)	*Cardigan*	5·03	5·29	134	105	·77	26	20
Llandudno	*Carnarvon*	3·10	3·06	78	99	·58	24	21
Dumfries (Cargen)	*Kirkcudbrt.*	5·41	6·27	159	116	·88	6	23
Marchmont House	*Berwick*	2·81	2·62	67	93	·68	30	20
Girvan (Pinmore)	*Ayr*	5·99	8·22	209	137	·78	6	27
Glasgow (Queen's Park)	*Renfrew*	4·23	5·79	147	137	·78	26	26
Islay (Eallabus)	*Argyll*	5·93	8·86	225	149	1·16	21	30
Mull (Quinish)	,,	7·13	8·04	204	113	·71	29	28
Loch Dhu	*Perth*	10·08	13·90	353	138	1·50	31	26
Dundee (Eastern Necropolis)	*Forfar*	2·66	1·46	37	55	·34	21	14
Braemar (Bank)	*Aberdeen*	3·57	3·01	77	84	·60	29	23
Aberdeen (Cranford)	,,	3·48	1·64	42	47	·45	4	18
Gordon Castle	*Moray*	2·69	2·90	74	108	·45	30	22
Fort William (Atholl Bank)	*Inverness*	10·08	15·40	391	153	2·14	5	26
Alness (Ardross Castle)	*Ross*	4·13	6·00	152	145	·79	30	23
Loch Torridon (Bendamph)	,,	10·20	15·01	381	147	1·54	31	27
Stornoway	,,	6·25	8·66	220	139	·69	6	28
Loch More (Achfary)	*Sutherland*	9·24	16·87	429	183	2·25	6	28
Wick	*Caithness*	3·08	4·14	105	134	·50	5	26
Glanmire (Lota Lodge)	*Cork*	5·50	2·25	57	41	·33	26	23
Killarney (District Asylum)	*Kerry*	7·28	3·89	99	53	·63	26	27
Waterford (Brook Lodge)	*Waterford*	4·69	1·90	48	41	·30	10	20
Nenagh (Castle Lough)	*Tipperary*	4·61	4·40	112	95	1·00	26	28
Foynes (Coolnanes)	*Limerick*	4·73	3·73	95	79	..	..	..
Gorey (Courtown House)	*Wexford*	3·82	1·38	35	36	·34	27	16
Abbey Leix (Blandsfort)	*Queen's Co.*	3·68	3·33	85	90	·63	27	25
Dublin (FitzWilliam Square)	*Dublin*	2·48	2·46	63	99	·92	27	18
Mullingar (Belvedere)	*Westmeath*	3·68	3·68	93	100	·70	27	27
Woodlawn	*Galway*	4·45	4·56	116	102	·69	27	30
Crossmolina (Enniscoe)	*Mayo*	6·55	5·97	152	91	·61	21	27
Collooney (Markree Obsy.)	*Sligo*	4·79	4·61	117	95	·42	24	28
Seaforde	*Down*	4·12	2·99	76	73	·47	26	21
Ballymena (Harryville)	*Antrim*	4·44	4·33	110	98	·35	4	27
Omagh (Edenfel)	*Tyrone*	4·23	6·00	152	142	·72	29	29

Ennistymon House, Nov., 4·96 in. 126 mm.

Supplementary Rainfall, December 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	1·04	26
,,	Sevenoaks, Speldhurst	1·97	50
,,	Hailsham Vicarage	3·17	81
,,	Totland Bay, Aston	1·70	43
,,	Ashley, Old Manor Ho.	1·49	38
,,	Grayshott	2·25	57
,,	Ufton Nervet	1·77	45
III.	Harrow Weald, Hill Ho.	1·47	37
,,	Pitsford, Sedgebrook	1·68	43
,,	Chatteris, The Priory	·98	25
IV.	Elsenham, Gaunts End	1·65	42
,,	Lexden, Hill House	1·17	30
,,	Aylsham, Rippon Hall	2·29	58
,,	Swaffham	1·35	34
V.	Devizes, Highclere	1·78	45
,,	Weymouth	1·55	39
,,	Ashburton, Druid Ho.	3·13	79
,,	Cullompton	2·38	61
,,	Hartland Abbey	2·78	71
,,	St. Austell, Trevarna	2·92	74
,,	Crewkerne Merefield Ho	1·93	49
,,	Cutcombe, Wheddon Cr.	4·49	114
VI.	Clifton, Stoke Bishop.	2·34	59
,,	Ledbury, Underdown.	1·25	32
,,	Shifnal, Hatton Grange	1·95	49
,,	Ashbourne, Mayfield	2·83	72
,,	Barnt Green, Upwood	1·66	42
,,	Blockley, Upton Wold	1·89	48
VII.	Grantham, Saltersford	1·23	31
,,	Louth, Westgate	1·67	42
,,	Mansfield, West Bank	2·41	61
VIII.	Nantwich, Dorfold Hall	2·63	67
,,	Bolton, Queen's Park.	6·68	170
,,	Lancaster, Strathspey.	6·04	153
IX.	Rotherham, Moorgate.	2·77	70
,,	Bradford, Lister Park.	4·89	124
,,	West Witton	4·50	114
,,	Scarborough, Scalby	2·31	59
,,	Middlesbro', Albert Pk.	1·96	50
,,	Mickleton	6·90	175
X.	Bellingham	4·88	124
,,	Ilderton, Lilburn	1·62	41
,,	Orton	12·61	320
XI.	Llanfrechfa Grange	3·20	81
,,	Treherbert, Tyn-y-waun	9·80	249
,,	Carmarthen Friary	3·78	96
,,	Llanwrda, Dolaucothy	5·95	151
,,	Lampeter, Falcondale	4·46	113
,,	Cray Station	9·50	241
,,	B'ham W.W., Tyrmyndd	6·70	170
,,	Lake Vyrnwy	10·79	274
,,	Llangynhafal, P. Drâw	3·60	91
,,	Oakley Quarries	15·19	386
,,	Dolgelly, Bryntirion	7·25	184
,,	Snowdon, L. Llydaw.	20·54	522
,,	Lligwy	4·70	119
XII.	Stoneykirk, Ardwell Ho.	3·59	91
,,	Carsphairn, Shiel	13·96	355
XII.	Langholm, Drove Rd.	9·48	241
XIII.	Ettrick Manse	9·93	252
,,	North Berwick Res.	2·02	51
,,	Edinburgh, Royal Ob.	3·13	79
XIV.	Biggar	5·40	137
,,	Leadhills	11·87	301
,,	Maybole, Knockdon	7·63	194
XV.	Dougarie Lodge	7·79	198
,,	Inveraray Castle	17·89	454
,,	Holy Loch, Ardnadam	14·22	361
,,	Oban	8·06	205
XVI.	Loch Venachar	7·50	191
,,	Glenquey Reservoir	9·20	234
,,	Loch Rannoch, Dall	8·65	220
,,	Blair Atholl	5·03	128
,,	Coupar Angus	1·80	46
,,	Montrose Asylum	1·17	30
XVII.	LogieColdstone, Loanh'd	1·99	51
,,	Fyvie Castle	1·83	47
,,	Grantown-on-Spey	3·72	95
XVIII.	Cluny Castle	7·63	194
,,	Loch Quoich, Loan	40·60	1,031
,,	Fortrose	4·03	102
,,	Faire-na Squir	10·75	273
,,	Skye, Dunvegan	11·70	297
,,	Glencarron Lodge	18·57	472
XIX.	Dornoch, St. Gilberts	3·90	99
,,	Tongue Manse	6·47	164
,,	Melvich Schoolhouse	6·94	176
XX.	Dunmanway Rectory	4·45	113
,,	Mitchelstown Castle	2·90	74
,,	Gearahameen	10·50	267
,,	Darrynane Abbey	2·68	68
,,	Lismore Castle	1·76	45
,,	Cashel, Ballinamona	2·19	56
,,	Roscrea, Timoney Pk.	3·28	83
,,	Ballybunion	3·59	91
,,	Broadford, Hurdlesto'n	4·87	124
XXI.	Kilkenny Castle	1·13	29
,,	Rathnew, Clonmannon	1·93	49
,,	Hacketstown Rectory	2·22	56
,,	Balbriggan, Ardgillan	2·37	60
,,	Drogheda	1·79	45
,,	Athlone, Twyford	4·17	106
XXII.	Castle Forbes Gdns.	3·78	96
,,	Ballynahinch Castle	7·56	192
,,	Galway Grammar Sch.	5·56	141
XXIII.	Westport House	5·36	136
,,	Enniskillen, Portora	4·79	122
,,	Armagh Observatory	3·27	83
,,	Warrenpoint	2·54	65
,,	Belfast, Cave Hill Rd.	3·63	92
,,	Glenarm Castle	4·27	109
,,	Londonderry, Creggan.	5·81	148
,,	Sion Mills	5·73	145
,,	Milford, The Manse	6·03	153
,,	Narin, Kiltoorish	5·85	149
,,	Killybegs, Rockmount	9·85	250

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	°F.		°F.		°F.	°F.	°F.	°F.
London, Kew Observatory	1018·0	+2·5	89	10	46	1	78·8	57·7	68·3	+5·6
Gibraltar	1016·6	+1·3	86	23, 25, 31	62	16	81·0	67·7	74·3	−0·4
Malta	1015·5	+1·5	99	20	70	8	84·6	73·3	78·9	+1·6
Sierra Leone	1014·2	+0·9	88	3, 8, 25	64	8	84·8	71·4	78·1	−0·8
Lagos, Nigeria	1015·0	+1·2	86	8	69	16	80·1	74·0	77·1	−0·2
Kaduna, Nigeria	1014·5	+2·7	91	29, 31	62	4	82·1	66·5	74·3	−0·3
Zomba, Nyasaland	1019·0	+1·1	81	19	47	24	69·5	51·6	60·5	−1·2
Salisbury, Rhodesia	1020·2	−0·7	77	20	37	6	69·7	42·1	55·9	−0·2
Cape Town	1023·5	+2·2	77	12	35	20	61·6	45·1	53·3	−1·6
Johannesburg	1026·0	−0·5	65	19	30	7	57·4	37·2	47·3	−3·3
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	69	17	16	2	58·4	27·9	43·1	−4·2
Calcutta, Alipore Obsy.	999·9	+0·7	94	20	75	11	89·3	79·4	84·3	+0·8
Bombay	1002·8	−0·9	90	6	75	20	84·3	77·5	80·9	−0·2
Madras	1003·9	−0·6	102	2	72	19	93·2	77·8	85·5	−1·8
Colombo, Ceylon	1008·6	+0·5	88	5	72	17	86·7	77·3	82·0	+0·7
Hong Kong	1006·9	+2·0	91	23	73	6	86·2	77·8	82·0	−0·5
Sandakan	..	..	91	5, 24	73	13, 15, 31	87·9	75·2	81·5	−0·4
Sydney	1016·7	−1·8	75	16	43	5	65·3	49·4	57·3	+4·9
Melbourne	1016·2	−2·7	66	11	33	23	57·1	43·4	50·3	+1·7
Adelaide	1018·5	−1·9	68	16	40	6	61·8	46·9	54·3	+2·7
Perth, Western Australia	1018·2	−0·9	76	21	41	29	65·1	52·5	58·8	+3·8
Coolgardie	1019·2	−0·7	71	6	30	29	64·8	43·3	54·1	+2·9
Brisbane	1016·9	−1·3	77	17	47	16	70·2	53·9	62·1	+3·8
Hobart, Tasmania	1009·6	−4·1	65	4	32	31	54·1	41·9	48·0	+2·6
Wellington, N.Z.	1014·6	+1·7	60	14	30	11	53·7	43·1	48·4	+0·9
Suva, Fiji	1015·2	+1·0	84	27, 29, 31	58	14	79·9	60·6	70·3	−3·3
Kingston, Jamaica	1014·9	+0·2	93	25	69	5	89·3	73·5	81·4	−0·3
Grenada, W.I.	1014·3	+1·0	90	24	72	5, 12	85·3	74·7	80·0	+1·1
Toronto	1014·8	+1·1	98	5	59	22	88·1	67·6	77·9	+9·7
Winnipeg	1013·6	+0·9	94	9	49	25	81·9	59·0	70·5	+4·3
St. John, N.B.	1014·8	+1·1	80	27	48	5	69	54	61·5	+1
Victoria, B.C.	1019·8	+3·1	77	22	47	9	64·8	50·5	57·7	−2·6

LONDON, KEW OBSERVATORY.—Mean speed of wind 7·2 mi/hr; 1 day with thunder heard.

MALTA.—Prevailing wind direction NW. From this month max. temp. refers to the period 7 h. to 18 h. and min. temp. 18 h. to 7 h.

SIERRA LEONE.—Prevailing wind direction SW, 2 days with thunder heard, 1 day with gale.

MADRAS.—11 days with thunder heard.

COLOMBO, CEYLON.—Prevailing wind direction WSW, mean speed 6·6 mi/hr.

HONG KONG.—Prevailing wind direction ESE; mean speed 11·0 mi/hr; 4 days with thunder heard.

MAURITIUS :—										
January 1921	1012·0	+0·1	88	7	67	20	84·4	71·8	78·1	−1·2
February	1010·3	−0·7	88	3	70	1, 28	83·1	73·6	78·3	−1·0
March	1012·6	+0·6	86	16	69	29	82·8	73·2	78·0	0·0
April	1014·7	+0·7	84	10	61	28	81·0	67·1	74·1	−1·7

MAURITIUS :—January, Prevailing wind direction E, mean speed 7·4 mi/hr. February, Prevailing wind direction E, mean speed 10·1 mi/hr.

British Empire, July 1921.

TEMPERATURE Mean Wet Bulb °F.	TEMPERATURE Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	PRECIPITATION Amount mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible	STATIONS
60·8	40	55	5·2	0·15	4	− 51	5	8·3	51	London, Kew Observatory.
69·5	61	79	3·1	0·00	0	− 1	0	..	..	Gibraltar.
71·1	65	61	1·1	0·00	0	− 1	0	11·6	81	Malta.
74·3	..	79	7·7	22·36	568	−305	26	..	..	Sierra Leone.
74·5	66	85	9·5	16·86	428	+159	25	..	..	Lagos, Nigeria.
70·3	..	93	..	11·10	282	+ 50	19	..	..	Kaduna, Nigeria.
..	..	81	4·1	0·92	23	+ 16	7	..	..	Zomba, Nyasaland.
48·6	29	56	2·8	0·04	1	0	1	..	..	Salisbury, Rhodesia.
49·3	..	72	4·6	4·25	108	+ 18	15	..	..	Cape Town.
36·2	27	55	0·5	0·00	0	− 6	0	9·8	92	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
33·5	..	73	1·5	0·00	0	− 10	0	..	..	Bloemfontein.
80·7	72	76	8·8	9·66	245	− 82	12*	..	..	Calcutta, Alipore Obsy.
77·6	69	83	8·7	35·67	906	+267	29*	..	..	Bombay.
76·4	..	78	8·0	8·36	212	+108	10*	..	..	Madras.
77·6	68	71	8·6	5·12	130	0	13	..	..	Colombo, Ceylon.
77·3	..	80	6·1	11·88	302	− 17	15	8·3	63	Hong Kong.
75·8	..	79	..	6·75	171	+ 5	13	..	..	Sandakan.
52·6	36	68	4·6	7·03	179	+ 57	11	5·3	52	Sydney.
47·5	30	76	6·5	2·41	61	+ 15	15	..	..	Melbourne.
50·3	29	74	5·0	2·01	51	− 16	12	4·6	46	Adelaide.
54·8	35	71	6·2	7·39	188	+ 21	19	..	..	Perth, Western Australia.
50·1	25	55	3·9	0·24	6	− 17	4	..	..	Coolgardie.
57·8	36	70	4·5	6·14	156	+ 98	10	..	..	Brisbane.
43·7	26	73	6·2	4·47	114	+ 60	18	4·3	46	Hobart, Tasmania.
45·9	22	82	7·5	4·61	117	− 27	16	3·2	34	Wellington, N.Z.
71·5	..	90	..	4·85	123	+ 6	17	..	..	Suva, Fiji.
..	..	71	6·7	1·21	31	− 11	7	..	..	Kingston, Jamaica.
75·3	..	75	4·1	7·09	180	− 69	20	..	..	Grenada, W.I.
69·7	55	73	4·0	2·65	67	− 10	11	..	..	Toronto.
66·8	..	68	4·0	3·71	94	+ 17	10	..	..	Winnipeg.
57·3	43	89	6·7	1·67	42	− 50	7	..	..	St. John, N.B.
52·5	41	76	2·7	0·15	4	− 5	3	..	..	Victoria, B.C.

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

SYDNEY.—Mean max. and mean min. temp. highest on record.
ADELAIDE.—With one exception mildest July on record.
PERTH, W. AUSTRALIA.—Abs. max. highest on record for July since 1896.
BRISBANE.—Mean temp. highest on record for July.
WELLINGTON, N.Z.—1 day with hail.
GRENADA.—Prevailing wind direction E.

										MAURITIUS :—
72·7	62	77	6·2	10·36	263	+ 66	23	8·7	67	January 1921.
73·8	64	80	6·7	5·03	128	− 85	23	7·3	58	February.
72·9	64	80	5·7	6·83	173	− 65	25	8·5	70	March.
68·5	55	75	5·4	2·67	68	− 46	13	7·7	66	April.

March.—Prevailing wind direction E ; mean speed 10·7 mi/hr.
April.—Prevailing wind direction ESE ; mean speed 6·8 mi/hr.

pressure distribution in southern Brazil was dominated by anticyclones moving from west to east. The crops, especially coffee and sugar cane, are affected by the scarcity of precipitation.

The rainfall of the month was below the average over the greater part of the British Isles, being less than half the average in the neighbourhood of London, in eastern Aberdeenshire, and in the south-east of Ireland. Only about one-third of the area of England received as much as 75 per cent. of the average and this was confined to the north-west. Locally in this district more than the average rainfall was recorded, reaching 135 per cent. at Seathwaite. In Scotland more than the average fell generally in the west, north-west, and south-west, and in Ireland most of the northern half had more than the average. More than 25 mm. (1 in.) during the month was recorded practically everywhere in the British Isles, the area in England with between 25 and 75 mm. (1 to 3 in.) being unusually large. More than 500 mm. (20 in.) fell in the English Lake District. In Scotland a considerable part of the Western Highlands received more than 250 mm. (10 in.) while as much as 1,031 mm. (40·60 in.) fell at Loan, a very rare occurrence even in this extraordinarily rainy region. In Ireland falls less than 25 mm. (1 in.) were confined to the south-east, while in the north-west more than 100 mm. (4 in.) fell generally. More than 250 mm. (10 in.) fell in the mountains of Connemara and Kerry.

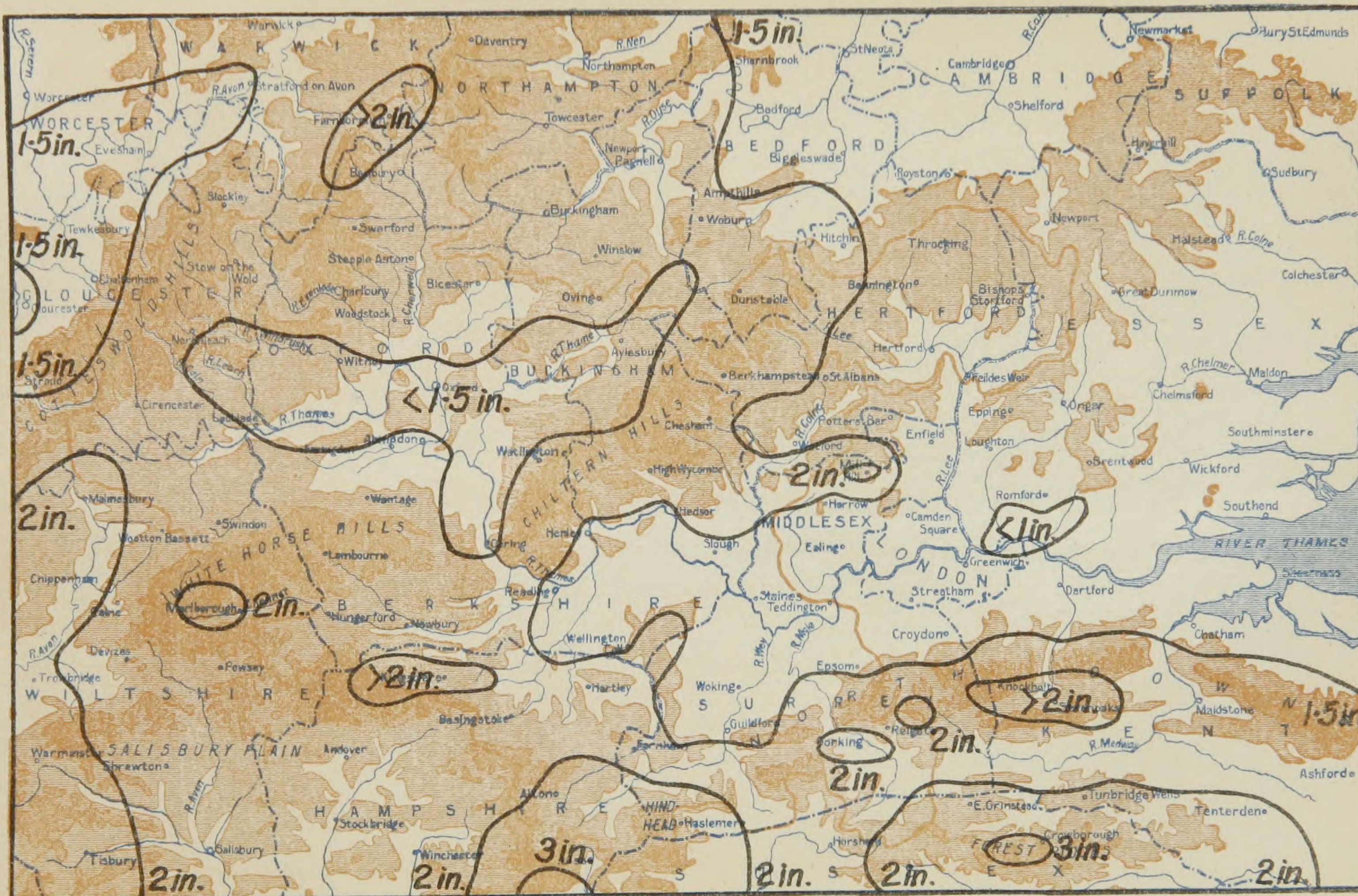
At Falstone Rectory in Northumberland 92 mm. (3·61 in.) fell on the 26th, and 61 mm. (2·39 in.) on the 30th, making 195 mm. (7·67 in.) in 5 consecutive days.

The general rainfall for December, expressed as a percentage of the average, was :—England and Wales, 83 ; Scotland, 133 ; Ireland, 80 ; British Isles, 101.

For the 11 months February to December a considerable area in the south-east of England has received less than half its average rainfall for the period. The areas with this deficiency are situated respectively in a broad band along the coast from Hampshire to Kent and in Herefordshire. Less than 60 per cent. of the average fell during these 11 months over about half the area of England to the south of a line roughly from Swansea to Boston. In the Western Highlands of Scotland the rainfall in this period was generally just above the average. In Ireland the fall has been nearly everywhere between 75 and 95 per cent. of the average.

In London, Camden Square, the mean temperature for December was 44·4° F. or 4·3° F. above the average. Duration of rainfall, 24·3 hours ; evaporation, ·28 inch.

THAMES VALLEY RAINFALL. —— DECEMBER, 1921.



ALTITUDE SCALE: Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES: 0 5 10 15 20

Watershed of River Thames above Teddington and River Lee above Feildes Weir.

Isohyetals.

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