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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.*,  $5\frac{1}{2}^{\circ}$  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  $5\frac{1}{2}^{\circ}$  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

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

where  $P_0$  and  $P_1$  are pressures outside and at the centre of the vortex,  $\rho$  is the mean density of the air,  $a$  the radius of the vortex,  $\omega$  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  $P_0 - P_1 = 30$ ,  $\rho = 1.2$ , 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

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\* 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.

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#### **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  $\beta$  rays, but Störmer has put forward reasons for considering them to be  $\alpha$  rays. After discussing these theories in the light of their observations, Vegard and Krogness discard the  $\alpha$  ray hypothesis in favour of that of  $\beta$  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  $\xi$  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  $\rho$  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.

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### 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 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  $4\frac{1}{2}$  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.*

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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 Willington, 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,  $49\cdot2^{\circ}$  F., failed to reach the mean maximum of January 1916 by  $\cdot3^{\circ}$  F.; but the mean minimum,  $40\cdot3^{\circ}$  F., easily eclipses that of its rival,  $39\cdot1^{\circ}$  F., and the mean for the month comes out as  $44\cdot8^{\circ}$  F.

—	Mean Minimum.	Mean Maximum.	Mean.
	$^{\circ}$ F.	$^{\circ}$ F.	$^{\circ}$ 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  $30^{\circ}$ , its bearing S.  $58^{\circ}$  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 FEARINGTON.

*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, 31st 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 Meteorological Service of the Ministry of War; and
- (c) the Meteorological Service of the Service de la Navigation Aérienne.

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.

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### 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.  $7^{\circ} 55' S.$ , long.  $14^{\circ} 25' W.$  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.

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### 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 from 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.

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### 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

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

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

$$\sigma_m^2 = 4\sigma_a^2 \dots \dots \dots (2)$$

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—

$$r \sigma_m \sigma_a = \sigma_a^2 \dots \dots \dots (3)$$

and hence that—

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

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

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

Thus correlation between cause and effect measured by the coefficient  $\cdot 5$  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—

$$\frac{m}{\sigma_m} = r \cdot \frac{a}{\sigma_a} + x \dots \dots \dots (6)$$

where  $x$  is independent of  $a$ , and—

$$\frac{a}{\sigma_a} = r \cdot \frac{m}{\sigma_m} + y \dots \dots \dots (7)$$

where  $y$  is independent of  $m$ .

Hence we may write—

$$\frac{m}{\sigma_m} = r \left[ r \cdot \frac{m}{\sigma_m} + y \right] + x \dots \dots \dots (8)$$

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  $r^2 m$ , 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.



**ALTITUDE SCALE**

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

**SCALE OF MILES**

0 5 10 15 20



## 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  $15^{\circ}$  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  $15^{\circ}$  F. was recorded and  $17^{\circ}$  F. on the 13th, on which day the temperature remained below  $40^{\circ}$  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  $51^{\circ}$  F. and  $59^{\circ}$  F. were recorded was very remarkable; at Falmouth there were 24 such days, 22 at Dublin (Phoenix 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  $60^{\circ}$  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.	1921.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days.
		in.	in.	mm.		in.	Date.	
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
Woksop (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 (Enniscooe).....	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.		Div.	STATION.	RAIN.	
		in.	mm.			in.	mm.
II.	Ramsgate .....	1.64	42	XII.	Langholm, Drove Rd.	11.37	289
"	Sevenoaks, Speldhurst	2.59	66	XIII.	Selkirk, Hangingshaw	5.22	133
"	Hailsbam 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.	Logie Coldstone, 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	"	Drumadrochit .....	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, Hatton Grange	2.14	54	"	Glencarron Lodge ...	17.60	447
"	Ashbourne, Mayfield .	4.08	104	"	Dunrobin Castle .....	4.29	109
"	Barn 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 .	..	..
"	Oiton.....	13.15	334	"	Balbriggan, Ardgillan .	3.33	85
XI.	Llanfrehfa 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, Ardwell Ho.	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							
	Mean of Day M.S.L.	Diff. from Normal	Absolute				Mean Values			
			Max.	Date	Min.	Date	Max.	Min.	$\frac{1}{2}$ 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		Relative Humidity	Mean Cloud Am't	PRECIPITATION			BRIGHT SUNSHINE		STATIONS	
Absolute				Amount		Diff. from Normal	Days	Hours per day		Per-centage of possible
Max. in Sun ° F.	Min. on Grass ° F.			in.	mm.					
° 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	..	..	Sava, 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 Styne 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. Saarna 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.