The Meteorological Magazine

Vol. 69

(Fifteenth of the New Series)

1934

Published by the Authority of the Meteorological Committee. Air Ministry. Meteorological Office.

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
Adastral House, Kingsway, London, W.C.2; 120 George Street, Edinburgh 2;
York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff;
80 Chichester Street, Belfast;
or through any Bookseller

INDEX

ERRATA

See pages 21, 125, 222, 270, 294.

CORRIGENDUM

See page 74.

ILLUSTRATIONS

KEW OBSERVATORY FROM THE AIR.

M.O. 371.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 69

Feb. 1934

No. 817

LONDON: PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

Meteorological Records at Kew Observatory

The suggestion having been put forward by a reader that it would add to the value of the *Meteorological Magazine* if it contained a record of the weather day by day at a representative station, it has been arranged that an abstract of the observations at Kew Observatory shall be reproduced each month. The first table is to be found in the present number (p. 25). The following elements are included: pressure and the strength and direction of the wind in the middle of the day (at 13h.); the extremes of temperature (night minimum and day maximum) and, for comparison with this maximum temperature the relative humidity at 13h.; rainfall for the calendar day and the duration of bright sunshine. Short notes on the weather of the day are also set out, some of the letters of the Beaufort weather code being used for brevity. The following Beaufort letters are the ones employed:—d, drizzle; f, fog; h, hail; i, intermittent; l, lightning; p, shower; q, squall; r, rain; s, snow; t, thunder; x, hoar frost. A capital letter is used to denote intensity and a suffix o to indicate slight.

The observations utilised are all made under standard conditions with the exception of the temperature readings. It is the usual practice of the Meteorological Office to publish the readings of thermometers exposed at a height of 4 ft. above the ground in a Stevenson screen. The accepted figures for Kew

(5146) 32/91 1,000 2/34 M. & S., Ltd. *Gp.303*

Observatory refer however to thermometers in a large screen on the north side of the building at a height of 17 ft. above the natural level of the ground. There have been long series of comparisons between the readings in the North Wall screen and the Stevenson screen—the large Stevenson screen and two or three experimental screens can be seen in the aerial photograph in the frontispiece—and it is known that on the average the maximum temperature in the North Wall screen is slightly the lower (by about 0·4° F.), whilst the minimum temperature in that screen is the higher, the discrepancy being about 2° F. The question whether it would not be better to bring the observatory practice into line with that at other stations has been discussed from time to time, and the decision has been that consistency from year to year is in this case more important than consistency from place to place.

A view of Kew Observatory from the air is reproduced as frontispiece to this number of the *Meteorological Magazine*. The Observatory is in the Old Deer Park on level ground within a bend of the River Thames. Outside the Observatory enclosure, which contains about six acres, the surrounding part of the Park is occupied by the links of the Mid-Surrey Golf Club. The village of Isleworth is on the other side of the river. Conspicuous within the enclosure, in addition to the main observatory building and several out-buildings, is the roof of the underground laboratory which is used for observations on atmospheric electricity. The tall masts on the other side of the enclosure are for experiments designed to determine the electric charge in the atmosphere.

It is well known that the observatory was not originally called Kew Observatory. It was the King's observatory at Richmond, and it seems that the name Kew Observatory was not used before the negotiations which led to the lease of the building to the British Association in 1842. Possibly the old style, the King's observatory, was felt incongruous when the Crown passed to Queen Victoria. At that time the observatory already had a long though not from a scientific point of view a very eventful history. When the King's observatory was built for King George III by William Chambers, the versatile architect who designed Somerset House but also the Pagoda in Kew Gardens, the park was by no means the extensive open space which we know. The immediate neighbour was Sheen Priory, once a great Carthusian House, but then a group of private houses. The observatory was built in 1769 and about 1771 these were swept away as well as a number of other buildings, including Richmond Lodge, the palace of George II.

The observatory was inaugurated by the famous Transit of Venus, which was duly observed by the King and a party of his friends. Subsequently the principal astronomical observations were those required for regulating the clocks. The observatory might well have had one of the longest meteorological records in the world. There is no mention of meteorological observations in any old account of the observatory, and it was with much surprise that I learned from my brother in 1926 that there were three volumes of a meteorological register in the library of King's College, London. These three volumes include observations made between 1773 and 1840. It was a great disappointment to find that the record was too fragmentary to have any statistical value. There are but few months for which the daily entries are complete and moreover there is a gap of more than 20 years, from May, 1783, to December, 1803, apparently because one volume of the register has been lost.

It is most unfortunate that the rainfall record is quite unreliable. The rain was collected in a funnel on the roof and measured below presumably by a tilting bucket. The amounts are recorded in cubic inches, suggesting that the capacity of the bucket was one cubic inch. It is surmised that the area of the funnel was one square foot so that the entries in the register are to be regarded as inches and 144ths. The apparatus was allowed to remain out of order for considerable periods, but there are 33 years altogether for which annual totals are available. Comparison with other London records reveals, however, great inconsistency in the Richmond figures. This may be attributed in part to the very bad exposure of the gauge on the roof of an isolated building.

Considering the rarity of meteorological observations in the eighteenth century and early part of the nineteenth century it must be regarded as a notable coincidence that one of the best records was that kept by the Steward to the Duke of Northumberland at Syon House just across the river and in sight of the observatory.

The history of the observatory as the object of the care of a public body begins with the lease to the British Association in 1842. Amongst the objects set out in the memorandum which stimulated the Association to this enterprise was the construction of "a universal meteorograph, which will accurately record half-hourly indications of various meteorological instruments, dispensing entirely with the attendance of an observer; an apparatus for recording the direction and intensity of the wind simultaneously at various heights above the earth's surface; an apparatus for telegraphing the indications of meteorological instruments carried up in balloons or by kites, to an observer at the earth's surface."

A year later it was reported that an ordinary meteorological record with standard instruments was being made by Mr. Galloway, under the superintendence of Professor Wheatstone.

This series of observations extended from 1843 to 1851, and was regarded as incidental to the work in atmospheric electricity. At the beginning of 1854 a meteorological journal was commenced, and regular observations have proceeded from that date without a break. No provision was made, however, for publication by the British Association. It was not until the organisation of a network of observatories by the Meteorological Office that adequate use was made of the Kew records. From that date, 1869, the observatory has had a conspicuous place in all meteorological statistics.

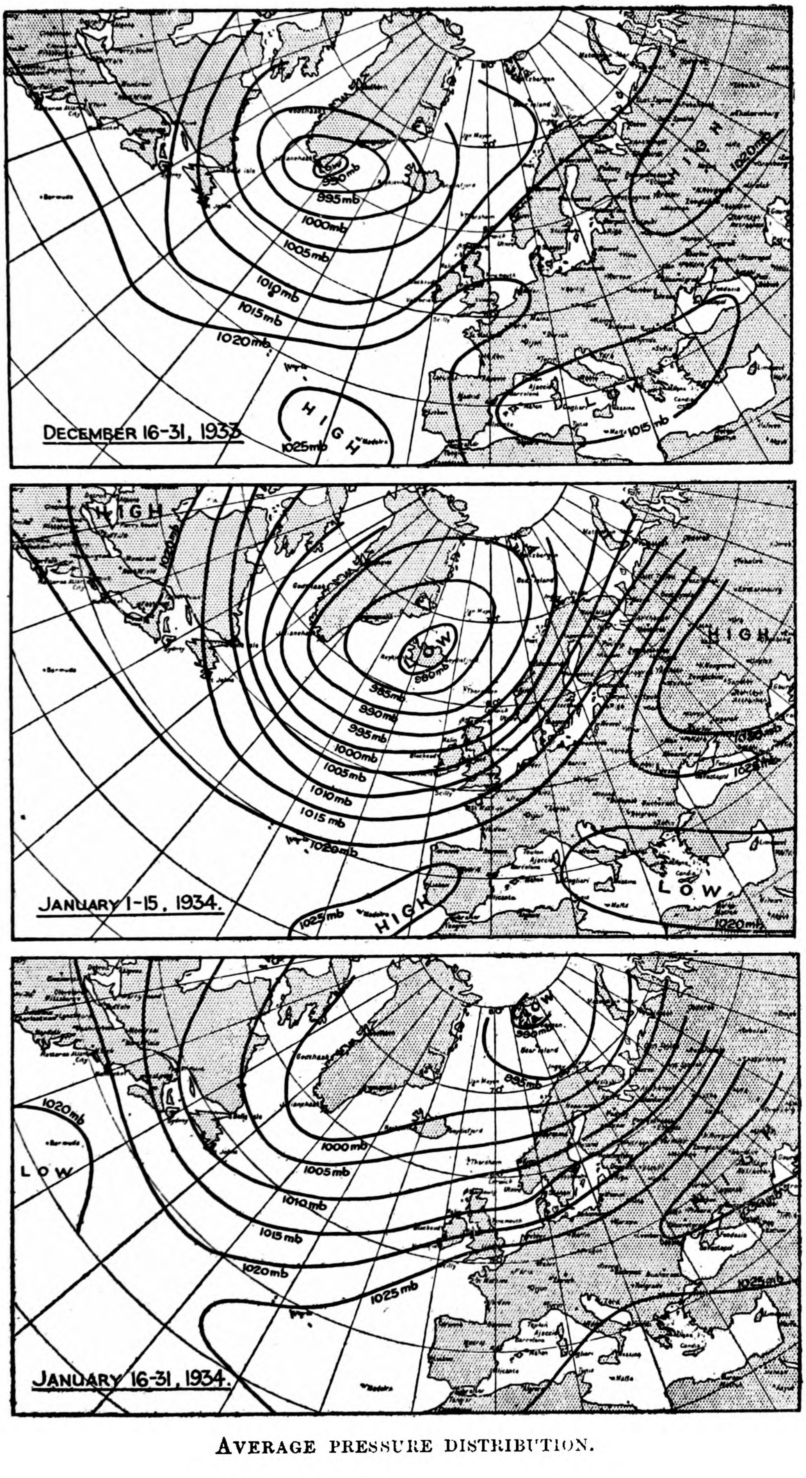
F. J. W. WHIPPLE.

Pressure Distribution during December, 1933, and January, 1934

The *Meteorological Magazine* for January contained on p. 280 a chart of the distribution of average pressure during the first half of December, 1933. The principal features of this chart are an intense anticyclone extending from the Faroes across Scotland and Denmark to northern Germany, and a depression, with average pressure below 1000 mb., centred south-west of Greenland. Another, relatively shallow, depression lies over the Pyrenees. The changes in the general pressure distribution during the succeeding six weeks show a well-marked progression, which is illustrated in the three charts opposite.

The uppermost chart shows the average pressure distribution during the period December 16th-31st. The anticyclone, which from the 11th to 15th had been centred over the Atlantic, gradually retreated eastwards across Europe, while at the same time the Azores anticyclone increased in intensity and the Pyrenees low spread eastwards and occupied the whole Mediterranean. The most remarkable development was shown by the Greenland depression, which deepened considerably and moved in an east-north-east direction to a position just east of the southern extremity of Greenland. Conditions during the second half of December were however not especially abnormal.

The second chart shows the distribution during the first half of January, 1934. The depression has moved still further towards the east-north-east to a position over Iceland, and has become very intense. At Reykjavik the average pressure for the 15 days was only 978 mb., which would be fairly low for a single reading and may be unparalleled for a 15-day average. At the same time the anticyclone over Russia has become intense, the average pressure at Moscow being 1,033 mb. The pressure difference between Iceland and Moscow was as much as 55 mb. in 2,000 miles. The Azores high has also increased in intensity and moved north-eastwards, the highest pressure, 1,027 mb.,



AVERAGE PRESSURE DISTRIBUTION.

being found at Lisbon. The Azores and Russian anticyclones already show a tendency to unite in a belt of high pressure along the axis of Europe. The Mediterranean depression has also moved eastwards and has become weaker.

The whole period was one of great storminess over north-west Europe. On the 4th, pressure fell below 964 mb. south-east of Iceland and gales were widespread. On the 6th a still deeper depression crossed Iceland and pressure at Seydisfjord fell to 951 mb. From the 7th to the 10th conditions were less violent, but on the 11th and 12th a new disturbance with pressure below 960 mb. passed slowly south-east of Iceland. On the 14th a deep secondary to this depression crossed the British Isles and gave a reading of 971 mb. at Manchester at 7h. Another disturbance passed just north of Scotland on the 17th and 18th, giving a pressure of 959 mb. at Lerwick at 1h. on the 18th. After the 18th the distribution changed rapidly. An offshoot from the Azores anticyclone moved north-east across the British Isles to Europe and the main focus of low pressure shifted towards Spitsbergen. From the 28th to 31st conditions were definitely anticyclonic over the British Isles.

The average pressure during January 16th to 31st is shown in the lowermost chart. The lowest pressure is found over Spitsbergen, and a well-marked anticyclonic belt extends from the Azores and Madeira across Spain and central Europe to southern Russia.

The whole series of four charts, including that in the December issue, forms a definite series, in which the focus of low pressure travels 2,500 miles from south-west of Greenland to Spitsbergen without losing its identity, while another focus travels from the Pyrenees the whole length of the Mediterranean. The last three charts show in addition the gradual building up of a long anticyclonic ridge, which from the data available extended continuously at least from northern California to the Aral Sea. The area of average low pressure which travelled continuously on a curved path from south-west of Greenland to Spitsbergen with an average speed of about 400 miles a week, is to be regarded rather as a focus of cyclonic activity than as an actual individual depression. Especially from January 1st-15th, and to some extent throughout the whole period of two months, depressions were continually originating to the west, passing through the focus, where they generally reached their greatest intensity, and moving away to the east or north-east. The charts represent the net result of these activities. The focus is therefore in some respects an abstraction, but it is difficult to believe that an abstraction could persist so definitely for two months without some underlying (or overlying ?) reality.

C. E. P. Brooks.

The West African Tornado

By D. E. Smith, M.A.

That the West African tornado has some very interesting features is revealed by the study of the various storms which passed over Lagos Observatory during the 13-month period of the Polar Year. Anemobiagrams, barograms, hygrograms, and thermograms were available for the complete period and have made a close and comprehensive study possible.

It is fairly apparent that these storms are due to the interaction of the dry north-easterly and warm, moist, south-westerly winds. As in most tropical countries there are two distinct seasons in west Africa, the rainy season lasting from May till October, and the dry or harmattan season from November till April. During the rainy season the coast is swept by the moist south-westerly, and in the dry season the north-easterly descends from the arid regions of north Africa and drives the monsoon coastwards. This north-easterly or harmattan very rarely establishes a complete ascendancy over the south-westerly at the coast, but in the central and northern provinces reigns supreme during its season. The west African tornado most frequently occurs in the months of March to May and September to early November. These are the two periods when the south-westerly and the north-easterly are fighting for supremacy and the proximity of the two air currents is sufficient to produce the storm energy.

One naturally expects that the west African tornado, caused apparently by the proximity of two air currents of different origins, would bear some resemblance to the squalls and discontinuities associated with the polar front in more northern latitudes and a glance at corresponding autograph charts is sufficient to convince us that the resemblance is more than superficial. Each tornado has its squall line with a discontinuity of wind direction and speed. Corresponding to each squall line there is a definite drop of temperature which during the Polar Year amounted to anything up to 15°.

The variations of barometric pressure associated with these storms were registered on a "Tycos" microbarograph manufactured by Messrs. Short and Mason. This barograph has a daily chart and is delicate enough to enable the reading of variations of the order of 0·005 in. In spite of the intensity of some of these storms (the instantaneous gust at the passage of the squall line must in some cases be about 70 or 80 m.p.h.) the charts show but little indication of either the approach or departure of these storms. In view of the proximity of Lagos to the equator (6° 28′ N.) it is not to be expected that the variations would be very large. The geostrophic component of the pressure gradient is naturally small but apparently the cyclostrophic component is also minute, which would indicate that the radius of curvature of these storms is rather large. I append a table showing the variations in the 3 hours preceding and in the 3 hours following the passage of the squall lines of half a dozen of the most intensive storms passing over Lagos during the Polar Year. In order that the fluctuations might

Date	Wind speed m.p.h.	Temperature drop.	Pressure variation preceding 3 hours.			Pressure variation 3 hours after.			Rain-fall.
			1	2	3	4	5	6	
		°F.	in.	in.	in.	in.	in.	in.	in.
Nov. 3rd, 1932	48	11	—0·013	0·000	+0·008	+0·041	—0·020	—0·033	0·45
Feb. 4th, 1933	30	11	—0·012	+0·007	—0·002	+0·032	0·000	0·000	1·26
Apr. 5th, 1933	35	15	—0·012	+0·013	—0·005	+0·037	—0·046	—0.012	0·28
Apr. 29th, 1933	44	13	—0·001	+0·026	+0·019	+0·045	+0·008	+0·004	0·92
May 5th, 1933	55	12	—0·011	+0·011	0·000	+0·022	—0·019	—0·009	1·45
May 16th, 1933	44	10	—0·002	+0·019	+0·073	—0·038	—0·009	—0·016	0·67

not be dwarfed by the diurnal wave I have made appropriate corrections to each of the hourly values. I have also tabulated the wind speed, temperature drop and rainfall. It will be seen that although there is a distinct indication of the passage of the storms as shown in the fourth column there is little or no indication of their approach as shown in the first three. Little then can be said for the microbarograph as a means of weather forecasting on the west coast of Africa. A weather chart might be more helpful; unfortunately our mercury barometers have not been standardised against each other for a considerable number of years and the isobars bear as a rule little or no relation to the atmospheric circulation.

The wind discontinuities at the passage of the front are quite instructive and in some ways rather perplexing. A study of the Lagos anemobiagrams and of the eye observations from all over Nigeria shows that in 99 per cent. of cases the squall breaks from the east-north-east or from within a point or two of that direction. This in itself is not very remarkable The cold wedge of the north-easterly current undermines the moist south-westerly current in the same way as the polar westerly or north-westerly undermines the warm south-westerly in more northerly latitudes. I think it is interesting, however, that in the case of the west African storm the south-westerly may veer or back towards the east-north-east on the passage of the squall line. In most of the cases I have studied, the veering or backing is not a gradual process but usually coincides instantaneously with the sudden increase of wind speed associated with the squall. In some cases indeed the veering or backing is a slow process and is in the nature of a storm warning, but usually the transition is quite sharp. In terms of cyclonic disturbances the explanation is simple enough. In the case of the veering wind the centre of the eastwards moving cyclone is north of the station; in the case of the backing wind the centre is south of the station. In terms of frontal theory the explanation becomes a little more difficult, and I shall be glad if any of your readers can offer an adequate explanation.

Air Currents in the Bay of Gibraltar

It is a common experience that a person seeking shelter from a high wind may be more rudely buffeted by the eddies in lee of a sizeable obstruction than he has been in the free wind before taking cover; and it is only logical to realise that similar conditions must affect larger objects in larger scale surroundings. A notable instance of this might be expected in the case of aeroplanes alighting in lee of that great upstanding obstruction the Rock of Gibraltar, shown in the photograph; and flying practice in Gbraltar Bay has shown that the turbulence in the wind shadow of the Rock is in fact of an extremely violent nature. It was there that in February 1929, the fatal accident occurred to the Fairey III D aeroplane in the act of alighting, and the present survey* of air currents was undertaken very shortly after the loss of that machine.

For the purpose of the survey a model of the Rock was made and exposed in a wind tunnel at the National Physical Laboratory, and measurement observations were then taken of the behaviour in pitch and yaw, and in eddy motion, of some 800 short silk-fibre indicators uniformly distributed in lee of the model to cover 14 sq. miles of the area of the Bay, and to reach in serried ranks up to 7,000 feet above sea. It was then found that a tunnel wind that was perfectly steady and quiescent upstream of the model, became in its lee a veritable "Witches' Cauldron" of eddies, vortices and mutually battling gusts: that these conditions prevailed for more than two miles to the west of the ridge of the Rock (as far, in fact, as the spot where Fairey III D was lost), and that they were embedded as detail in a system of wild but large-scaled turbulence which, with cyclic repetition, carried the ends of some long exploring fibres from heights of 4,000 feet downwards to lick the sea and up again. It seemed in fact, as far as model evidence showed, that all the conditions for flying accidents were present in easterly winds of any considerable strength.

By skewing the model in the tunnel the measurements were

*London, Meteor. Office, Geophysical Memoirs, No. 59. A survey of the air currents in the Bay of Gibraltar: 1929-30. By J. H. Field, C.S.I., M.A., and R. Warden, Ph.D. (M.O. 356b).

taken for each of seven wind directions between NE. and SE., 45° and 135°, and the interesting further point was then found that while a due east wind, 90°, resulted in two main vortices, each about half a mile in diameter and with its axis curving over from a horizontal attitude at the ridge level to bury its nose vertically in the sea, any shift of the prevailing free wind towards north or south of east progressively augmented one vortex at the expense of its fellow until at angles 60° and 120° only one vortex was left, but with its whole axis turned up into the horizontal plane and extending now the full length of Gibraltar Bay.

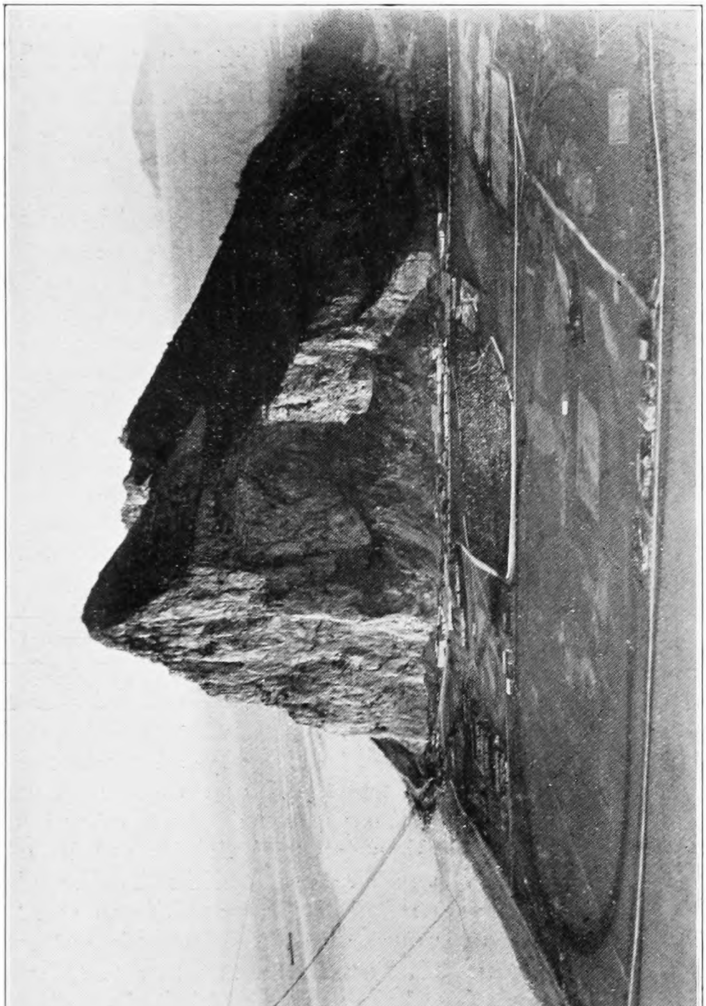
This condition is shown in fig. 2, which is a reproduction on a reduced scale of Plates XVIII C and D of the Memoir. The model is placed aslant in the tunnel to represent a wind from 60°, or a little north of ENE. The streamers shown by the fine wavy lines terminating in ellipses represent 12,000 feet on the full scale; they start just up-wind of the model and their position has been so adjusted that the vortex position occurs at the end of the streamer.

Armed with these preliminary views of what might be found on the actual spot, a party of observers sent up in Gibraltar between November, 1929, and the following March a series of 138 balloons, of known rate of rise in still air, and plotted their courses and rise rates as determined from theodolite observations taken at the two ends of a base line. An intensive examination was made of the results, and a comparison with the model behaviour at corresponding points in the Bay showed a strong measure of agreement.

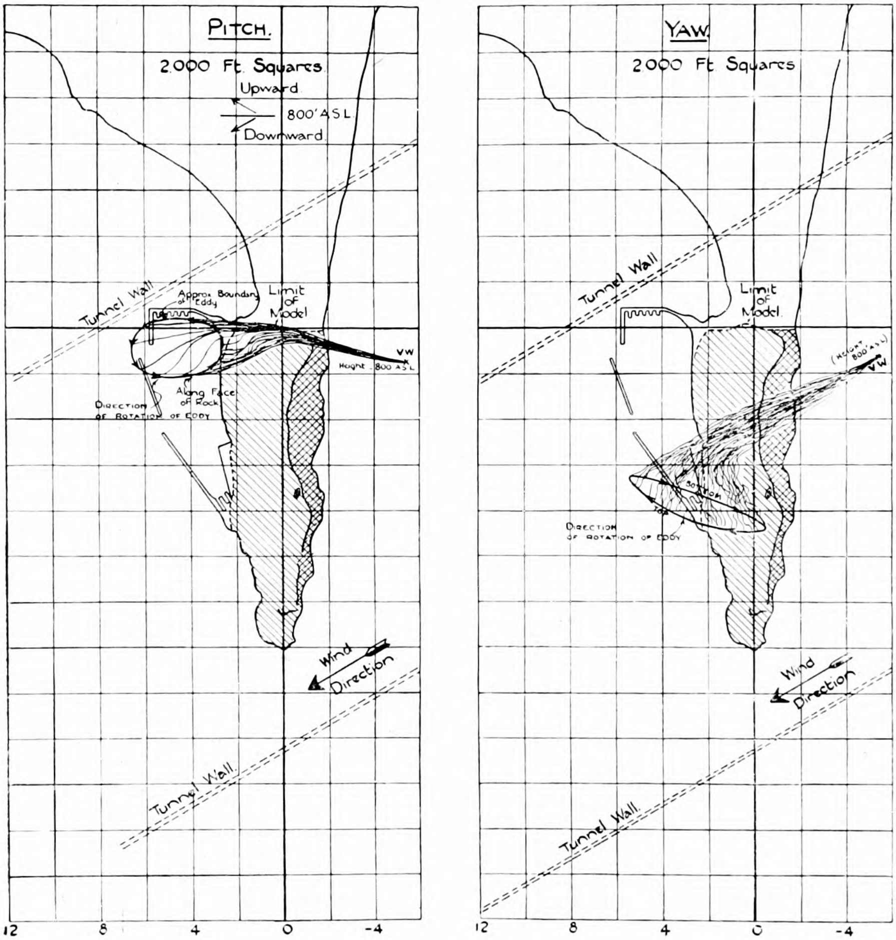
It was true that over a considerable area of the field a liberal amount of choice in balloon motion was offered by the model results, both in pitch and yaw, but out of a total of 360 plottings of balloon points there were only 24 instances of discordances and many of these were slight. The conclusion followed from the available evidence as a whole that the model observations, though on the very small scale ratio 1/5000, gave a definite picture of vortex and eddy distribution which proved to be consistent with the results found later on the full scale. In regard, however, to the two features of wind detail, actual strength and quickness of change in strength and direction, measurements with small models will not readily give a forecast, and these matters had accordingly to be left for examination on the spot at Gibraltar. It was there found that vertical currents over the sea in lee of the Rock would reach strengths as great as 1,500 feet per minute, up or down, even on days of good flying weather; that they were often exceedingly local, and that down currents were more violent than up currents and considerably more frequent.

A point of much interest arose when watching the behaviour

facing p. 10



GIBRALTAR : FROM THE AIR OVER NEUTRAL TERRITORY TO ITS NORTH.



Eddies as shown by streamers of great length in the Bay of Gibraltar at 800 ft. Wind 60°.

of clouds over Gibraltar Bay. When a humid wind blows past a great obstruction such as a hill top or mountain peak, there is frequently to be observed a "banner cloud" trailing downwind as a stationary feature anchored on the apex, the free wind of the day blowing along and through its body, yet leaving it unmoved. We know of celebrated instances in the "plume" of Mt. Everest and the "table-cloth" of Table Mountain, and at Gibraltar, to correspond with these, there occurs the "Levanter cloud." On a day of strong east wind from the damp Mediterranean, this banner cloud will spring from Gibraltar's ridge and stretch westwards for several miles, with the free wind rushing through it in its onward course over the Bay. At regular intervals of a few minutes a terminal part of the banner will break off and travel away downwind, to be succeeded in formation and break-off by similar cloudlets in due time order. This is entirely in accordance with the known behaviour of a bluff obstruction in a wind tunnel, for eddies form in its lee and break away at time intervals which can be calculated from the scale of the obstruction. In the case of Gibraltar, Mr. Relf, of the National Physical Laboratory, had already calculated that the time interval would be about three minutes, and it was interesting to find that not only was evidence of these break-away eddies offered visually by the activity at the tip of the Levanter cloud, but that the period of recurrence agreed closely with his forecast.

On the general question of determining the characters of movement in turbulent air, it must be recognised that the method of using balloons and theododites has strong limitations, and the Gibraltar observers spent a good deal of trouble in making and using a kite instrument of new design, which should give a continuous record of pitch, yaw and velocity of wind, with sufficient quickness of response to prove satisfactory when dealing with eddies. In the case of the present work at Gibraltar, the available time in the sanctioned tour of duty proved too short for this instrument to be effectively used there, but the observers concluded that in other cases where a proposed site for an aerodrome should come under preliminary trial, the best course to pursue would be to use first a model of the site and its surrounding country in a wind tunnel, and then on the site itself a kite or kite-balloon carrying this new instrument, but with a standby provision of pilot balloons and theodolites to fall back upon in case of unexpected difficulty with the new method.

Royal Meteorological Society

The Annual General Meeting of this Society was held on Wednesday, January 17th, at 49, Cromwell Road. South Kensington, Prof. S. Chapman, F.R.S., President, being in the Chair.

The Report of the Council for 1933 was read and adopted, and the Council for 1934 duly elected, the new President being Lt.-Col. E. Gold, D.S.O., F.R.S.

The Symons Gold Medal, which is awarded biennially for distinguished work done in connexion with meteorological science, was presented to Sir Gilbert T. Walker, C.S.I., F.R.S.

Prof. Chapman's Presidential Address was on

The Gases of the Atmosphere.

The permanent gases of the atmosphere (mainly nitrogen and oxygen) are known, from direct measurements in the stratosphere, to be in constant proportions up to the greatest heights yet attained by Piccard and his successors in stratospheric flight. Other constituents vary in their concentration, because of processes tending to produce and destroy or transfer them in the atmosphere; among such constituents are water, ozone, and the newly discovered positrons, which enter the atmosphere from outside as cosmic rays. Experiments are suggested to determine the rate of large-scale transfer of such gases by turbulence, using some easily detectable gas, artificially introduced, as an "indicator." Such experiments might also be made using ozone as the indicator, which would throw light on the distribution of ozone, as recently estimated by Dobson, Gotz and Meetham. The possibility of removing the atmospheric ozone above a certain ground area is also considered. The absorption of solar radiation by oxygen and ozone is discussed in the light of new experimental data, and in relation to the composition and temperature of the upper atmosphere.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are :—

February 26th, 1934.—*Kinematical and dynamical properties of the field of pressure with application to weather forecasting.* By S. Pettersen (Geofys. Publ., Oslo, Vol. 10, No. 2, 1933). *Opener.*—Mr. R. C. Sutcliffe, Ph.D.

March 12th, 1934.—Subject to be announced later.

Correspondence

To the Editor, *The Meteorological Magazine.*

Solar Coronæ

In your January issue Mr. L. W. C. Bonacina expresses the view that coronæ round the sun are relatively rare, and that one should look for them especially in December. May I direct his attention to our yearly volume, *Onweders, Optische Verschijnselen enz.*, which usually is mentioned also in this magazine.

In the 1929 volume he will find 109 observations of sun's coronæ by one observer at Aerdenhout near Haarlem, incidentally not a single one in December, all of them with accurate estimation of the coloured rings—and in 1933 this observer has developed even more zeal, and recorded 292 sun's coronæ on 257 days. Of course this is only possible by using coloured spectacles or a black mirror in order to get rid of diffuse sunlight, but certainly the sun's corona is not a rare phenomenon.

E. VAN EVERDINGEN.

K. Ned. Meteorologisch Instituut, De Bilt, Holland. January 30th, 1934.

A Lunar Corona

On January 27th, 1934, at about 18h. 30m. (G.M.T.), I observed a magnificent lunar corona. The central part next the moon was white and surrounded by a circle (diameter about 6°) of a very dark brown, almost, in fact, of the hue of a lunar eclipse. Surrounding this, was a splendid circle, green and blue, very bright and luminous and, at its rim, a delicate purplish ring (outer diameter approximately 16°). The green and blue zone was almost dazzling and attracted the notice of many people in streets and open spaces. I do not remember ever seeing so beautiful a lunar corona. In a few minutes, unhappily, this splendid phenomenon passed away.

M. MOYE.

12 *rue Boutonnet, Montpellier, France. February 1st,* 1934.

Rainbows and Sky Illumination

On the afternoon of Sunday, October 15th, about 4.15 p.m., there occurred here a heavy rain squall from south-west. It lasted about half an hour, and when the sky began to clear from west-south-west, there developed a rainbow of unusually brilliant hues. At the stage of greatest intensity, it was accompanied by a complete secondary bow, while the primary bow was so brilliant that the colours appeared to glow and give forth light on their own account. The spectacle was one of great beauty, and, curious to see how it would photograph, I got my camera and took three photographs (not reproduced). These clearly show the greater illumination of the sky inside the bow than outside, and I would like to know whether this feature, which is common to the whole three photographs, and is shown even more clearly in the negatives, has been remarked before. I may say that I have never observed it in looking at a rainbow directly.

W. D. LAING.

Holmwood, Nairn. November 20th, 1933.

[It appears that the greater illumination of the sky inside the primary bow can be perceived at times by the naked eye. For the reason why the difference shows up so clearly in photographs (there is a striking example of this given in "Clouds," by G. A. Clarke, plate 35B), I suggest the following explanation. In accordance with the accepted theory, the light which reaches the eye after one internal reflection in the raindrops comes out in all directions lying within about 42° from the central line passing through the sun and the observer's head. This reflected light is most intense near the limit, which corresponds with the path of minimum deviation of the ray, and the rainbow is seen at this angle. Of the light which undergoes two internal reflections, none which reaches the observer makes an angle of less than 50° with the central line. The space between the inner and outer bows therefore appears darker than the space within the inner or beyond the outer bow. Moreover the part of the cloud within the primary bow is seen partly by regularly refracted and reflected light, whereas the cloud between the two bows is seen only by scattered light. The light of shortest wave-lengths would be less scattered than the light of longer wave-lengths, hence from this part of the cloud there would be a deficiency of these wave-lengths (violet and ultra-violet) which affect the camera but which are less appreciated by the eye.—A. F. CROSSLEY.]

Parhelic Circle

In his letter with the above title in the January issue of the *Meteorological Magazine* (p. 287), Mr. Treloar asks whether the statement in Wood's "Physical Optics" that "the white horizontal circle, mock moons and other halo phenomena except the two halos of 22° and 46° require still air for their production" is generally accepted.

Pernter and Exner (pp. 440-2) seem to indicate that wind does not prejudice the production of halo phenomena but may affect the symmetry of certain forms, such as contact arches, and the parhelic circle. They quote an instance when the upper arc of contact was displaced 5° or 6° to the left and the parhelic circle instead of going through the sun passed 1° or 2° below. (Met. Zs., 1915, 552). The observer Saring attributed this to an unusually strong south-west current.

The ring-shaped halos such as 22° and 46° are not affected by wind.

CICELY M. BOTLEY.

Guildables, 17, *Holmesdale Gardens, Hastings*. *January* 23*rd*, 1934.

The Droughts of 1868 and 1933

The chance turning up of a record has solved for me the problem why the land in the 1868 drought left the landscape far more impressively burnt up than in 1933 in Somerset. For the first four months of 1868 only 5·54 inches fell; February 0·41; May to July only just reached 3 inches. May 0·76, July 0·85 inches. On the day the drought broke, about August 10th, as I reached home from a walking tour in drenching rain from the Quantocks for 12 miles into Bridgwater and then by train, our fine landmark of Tor Hill was brown as any new railway embankment in all its 500 feet.* The rain continued all night, over two inches in all being measured, and for the month 5·91 inches.

That was only a beginning. Against 8·54 in. for 7 months the last five yielded 18·83 in., closing with 5·14 in. in December. 1869 had therefore a fine start for water supply. Only yesterday I found the upper turf moor rhines, below Ashcot, perfectly dry. Usually they are full to overflowing, even before receiving the last drop of February fill-dyke. Their present dryness appears to be a record.

J. EDMUND CLARK.

Portway, Street, Somerset. January 13th, 1934.

Malayan Rainfall

As an instance of the distribution of rainfall in the tropics, the annual report on the Rural Board, Province Wellesley, Straits Settlements, cites the case of a rainstorm in the southern portion of the Province when 17·44 inches of rain were recorded between 6 p.m. and midnight, while in the north of the Province on the same day the rainfall was less than one inch.

THE MALAYAN INFORMATION AGENCY.

57, *Charing Cross Road, London, S.W.*1.

Cyclonic Formation, November 13th, 1933

An interesting phenomenon was observed in the Palk Strait on November 13th. The Sub-Collector of Customs, Kankesanturai, had noticed about sunrise what he believed to be the copious smoke of a steamer some miles out at sea off the north coast. The smoke was static, rising into the air and disappearing in a cloud. As daylight broadened the phenomenon faded until about 9 a.m., when a heavy thunder-cloud gathered in the north-western quarter of the sky. I was driving along the north coast road at that time, and while passing Kankesanturai observed a cyclonic formation over the sea to the north-west. This formation took the shape of a cylinder extending from the centre of the thunder-cloud down a considerable length of sky until, as it approached the sea, it lost its outline and was dissipated into a mist. The cylinder was altogether detached from the clouds behind and was distinctly defined against them. It was perfectly shaped as a pencil, coned

*In about four days it was again green.

at neither end. Had a camera been to hand, a most definite picture could have been obtained. I stopped my car and went down to the beach. The cylinder was moving against the background of clouds, and it became apparent after a minute's observation that it was moving rapidly towards the coast. The sea beneath the mist was considerably agitated. The formation passed to the south-east on the far side of a catamaran which was some miles out from the coast, and continued its journey until it was between the fishing fleet and the shore. The disturbance on the sea, which was impressively marked by the white spray thrown into the air, was narrowly localised, and appeared to be confined to an area of a hundred yards' diameter or so, possibly smaller. After three or four minutes the cylinder was no longer straight but was blown into a curve, and seemed to lose power, in that it lost its clarity of outline at a greater elevation from the sea. Very soon the cylinder disappeared altogether, but the agitated area on the sea continued to move rapidly towards Mayiliddi, until it, too, sank away about one mile from the coast. A small crowd of villagers were watching from the shore, and they stated that they had never seen such a thing previously. A strong wind sprang up from the north-west, and brought a heavy but brief local shower. From the distance, about five miles, travelled by the formation within a time of about five minutes, a speed of sixty miles an hour may be deduced, subject to a wide margin of error owing to the absence of better landmarks than a few fishing sails.

R. J. WILKINSON.

The Kachcheri, Jaffna, Ceylon. November 13th, 1933.

Travel of Thunderstorms

My attention has recently been drawn to what is stated to be a well-known peculiarity in the travel of thunderstorms in three different districts. I refer to the influence of rivers in controlling their movements. To the north of Lowestoft and again at Felixstowe it is said, on good authority, that thunderstorms tend to miss the locality, appearing to prefer a track either to the north or to the south, and it is in both cases suggested that the rivers have a controlling influence. At Wellingborough, Northamptonshire, it is also firmly believed that thunderstorms rarely cross the river.

In spite of the apparent authenticity of the statements I find it difficult to believe that a river, a few hundreds of feet in width, can, in the absence of marked relief, have any important influence on the motion of a storm system which may be anything up to 30,000 feet in height and of comparable horizontal dimensions. It is, moreover, not difficult to find a reasonable explanation for these beliefs as due to illusions of perspective when it is remembered that thunderstorms usually become noticeable at distances up to fifty miles so that far more storms will appear to approach any station than will actually pass overhead.

It must, however, be admitted that such an explanation does not easily satisfy the observer and it would be interesting to know whether any of your readers have come across similar beliefs in other parts of the country.

R. C. SUTCLIFFE.

De Freville, Brook Lane, Felixstowe. January 1st, 1934.

Buxton Weather Bulletin

Mr. H. Everard sends us the following copy of a weather bulletin which was displayed in a shop window at Buxton. In explanation of the remark about pressure it must be remembered that Buxton is at a height of 1,000 ft. above M.S.L.

Temperature.—Keeps up a good average.
Pressure.—Finds effort of climbing too much for it.
Rainfall.—Fairly frequent visitor.
Wind.—Speaks with a soft southern accent.
Current noting.—Ridge of high pressure giving way.
Further outlook.—Good, bad and indifferent in turn.
Propitious features.—Rest from their toils.
Ominous symptoms.—Collecting a representative array.

To-day's local weather handicap.

Pressure—drooping once more.
Distant influences—still quarrelsome.
Inferences—Bashful sunshine.
Arrogant clouds.
General dampness.
Fair periods.
Fairly mild.

Extreme December Minimum in Relation to Extreme June Maximum Temperatures: An Interesting Anomaly

Although it is sometimes said that the month of December hardly justifies its traditional reputation for hard frost the allegation is only true in regard to the frequency of south-westerly winds in the British Isles with the accompanying heavy Atlantic gales which keep frost at bay. But frost in December is always biding its chance in these latitudes, and our thermometric records show quite clearly that the potentialities of this month for intense cold are equal to those of any later winter month—if, indeed, they are not greater. Thus the absolute screen minimum on record for these islands of $-23°$ F. at Blackadder in Berwickshire occurred in December, 1879, a month which in Scotland was truly Arctic, and on the Continent was of almost incomparable rigour seeing that in Paris the mean day and night temperature for the entire month was as low as 18° F. In the south of England December, 1890, was colder than 1879, and at Cambridge the mean of 28·0° and the absolute minimum of 0° have not been equalled in any month of any name since records began in 1876. In London the means at Greenwich and Kew for December, 1890, of respectively 29·3° and 29·4° are just 0·3° and 0·2° higher than those for February, 1895.

If now we turn from dark December to the corresponding summer month, namely "flaming" June, which no doubt derives this epithet from the fierce sun-heats of the summer solstice, we find that the maximum air temperatures on record are notably less conspicuous in relation to the later summer months than are the December minima in relation to the later winter months. Thus at Greenwich the hottest June, which occurred as far back as 1846, had a mean of 67·7° as compared with cases of over 69° both in July and August, and nearly, if not actually, all maxima in the screen exceeding 95° recorded anywhere in England have happened in July and August.

The explanation of the anomaly which seems too definite to be accidental is probably this: at the summer solstice the upper air is still relatively cold and the intense surface heating tends to give rise to convectional instability so that the warm air does not keep down; at the winter solstice, on the other hand, when the upper air is still relatively warm the stratification is stable and surface freezing during the long nights can go on unchecked. That this explanation is correct seems to be supported by the fact that whereas very high maximum temperatures sometimes occur as late as September when a comparatively warm upper atmosphere tends to keep heated surface air down, very low minimum temperatures sometimes occur as early as November, as in the remarkable contrasts of 1919.

L. C. W. BONACINA.

35, *Parliament Hill, London. N.W.*3. *January 27th*, 1934.

NOTES AND QUERIES

Recent Calm Winters on the Lancashire Coast

In the course of a recent investigation it was necessary to tabulate the frequency of occurrences, during the past 11 years, of hours of wind with a mean velocity exceeding 24 miles per hour. An interesting fact revealed by these tabulations, which were confined to the four months November to February, was that the winters of 1931-2 and 1932-3 showed a remarkable deficiency of strong winds at Southport. The tabulations were, therefore, extended backwards to include the whole period for which analyses of wind velocity are available and similar tabulations were made for Holyhead and Spurn Head. The results for the four winter months are shown on Table I. At all three stations the conditions of measurement have remained practically unaltered throughout the whole period.

It will be seen that at Southport the winter of 1931-2 yielded only 43 per cent., and 1932-3 only 52 per cent. of the usual frequency of strong winds. At Holyhead both winters gave less than the average frequency, but the deficiency was in neither case so marked as at Southport. At Spurn Head 1931-2 was

TABLE I.—FREQUENCY OF STRONG WINDS (MEAN VELOCITY EXCEEDING 24 M.P.H.); TOTAL NUMBER OF HOURS IN THE FOUR MONTHS NOVEMBER TO FEBRUARY.

Winter	Southport		Holyhead		Fleetwood		Spurn Head	
	Hours	Per cent. of Average	Hours	Per cent. of Average	Hours	Per cent. of Average	Hours	Per cent. of Average
1913-14	758	147	811	110	...	...	381	71
1914-15	616	119	1,027	140	...	...	..	...
1915-16	801	155	1,047	142	...	...	678	127
1916-17	404	78	745	101	...	...	...	...
1917-18	753	146	924	126	...	...	...	...
1918-19	385	75	532	73	...	...	...	...
1919-20	829	160	936	127	...	...	...	...
1920-21	418	81	533	72	...	...	...	...
1921-22	597	116	831	113	...	...	728	136
1922-23	666	129	748	102	...	...	609	114
1923-24	498	96	655	89	176	63	652	122
1924-25	528	103	623	85	407	146	481	90
1925-26	401	77	615	83	272	97	419	79
1926-27	399	77	517	70	281	100	325	61
1927-28	512	99	779	106	472	169	831	156
1928-29	316	61	547	74	249	89	468	88
1929-30	421	81	773	105	300	117	542	102
1930-31	541	105	802	109	298	117	491	92
1931-32	222	43	588	80	146	52	318	60
1932-33	268	52	675	92	193	69	535	100
Average	517	...	735	...	279	...	533	...

the calmest winter of the whole series, but 1932-3 was normal.

The nearest station to Southport from which the records of a pressure tube anemometer are regularly received in the Meteorological Office is Fleetwood. Records from this station are available back to 1923 and the tabulations of strong winds have been added to Table I. They do not show as much parallelism with the Southport figures as might, perhaps, be expected, but they confirm the relative calmness of the winters of 1931-2 and 1932-3.

Analyses for a number of other stations gave the results shown in Table II. The averages refer to the past eleven winters. The winter of 1931-2 gave a high frequency of strong winds at Kew, but was relatively calm at Scilly and Aberdeen. 1932-3 gave an excess of strong winds at Scilly and Valentia and a deficiency at Lympne and Kew. The remarkable calmness of both winters

TABLE II.—FREQUENCY OF WINDS WITH MEAN VELOCITY EXCEEDING 24 M.P.H. IN WINTER MONTHS NOVEMBER TO FEBRUARY.

	Lympne	Kew	Scilly	Valentia	Aberdeen
	%	%	%	%	%
1931-32	105	203	85	95	62
1932-33	79	87	114	114	99

appears, therefore, to have been confined to the small area represented by the observations at Southport and Fleetwood. At Southport the deficiency of strong winds is continuing also during the present winter.

In his Annual Report for the year 1932, Mr. J. Baxendell, Meteorologist to the Southport Corporation, makes the following comment :—

"The general calmness of the year, coupled with the scarcity of even moderate gales, was astonishing. North-easterly and easterly winds, the latter in particular, were abnormally prevalent; during February they were of more than three times their customary frequency; so also were currents from the north in May and from the east in August. Not a single 'whole gale' was experienced at any time."

Broadcast Weather Noises

Now that weather noises "off" form such a usual—and vivid —accompaniment of many broadcast plays, meteorologists may be interested in the methods which are used in the studio for reproducing these realistic effects. Mr. J. E. Cowper has kindly supplied the following notes on the subject :—

Wind.—This is done on a cylinder 2 ft. in diameter and 6 in. deep, set in a wooden frame 3 ft. high with a length of canvas stretched over the top. A handle is fixed to this, and by rotating at a normal rate one gets a steady wind, and with a quick motion gusts. It is a most realistic noise, and usually comes over very well.

Rain.—A rose on a water tap is usually used for this, which is turned on fully into a large wooden tank.

Thunder.—This is produced by suspending from the ceiling a huge piece of sheet iron, with a wooden shaft at the bottom where two handles are fixed for the hands. This, when shaken in an intelligent way, produces excellent thunder.

Sea.—A one-sided drum with lead shot inside shaken from side to side and round and round produces waves breaking on the shore, and is quite one of the best noises "off."

May I add that in nearly all cases we use gramophone records of these sounds, and these records will, I think, gradually efface the instruments I have tried to explain to you.

Review

The Wairarapa Floods of August, 1932. By Dr. E. Kidson, Wellington N.Z. Meteor. Office Note No. 13 extracted from New Zealand, J. Sci. Tech., Vol. XIV, No. 4, pp. 220-7, 1933.

The note deals with the meteorological conditions associated with the record flooding experienced to the east of Wellington, in the south of North Island, New Zealand, towards the end of August, 1932. A number of stations in that area recorded more than 6 inches for August 27th to 30th, the largest total being 14·58 in. at Putara, west of Eketahuna, where 8·00 in. fell on the 28th. Maps are given showing the pressure distribution, "cold fronts" and "warm fronts" over Australia and New Zealand for each of these days. The storm is of special interest because of the rapid change from strong north-westerly winds to southerly winds over North Island.

J. GLASSPOOLE.

Obituary

Mr. Stillman Call.—The death of Mr. Call, which we regret to announce occurred on February 6th, severs one of the last remaining links of the Meteorological Office with its earliest history as an independent Government Department. In 1867, Armagh Observatory, then under the charge of Dr. T. R. Robinson (of anemometer fame) was selected as one of seven first-class meteorological stations, and in May, 1868, Mr. Call, a native of Armagh, was appointed as assistant to carry on this section of the work of the observatory. At the close of 1883 the meteorological work at Armagh on behalf of the Meteorological Council was discontinued, and Mr. Call transferred to the office at Westminster, where he remained until his retirement in October, 1907, after 39 years' service. Although of a retiring disposition, Mr. Call had many friends among the older section of the staff. At the time of his decease had reached his 90th year. An enduring record of his work is contained in remarkably beautiful caligraphy amongst the various early manuscript records of the Office. A. T. BENCH.

Erratum

December, 1933, p. 259, line 30, *for* "The total rainfall (June to August inclusive) this year 8·35 inches." *read* "The total rainfall (June to August inclusive) this year 8·95 inches."

News in Brief

Miss E. M. Edge, of Strelley Hall, Nottingham, wishes to sell the following books, and would be glad to receive offers for them :—

Meteorological Magazine (cloth), 1880-1930 inclusive.
British Rainfall (cloth), 1865-1929 inclusive.
Royal Meteorological Society, Quarterly Journal (paper covers), 1906-26 (a few numbers missing).

The thirteenth annual dinner of the staff of the Meteorological Office, Shoeburyness, was held at the Queen's Hotel, Westcliff, on Saturday, February 3rd, 1934. There was an excellent attendance, including a number of former members of the staff now serving at other stations.

The Weather of December, 1933

Pressure was below normal over Alaska, most of Canada, central United States, Greenland, Iceland, Scotland, Norway, northern Sweden, the extreme north of Russia and Spitsbergen, the greatest deficits being 17·0 mb. at Spitsbergen and 6·9 mb. at Kodiak. Pressure was above normal over western and eastern United States, Newfoundland, most of the North Atlantic, including the Bermudas and Azores, north Africa and Europe south of a line from Londonderry through Hernosand to Obdorsk, the greatest excesses being 8·9 mb. at Astrakhan and 7·6 mb. at Madrid. Temperature was above normal over Spitsbergen and western and central Europe, being as much as 16° F. above normal in central Lapland (the highest on record since observations began in 1861). Rainfall was below normal at Spitsbergen, northern Norway and eastern Gothaland, but about normal elsewhere in Sweden.

The weather over the British Isles during January was generally mild, unsettled and rather stormy in Scotland and Ireland, and colder and quieter with much fog or mist in England especially in the south-east. There was generally an excess of sunshine. Widespread fog or mist was experienced in most parts of England during the first three days, but depressions moving north-eastwards across Iceland gave unsettled weather in the west and north with gales in the extreme north and local heavy rain; 2·00 in. fell at Borrowdale (Cumberland) on the 2nd, and 2·15 in. on the 3rd. Good sunshine records, however, were obtained in south Scotland on the 2nd. From then until the 10th pressure was low to the north and west and high to the south, and the mild unsettled weather continued with local rain but sunny intervals. The 5th was a sunny day generally and the 8th in England and Ireland, 7·0 hrs. bright sunshine being recorded at Eastbourne on the 5th and 6·6 hrs. at Dublin on the 8th. The rainfall was slight in the south and east but moderate elsewhere, while day temperature rose above 50° F. on the 4th, 6th, 7th and 10th mainly in north England, south Scotland and Ireland, being colder elsewhere. Fog or mist was again general in England on the 9th. From the 11th to 18th the depressions centred to the north-west moved on a more southerly course right over the British Isles giving stormy weather with frequent gales and much rain at times, 2·31 in. fell at Tynywaun (Glamorgan) on the 11th, 1·79 in. at Brecon on the 13th and 2·68 in. at Borrowdale on the 16th. Slight snow or sleet occurred locally in the north. A gust of 84 m.p.h. was recorded at Abbotsinch (Glasgow) and at Kirkwall (Orkneys) on the 17th and of 82 m.p.h. at Scilly and 77 m.p.h. at Lympne on the 14th. On the 17th there was a general rise of temperature, 50° F. being exceeded at most places both on that day and the 18th, while 58° F. was reached at Sidmouth on the 17th. Thunderstorms were experienced at Fort Augustus on the 8th, Oban and Mallarany on the 11th and Falmouth on the 14th. On the 19th the winds veered to north and the temperature fell somewhat as an anticyclone spread across the country from the south-west. Quiet sunny weather was maintained over most of England until the 24th with good sunshine records except when affected by fog or mist; 8·0 hrs. at Penzance on the 24th and 7·8 hrs. at Guernsey on the 20th. Sharp night frosts occurred during this period, at Greenwich temperature on the grass fell to 10° F. on the 22nd. Meanwhile the Atlantic depressions had caused a renewal of unsettled weather by the 21st in the west and north where the wind reached gale force locally from the 21st to 25th. A trough of low pressure moved across the country on the 26th accompanied by slight general rain. On the 27th an anticyclone spread in from the the west over the whole country and sunshine records were good everywhere not affected by fog. Penzance and Ilfracombe recorded 8·0 hrs. sunshine on the 28th, but at Manchester temperature did not exceed 30° F. on the 28th or 29th owing to dense fog. Secondary troughs of low pressure moved southwards across the country on the 30th and 31st and gave slight rain, mostly in the east. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	28	0	Liverpool	73	+18
Aberdeen	55	+ 7	Ross-on-Wye	56	+10
Dublin	71	+14	Falmouth	62	+ 4
Birr Castle	57	+ 8	Gorleston	70	+14
Valentia	51	+ 3	Kew	45	+ 2

Mr. Alfredo Salgado, of Ceará, Brazil, has sent us the following notes :—222 mm. (8·74 in.) of rain fell at Ceará on

January 5th between 2.45 a.m. and 2 p.m. There was a serious drought in Ceará during 1932 and a poor rainy season in 1933.

The special message from Brazil states that the rainfall in the northern and central regions was generally scarce with 0·95 in. and 3·46 in. below normal respectively and in the southern regions irregular with 0·43 in. above normal. Four anticyclones passed across the country. The crops were generally in good condition. At Rio de Janeiro pressure was 1·5 mb. above normal and temperature 0·4° F. above normal.

Miscellaneous notes on weather abroad culled from various sources. Navigation closed at Viipuri (Finland) and outer ports on the 2nd. On the 5th and 6th temperature was mild in Switzerland and rainfall was recorded even at the 2,000 ft. level, but on the 7th there was a change to frosty sunny conditions, excellent for ski-ing. The temperature again rose rapidly under the influence of a mild Föhn wind on the 12th and on the 15th a SW. gale brought heavy rain over the lower parts of Switzerland and much snow in the mountains, but there was a change back to colder conditions on the 19th. A short mild spell, however, was experienced again between the 25th and 27th. Owing to the hard frosts in several districts of Franconia (Bavaria) from Christmas to the 9th the water supply was interrupted. Floods were reported from Yugoslavia about the 9th as the result of rain and thaw. Dense fog occurred over the river Scheldt on the 9th, but on the 10th navigation re-opened. Navigation was still held up by ice at Braila (Roumania) on the 10th (*The Times*, January 3rd-30th).

By the 5th the Orange River swollen by heavy rains in the Free State and reinforced by floodwaters of the Vaal River was devastating the northern part of Cape Province, though six weeks previously the river had been dry at Upington. Unusually heavy rain continued during the month throughout the Union, and for hundreds of miles in South-West Africa the railway was repeatedly washed away. A cyclone of moderate intensity passed over Mauritius on the 28th and 29th and three people were klled (*The Times*, January 5th-31st).

From about the 13th to 31st unusually cold weather prevailed in Bombay Province causing much damage to the cotton and seed crops. For the third time during the last 100 years the temperature at Colaba Observatory fell below 54° F. being 53·7° F. on the 13th and 53·2° F. on the 31st (*The Times*, January 15th-February 2nd).

On the 10th heavy general rains were reported in New South Wales and Victoria causing floods and damage to crops. Widespread thunderstorms from Queensland towards the end of the month (*The Times*, January 10th-31st).

Temperature was low at the beginning of the month in the eastern and northern United States, but throughout most of the month temperature was above normal especially in the western States. A cold spell however occurred in the east during the last week-end. Precipitation was generally below normal except in parts of the Gulf States. High winds and excessive rains caused severe floods throughout British Guiana. As the result of severe floods caused by a sudden thaw many deaths from drowning occurred in Mendoza, Argentina, and the trans-Andean traffic stopped about the 10th (*The Times*, January 11th-13th, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*).

Daily Readings at Kew Observatory, January, 1934

Date.	Pressure, M.S.L. 13h	Wind, Dir., Force 13h	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain	Sun	REMARKS (see p. 1)
	mb.		°F	°F	%	in.	hrs.	
1	1029·1	Calm	29	32	100	—	0·0	F all day
2	1023·0	SSW.1	28	41	97	0·08	0·0	r 15h. 30m.-18h.
3	1019·9	WSW.1	39	41	87	0·01	0·0	r_o early. f 21h.
4	1012·5	SW.4	35	50	89	0·07	0·0	r 20h.-23h.
5	1022·0	WNW.3	36	44	67	—	5·4	x early
6	1027·1	SW.5	31	47	77	trace	1·2	Breezy all day
7	1021·6	SSW.5	45	46	88	—	0·0	Breezy all day
8	1022·9	SW.3	39	41	86	0·03	1·6	f_o early. x 18h.
9	1027·8	Calm	28	33	96	trace	0·0	F all day
10	1022·6	S.4	29	43	94	—	0·0	r_o 13h.
11	1005·0	S.4	39	48	90	0·11	0·7	Breezy. rs 12h.
12	993·6	SW.3	47	47	81	0·17	0·7	r-r_o 0h.-11h.
13	1006·3	SW.4	40	48	76	0·04	0·3	r 23h.-24h.
14	983·3	WSW.5	45	48	70	0·21	0·0	r early. Breezy
15	995·3	WSW.3	38	45	84	0·08	1·4	Breezy
16	1015·1	W.4	37	43	59	0·10	4·9	r 19h.-24h.
17	1001·7	SW.5	39	56	90	0·01	0·2	Breezy
18	1001·0	SW.5	49	55	77	0·08	0·1	Breezy all day
19	1013·5	NW.3	40	47	60	0·02	4·6	r 1h.-1h.30m.
20	1037·8	N.3	32	43	55	—	5·7	F at night
21	1040·1	W.1	24	40	82	—	4·0	F till 10h.
22	1035·1	SSW.2	22	36	94	—	1·8	F till 10h.
23	1038·9	S.2	25	40	72	—	6·3	F early & late
24	1033·6	Calm	22	31	98	—	0·0	F & x all day
25	1024·5	S.3	26	39	85	0·06	0·0	r 23h.-24h.
26	1020·0	SW.3	38	48	86	0·06	2·3	r 8h.30m.-9h.
27	1023·8	WNW3	37	47	79	0·01	2·6	pr_o 7h. ;7h.15m.&12h.
28	1032·4	N.3	36	43	69	—	0·0	Dull
29	1035·9	NNE.3	40	40	66	—	0·0	F & x 21h.
30	1035·2	W.2	31	41	82	0·04	0·0	r-r_o 22h.-24h.
31	1038·5	N.3	39	45	67	0·01	0·9	r 1h.-2h.

General Rainfall for January, 1934

England and Wales ...	105	per cent of the average 1881-1915.
Scotland	117	
Ireland	124	
British Isles	112	

Rainfall: January, 1934: England and Wales.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond	Camden Square	1·35	73	*Leics.*	Thornton Reservoir	2·53	128
Sur	Reigate, Wray Pk. Rd.	2·37	99	,,	Belvoir Castle	2·03	115
Kent	Tenterden, Ashenden...	2·63	122	*Rut*	Ridlington	1·58	85
,,	Folkestone, Boro. San.	3·03	...	*Lincs*	Boston, Skirbeck	1·60	99
,,	Eden'bdg., Falconhurst	3·01	123	,,	Cranwell Aerodrome	1·64	95
,,	Sevenoaks, Speldhurst	1·76	...	,,	Skegness, Marine Gdns	1·25	72
Sus	Compton, Compton Ho.	2·68	84	,,	Louth, Westgate	1·76	81
,,	Patching Farm	2·05	79	,,	Brigg, Wrawby St.	1·92	...
,,	Eastbourne, Wil. Sq.	3·12	119	*Notts*	Worksop, Hodsock	1·47	83
,,	Heathfield, Barklye	3·71	137	*Derby*	Derby, L. M. & S. Rly.	2·41	120
Hants	Ventnor, Roy. Nat. Hos.	2·81	109	,,	Buxton, Terr. Slopes	5·24	117
,,	Fordingbridge, Oaklnds	2·89	105	*Ches*	Runcorn, Weston Pt...	1·91	81
,,	Ovington Rectory	3·71	137	*Lancs*	Manchester, Whit Pk.	2·10	84
,,	Sherborne St. John	2·34	100	,,	Stonyhurst College	4·37	102
Herts	Welwyn Garden City	2·11	115	,,	Southport, Hesketh Pk	2·41	94
Bucks	Slough, Upton	1·47	79	,,	Lancaster, Greg Obsy.	5·07	145
,,	H. Wycombe, Flackwell	1·86	86	*Yorks*	Wath-upon-Dearne	1·39	72
Oxf	Oxford, Mag. College	1·62	94	,,	Wakefield, Clarence Pk.	1·39	72
Nor	Pitsford, Sedgebrook	...	...	,,	Oughtershaw Hall	7·98	...
,,	Oundle	·80	...	,,	Wetherby, Ribston H.	2·00	97
Beds	Woburn, Exptl. Farm.	1·09	64	,,	Hull, Pearson Park	1·41	78
Cam	Cambridge, Bot. Gdns.	·83	55	,,	Holme-on-Spalding	1·79	95
Essex	Chelmsford, County Lab	1·36	89	,,	West Witton, Ivy Ho.	2·76	87
,,	Lexden Hill House	1·29	...	,,	Felixkirk, Mt. St. John	1·84	92
Suff	Haughley House	1·31	...	,,	York, Museum Gdns.	1·66	94
,,	Campsea Ashe	1·48	81	,,	Pickering, Hungate	1·46	70
,,	Lowestoft Sec. School	1·28	77	,,	Scarborough	1·26	63
,,	Bury St.Ed., Westley H.	1·42	79	,,	Middlesbrough	·83	52
Norf	Wells, Holkham Hall	1·82	126	,,	Baldersdale, Hury Res.	3·77	116
Wilts	Calne, Castleway	2·12	93	*Durh*	Ushaw College	1·83	89
,,	Porton, W.D. Exp'l. Stn	2·37	103	*Nor*	Newcastle, Town Moor	1·52	74
Dor	Evershot, Melbury Ho.	4·40	127	,,	Bellingham, Highgreen	3·81	133
,,	Weymouth, Westham	2·51	103	,,	Lilburn Tower Gdns...	1·68	81
,,	Shaftesbury, Abbey Ho.	2·15	83	*Cumb*	Carlisle, Scaleby Hall	4·15	167
Devon	Plymouth, The Hoe	3·29	99	,,	Borrowdale, Seathwaite	20·50	163
,,	Holne, Church Pk. Cott.	9·08	147	,,	Borrowdale, Moraine...	21·00	200
,,	Teignmouth, Den Gdns.	2·89	99	,,	Keswick, High Hill...	9·56	189
,,	Cullompton	2·62	81	*West*	Appleby, Castle Bank	4·62	144
,,	Sidmouth, Sidmount...	2·38	83	*Mon*	Abergavenny, Larchf'd	4·77	141
,,	Barnstaple, N. Dev. Ath	3·79	116	*Glam*	Ystalyfera, Wern Ho.	9·36	148
,,	Dartm'r, Cranmere Pool	9·40	...	,,	Cardiff, Ely P. Stn.	3·43	91
,,	Okehampton, Uplands	6·82	134	,,	Treherbert, Tynywaun	14·23	...
Corn	Redruth, Trewirgie	4·54	107	*Carm*	Carmarthen	...	...
,,	Penzance, Morrab Gdn.	4·66	123	*Pemb*	Haverfordwest, School	5·87	127
,,	St. Austell, Trevarna...	4·56	106	*Card*	Aberystwyth	3·31	...
Soms	Chewton Mendip	3·28	85	*Rad*	Birm W.W. Tyrmynydd	7·09	112
,,	Long Ashton	2·16	76	*Mont*	Lake Vyrnwy	7·96	141
,,	Street, Millfield	2·00	82	*Flint*	Sealand Aerodrome	1·28	65
Glos	Blockley	2·31	...	*Mer*	Dolgelley, Bontddu	5·73	101
,,	Cirencester, Gwynfa	2·92	116	*Carn*	Llandudno	2·54	105
Here	Ross, Birchlea	2·91	120	,,	Snowdon, L. Llydaw 9	20·49	...
Salop	Church Stretton	4·41	174	*Ang*	Holyhead, Salt Island	3·53	121
,,	Shifnal, Hatton Grange	2·32	120	,,	Lligwy	4·16	...
Staffs	Market Drayt'n, Old Sp.	2·11	96	*Isle of Man*			
Worc	Ombersley, Holt Lock	2·37	123		Douglas, Boro' Cem.	4·92	145
War	Alcester, Ragley Hall	1·83	95	*Guernsey*			
,,	Birminghm, Edgbaston	3·13	155		St. Peter P't. Grange Rd	3·57	122

Rainfall: January, 1934: Scotland and Ireland.

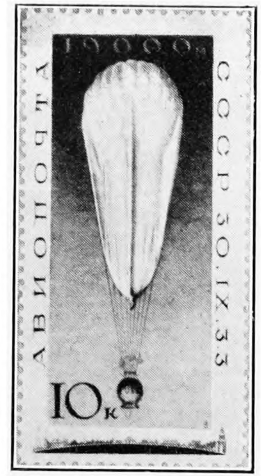
Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per cent. of Av.
Wig	Pt. William, Monreith	4·30	131	*Suth*	Melvich	2·65	80
,,	New Luce School	...	...	,,	Loch More, Achfary	7·41	102
Kirk	Dalry, Glendarroch	8·50	152	*Caith*	Wick	1·84	75
,,	Carsphairn, Shiel	14·24	195	*Ork*	Deerness	3·36	97
Dumf	Dumfries, Crichton, R.I	4·72	156	*Shet*	Lerwick	4·36	102
,,	Eskdalemuir Obs.	11·33	210	*Cork*	Caheragh Rectory	6·39	...
Roxb	Branxholm	4·15	152	,,	Dunmanway Rectory	7·63	122
Selk	Ettrick Manse	10·22	216	,,	Cork, University Coll.	4·67	115
Peeb	West Linton	4·26	...	,,	Ballinacurra	3·30	83
Berw	Marchmont House	1·52	68	*Kerry*	Valentia Obsy	6·74	123
E.Lot	North Berwick Res.	1·27	74	,,	Gearhameen	15·60	154
Midl	Edinburgh, Roy. Obs.	1·96	111	,,	Darrynane Abbey	4·88	97
Lan	Auchtyfardle	5·40	...	*Wat*	Waterford, Gortmore	3·52	97
Ayr	Kilmarnock, Kay Pk.	4·86	...	*Tip*	Nenagh, Cas. Lough	5·71	144
,,	Girvan, Pinmore	6·30	133	,,	Roscrea, Timoney Park	3·71	...
Renf	Glasgow, Queen's Pk.	5·05	151	,,	Cashel, Ballinamona	4·19	110
,,	Greenock, Prospect H.	10·20	149	*Lim*	Foynes, Coolnanes	5·03	133
Bute	Rothesay, Ardencraig.	6·39	...	,,	Castleconnel Rec.	4·86	...
,,	Dougarie Lodge	4·31	...	*Clare*	Inagh, Mount Callan	8·21	...
Arg	Ardgour House	17·24	...	,,	Broadford, Hurdlest'n.	6·67	...
,,	Glen Etive	17·41	165	*Wexf*	Gorey, Courtown Ho.	3·71	119
,,	Oban	8·53	...	*Wick*	Rathnew, Clonmannon	3·29	...
,,	Poltalloch	6·96	139	*Carl*	Hacketstown Rectory	2·97	84
,,	Inveraray Castle	...	...	*Leix*	Blandsfort House	3·22	98
,,	Islay, Eallabus	6·01	128	,,	Mountmellick	5·00	...
,,	Mull, Benmore	9·60	71	*Offaly*	Birr Castle	4·44	157
,,	Tiree	4·62	109	*Dublin*	Dublin, FitzWm. Sq.	1·54	67
Kinr	Loch Leven Sluice	3·48	110	,,	Balbriggan, Ardgillan.	3·05	133
Perth	Loch Dhu	15·20	167	*Meath*	Beauparc, St. Cloud	3·60	...
,,	Balquhidder, Stronvar	12·20	...	,,	Kells, Headfort	3·90	124
,,	Crieff, Strathearn Hyd.	5·66	140	*W.M.*	Moate, Coolatore	3·87	...
,,	Blair Castle Gardens	4·44	133	,,	Mullingar, Belvedere	4·61	144
Angus	Kettins School	2·21	85	*Long*	Castle Forbes Gdns.	5·43	163
,,	Pearsie House	2·91	...	*Gal*	Galway, Grammar Sch.	4·95	...
,,	Montrose, Sunnyside	1·33	67	,,	Ballynahinch Castle	8·29	133
Aber	Braemar, Bank	3·80	119	,,	Ahascragh, Clonbrock.	5·46	141
,,	Logie Coldstone Sch.	·95	43	*Mayo*	Blacksod Point	7·31	144
,,	Aberdeen, King's Coll.	1·72	79	,,	Mallaranny	7·13	...
,,	Fyvie Castle	1·74	73	,,	Westport House	6·78	146
Moray	Gordon Castle	·99	49	,,	Delphi Lodge	13·48	136
,,	Grantown-on-Spey	2·48	102	*Sligo*	Markree Obsy	4·63	119
Nairn	Nairn	1·76	88	*Cavan*	Crossdoney, Kevit Cas.	4·65	...
Inv's	Ben Alder Lodge	9·88	...	*Ferm*	Enniskillen, Portora	3·37	...
,,	Kingussie, The Birches	4·90	...	*Arm*	Armagh Obsy	2·90	115
,,	Inverness, Culduthel R.	2·72	...	*Down*	Fofanny Reservoir	8·43	...
,,	Loch Quoich, Loan	14·40	...	,,	Seaforde	3·40	108
,,	Glenquoich	21·27	155	,,	Donaghadee, C. Stn.	2·76	109
,,	Arisaig, Faire-na-Sguir	5·80	...	,,	Banbridge, Milltown	2·37	106
,,	Fort William, Glasdrum	13·79	...	*Antr*	Belfast, Cavehill Rd.	2·88	...
,,	Skye, Dunvegan	8·24	...	,,	Aldergrove Aerodrome	2·72	99
,,	Barra, Skallary	4·70	...	,,	Ballymena, Harryville	3·83	103
R & C	Alness, Ardross Castle	3·79	100	*Lon*	Garvagh, Moneydig	3·77	...
,,	Ullapool	7·02	152	,,	Londonderry, Creggan	4·77	132
,,	Achnashellach	10·73	112	*Tyr*	Omagh, Edenfel	5·14	145
,,	Stornoway	6·40	124	*Don*	Malin Head	4·01	...
Suth	Lairg	3·74	114	,,	Milford, The Manse	4·41	118
,,	Tongue	3·17	80	,,	Killybegs, Rockmount.	3·56	...

Climatological Table for the British Empire, August, 1933

STATIONS	PRESSURE Mean of Day M.S.L. mb.	PRESSURE Diff. from Normal mb.	TEMPERATURE Absolute Max. °F.	TEMPERATURE Absolute Min. °F.	TEMPERATURE Mean Values Max. °F.	TEMPERATURE Mean Values Min. °F.	TEMPERATURE Mean Values ½ max. and min. °F.	TEMPERATURE Mean Values Diff. from Normal °F	TEMPERATURE Mean Wet Bulb °F.	Relative Humidity %	Mean Cloud Am'nt 0—10	PRECIPITATION Am'nt in.	PRECIPITATION Diff. from Normal in.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible
London, Kew Obsy.	1018·0	+ 2·7	89	48	76·1	56·8	66·5	+ 4·9	57·5	82	5·5	0·50	— 1·74	4	8·1	56
Gibraltar	1016·3	— 0·2	96	67	85·2	71·5	78·3	+ 2·3	69·1	81	3·8	0·00	— 0·12	0	..	..
Malta	1016·0	+ 1·2	92	62	83·3	70·9	77·1	— 2·0	69·8	71	1·7	0·78	+ 0·64	2	11·9	88
St. Helena	1017·2	+ 0·7	65	52	60·1	54·5	57·3	— 0·1	55·4	95	9·5	1·64	..	16	..	..
Freetown, Sierra Leone	1015·4	+ 2·7	86	64	81·0	69·9	73·9	— 4·0	74·2	91	8·2	37·45	+ 0·88	31	..	..
Lagos, Nigeria	1014·3	+ 1·3	84	72	82·1	74·8	78·5	+ 0·6	74·1	86	9·4	1·51	— 1·13	14	3·4	28
Kaduna, Nigeria	1014·4	— 0·7	87	65	81·6	68·2	74·9	+ 1·0	70·5	90	9·1	8·61	— 3·71	24	4·2	34
Zomba, Nyasaland	1016·9	+ 0·1	83	49	75·5	52·4	63·9	— 1·0	56·4	58	3·9	0·04	— 0·33	2	..	..
Salisbury, Rhodesia	1019·3	— 0·4	82	34	74·8	45·1	59·9	— 0·3	49·8	49	0·3	0·00	— 0·06	0	9·9	86
Cape Town	1021·6	+ 1·3	75	39	62·9	46·5	54·7	— 0·9	47·4	87	4·7	2·80	— 0·57	13	..	..
Johannesburg	1020·4	+ 0·2	74	28	65·5	42·6	54·1	— 0·3	43·0	53	1·8	0·01	— 0·50	1	9·5	85
Mauritius	1020·2	— 0·3	79	54	74·8	60·3	67·6	— 0·9	64·0	71	5·8	1·35	— 1·00	14	6·6	58
Calcutta, Alipore Obsy.	1003·2	+ 2·2	94	74	88·3	78·3	83·3	+ 0·1	79·2	90	9·3	14·70	+ 1·32	20*	..	..
Bombay	1006·0	+ 0·1	88	74	84·9	76·6	80·7	— 0·1	76·8	87	8·2	18·81	+ 4·36	15*	..	..
Madras	1005·9	+ 0·4	100	73	92·7	78·8	85·7	— 0·3	77·2	75	7·3	3·00	— 1·54	4*	..	..
Colombo, Ceylon	1009·8	+ 0·5	85	71	83·2	75·3	79·3	— 1·9	76·4	82	7·2	14·64	+ 11·40	19	5·1	41
Singapore	1009·4	— 0·1	93	71	88·0	75·5	81·7	+ 0·6	77·5	82	5·6	5·92	— 2·03	14	6·9	57
Hongkong	1007·8	+ 3·0	93	76	89·5	80·1	84·8	+ 2·7	78·4	76	5·5	1·73	— 12·67	8	9·7	75
Sandakan	1009·7	..	91	73	88·8	76·0	82·4	+ 0·6	77·5	81	5·8	3·92	— 3·97	11	..	..
Sydney, N.S.W.	1021·3	+ 3·1	73	39	62·2	44·1	53·1	— 1·9	47·3	70	3·8	0·25	— 2·72	4	7·8	72
Melbourne	1021·2	+ 3·2	71	33	57·6	41·4	49·5	— 1·5	44·9	75	6·7	2·05	+ 0·18	17	4·3	40
Adelaide	1022·0	+ 2·7	70	38	60·3	45·4	52·9	— 1·0	47·6	69	6·7	3·36	+ 0·83	19	4·8	44
Perth, W. Australia	1019·9	+ 1·0	71	39	63·4	47·8	55·6	— 0·4	49·8	71	6·3	5·67	+ 0·02	15	6·1	56
Coolgardie	1021·3	+ 2·0	73	34	62·2	43·5	52·9	— 0·7	45·8	68	5·3	2·36	+ 1·37	9	..	..
Brisbane	1022·5	+ 3·3	75	41	68·6	48·4	58·5	— 1·9	52·3	68	4·6	0·90	— 1·11	5	7·1	64
Hobart, Tasmania	1016·7	+ 3·3	60	34	53·8	39·4	46·6	— 1·4	41·6	67	6·2	0·99	— 0·84	14	5·0	48
Wellington, N.Z.	1018·3	+ 3·2	61	34	52·5	41·8	47·1	— 1·5	45·4	82	7·0	4·43	— 0·06	17	4·3	41
Suva, Fiji	1016·4	+ 2·2	88	65	79·3	68·6	73·9	+ 0·3	69·7	80	7·0	2·94	— 5·35	17	4·9	43
Apia, Samoa	1013·6	+ 1·3	87	68	84·8	72·7	78·7	+ 0·9	74·7	71	4·6	1·75	— 1·88	11	9·1	78
Kingston, Jamaica	1012·6	— 0·9	91	70	87·9	73·2	80·5	— 1·0	73·3	84	5·3	13·50	+ 9·95	11	6·9	54
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1015·6	+ 0·2	94	53	78·9	59·3	69·1	+ 1·9	62·2	71	3·6	2·41	— 0·38	8	9·3	66
Winnipeg	1014·7	+ 1·5	93	38	79·2	54·3	66·7	+ 2·9	54·6	82	9·8	3·63	+ 1·47	10	10·0	69
St. John, N.B.	1016·3	+ 1·0	79	50	70·7	54·9	62·8	+ 2·2	60·2	91	6·4	7·05	+ 3·19	16	6·2	44
Victoria, B.C.	1015·2	— 1·7	91	50	70·5	53·8	62·1	+ 2·4	56·9	74	3·5	0·35	— 0·29	17	10·5	73

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

1fr. 75c. Belgian stamp.



10 kopec U.S.S.R. stamp.

STAMPS COMMEMORATING THE FIRST STRATOSPHERE BALLOON FLIGHTS.

M.O. 371.

The Meteorological Magazine

Vol. 69

Mar. 1934

No. 818

Air Ministry :: Meteorological Office

LONDON: PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

The Loss of the "Osoaviakhim"

At 9 a.m. on January 30th a Soviet balloon, the Osoaviakhim, with a specially constructed gondola and a crew of three—M. Fedoseenko, M. Vasenko and M. Usyskin, commenced an ascent into the stratosphere and before noon reached a height of 22,000 metres (72,000 feet) the greatest elevation yet obtained. On the following day the sad news was received that the gondola had been torn away from the balloon and had fallen from an unknown height, all three members of the heroic crew being killed.

A Commission of Inquiry immediately left for the spot where the disaster occurred, and the following account of the report of the Commission is translated from the *Moscow Daily News* for February 2nd:—

"The inquiry commission into the disaster reports that the maximum height reached was 22,000 metres (on January 31st, *Izvestia* reported the maximum height was 20,600 metres).

The excessive and progressively increasing velocity of the descent of the stratostat began at 4.10 p.m. at a height of 12,000 metres. This caused the snapping of some of the trusses, and disturbed the equilibrium of the stratostat, causing the severance of the gondola from the balloon. The disaster actually occurred at 4.23 p.m. The biograph worked till 4.21 and the records in the diary were kept up to 4.7. The diary and the biograph

(5643) 32/91 1,000 3/34 M. & S., Ltd. *Gp.303*

readings are intact. These show that at 12.33 p.m. the stratostat reached an altitude of 22,000 metres, and remained at that height till 12.45 when the descent was begun.

The commission strongly denounced the theory that the disaster was caused by the stratostat being weighed down by ice. Eye-witnesses caught glimpses of it during the descent. Until 4.10 p.m. the records show that the crew were in the best of spirits and had every hope of a good landing.

Two airmen, Popov and Konavalchik, have informed Osoaviakhim (Society for Aviation and Chemical Warfare) that they are ready to make another ascent into the stratosphere."

Commemorating the First Stratosphere Balloon Flights

The recognition by the Belgian post office in 1932 of Professor Piccard's two balloon ascents into the stratosphere created one of the rare links, possibly the first, between philately and meteorology. In commemoration of these pioneer feats two large postage stamps were issued inscribed with a design of the balloon and the dates of the flights, one stamp in brown of value 75 centimes and the other blue for 1f. 75c. Piccard's ascents were undertaken in the interests of scientific research, particularly to obtain observation of cosmic radiation in regions removed from the immediate effects of the earth's surface, but once he had demonstrated the practicability of a balloon flight into the stratosphere, it was only to be expected that others should soon endeavour to improve on his height record of over 53,000 feet. This has in fact already been exceeded on three occasions; a balloon released in the United States has reached to over 61,000 feet, and the Union of Soviet Socialist Republics balloons to 62,000 and 72,000 feet approximately. The latter country has followed the example of Belgium in celebrating its success with the issue of a set of three postage stamps, each with a design of the balloon—one for 5 kopecs in blue, for 10 kopecs in red, and for 20 kopecs in violet. Photographs of the Belgian and U.S.S.R. stamps are reproduced as the frontispiece of this number of the magazine. These show the balloon in its elongated state when about to leave the ground. It does not seem to be generally realised by the public that as the balloon ascends and the gas expands, it gradually assumes the customary spherical shape.

Detailed results of these notable ascents have not yet come to hand. The lowest temperature experienced by the first U.S.S.R. balloon is reported to have been 120·6°F. below the freezing point (−67°C.). As the base of the stratosphere is at about 36,000 feet in these latitudes it is seen that just half of the second U.S.S.R. ascent took place within this region. Unfortunately this flight, which was made in January of this year, ended in tragedy, as described in the preceding pages. Incidentally a height of 72,000 ft. (22 Km.) is about equal to the greatest achieved by unmanned balloons until a year or two ago, but more recently the construction of sounding-balloons has been improved so much that M. Jaumotte in Belgium has been sending balloons on the average up to 27 Km. (88,000 ft.) and a height of 33 Km. (108,000 ft.) has been attained.

At the moment other preparations are being made to further the exploration of the stratosphere. In particular may be noticed Professor J. S. Haldane's invention of a kind of diving suit which will so protect the balloonist that the sealed cabin which has hitherto been used will be unnecessary, and with the saving of weight much greater heights should be attainable. It is clear that the end is not yet in sight.

A. F. CROSSLEY.

A Thermal Anomaly in the Stratosphere

In *Bulletins de l'Academie royale de Belgique* of December 2nd, 1933, pp. 1311-31, M. Jaumotte gives an account of a number of high soundings made with free balloons into the stratosphere from Uccle between April and September, 1933. These soundings were part of a special effort made in connexion with the Polar Year, and for a period of 13 months daily soundings were made. Up till April, 1933, no unusual heights were reached, but at that time a change in the type of balloon employed resulted in a number of the succeeding soundings reaching heights of 25 Km. or more, and these latter revealed a remarkable systematic negative lapse rate within the stratosphere. It was found that all through the summer half of 1933, from a point some kilometres above the tropopause, the temperature rose more or less steadily with height up to the highest point reached, which in two cases exceeded 29 Km. The height at which this conspicuous inversion started appeared to fall steadily, being about 17 Km. above M.S.L. in June and about 14 Km. in September. The mean rise of temperature was about 2·4°C. per Km.; the temperature at the highest point was sometimes over 240°A., the latter occurring at heights which varied between 22 and 32 Km. above M.S.L. Most of the soundings were made by day, but a few made at night agreed in the general features with those made by day.

As is well known, at great heights in the daytime intense solar radiation exists, while the density of the air is very low, hence it is very easy to record temperatures at these levels appreciably higher than the real air temperature; also at a height of 30 Km. the pressure is only about 14 mb., and falls off at the rate of about 2 mb. per Km., unless therefore the barograph employed is accurate and thoroughly calibrated it is easy to make serious errors in the calculation of the height. M. Jaumotte is well aware of both of these difficulties and has taken pains to overcome them; he lays all his cards on the table, and the reader can judge for himself of the reliability of his figures. In the opinion of the writer there is no reason to doubt the substantial accuracy of the results which he has obtained.

From this point M. Jaumotte becomes more speculative. He puts forward the hypothesis that the reason for this large and unsuspected inversion is the presence of fine volcanic dust originally thrown up into the upper atmosphere by the eruptions in the Corderillas in April, 1932, and slowly sinking ever since. He regards the lower limit of the inversion as indicating the level to which the dust has penetrated downwards, and supports his hypothesis by the aid of various calculations. Whether or not this explanation be finally accepted must depend on the extent to which it is confirmed by other observations, both those made at the same time elsewhere and in the future. Be that as it may, the outstanding results of M. Jaumotte's work are first that he has found it possible to explore the stratosphere systematically to a greater height than has been usual heretofore, and secondly that he has proved that this part of the atmosphere over Belgium in the summer of 1933 was far from being an isothermal region.

One comment may be made; this paper brings out the misfortune of the present almost universal habit of making soundings into the stratosphere during the hours of daylight, when the difficulties besetting the accurate measurement of temperature are at their maximum. The same soundings made at night would have told their tale even more convincingly, without the need of elaborate justification, such as is invariably required when soundings are made by day.

In order to test the probability of the truth of M. Jaumotte's hypothesis, the writer has examined the published data of a number of soundings reaching heights of 24 Km. or more, made from various other stations on the continent of Europe during recent years up to 1930. None of them showed the massive inversion in the stratosphere which M. Jaumotte found in 1933, but on the other hand it is evident that from the height of 14 Km. upwards there is in the summer half of the year a greater tendency towards a systematic rise of temperature with height than there is in the winter half of the year. Soundings made in England have not reached such great heights as those on the continent, but in the 10 years ending January, 1934, some 26 have reached 21 Km., and it is equally clear from them that in England also the tendency towards a steady rise of temperature with height above 14 Km. does definitely appear in the summer half of the year, but that in the winter half it is absent or very slight. The two highest soundings made in England are particularly interesting. The first was made in September, 1931, and showed exactly the same thing as M. Jaumotte found in 1933, namely a steady rise of temperature from 18 Km. to 25 Km., the highest point. The mean rate was 1·8°C. per Km. and the highest temperature 237°A. This sounding was made in daylight but its credentials were good. The second was made in January, 1934, and reached to between 24 and 25 Km.; no definite rise was found in this case above 14 Km., the temperature at the top being 218°A., which is very close to the mean value at 19 Km. for the time of year.

The inference from both the continental and English soundings is that the inversion found by Jaumotte in the summer of 1933 has not been entirely confined to that year alone, and the possibility is suggested that it may be a seasonal phenomenon which was particularly pronounced in 1933, rather than being entirely due to specific volcanic activity.

In conclusion, a caution may be added against the acceptance, without careful examination, of claims made to have reached heights exceeding 30 Km. with the aid of sounding balloons. This point has been raised before in the *Meteorological Magazine.** The writer has studied the published data of a number of soundings made on the continent of Europe during recent years, and it must be admitted that it is exceedingly difficult to accept some of the claims that have been made. Some of the figures given for the vertical velocities of the ascending balloon in the higher levels are incredibly large, but no hint is given that a slight error in the measurement of the pressure would account for it entirely. Furthermore, some stations publish details of the corrections which have to be applied to the original readings of the pressure in order to allow for the effect of temperature on the recording mechanism. A statistical examination of these corrections shows plainly that very appreciable casual errors must sometimes exist in the computed minimum pressures. It would be a great help if observing stations publishing data of soundings exceeding 30 Km. would discuss the question of the probable error involved in the measurement of pressure at low temperatures with the particular type of instrument which they employ.

L. H. G. DINES.

The Stratosphere

Ever since the discovery of the stratosphere by Teisserenc de Bort at the end of the last century, it has been a problem to meteorologists why the temperature did not continue to decrease

*The highest aerial sounding. Vol. 55, p. 226 and Vol. 56, p. 121.

in that region more or less as it does in the troposphere. It may help to throw light on this question if we ask why the temperature was expected to continue to fall indefinitely. There appear to be three reasons for this expectation:—(1) As the temperature of the base of the atmosphere is that of the surface of the earth, and as the outer limits of the atmosphere must approach the absolute zero of temperature, the air temperature must on the whole decrease from the surface outwards. (2) The temperature is observed to decrease with height up to 10 Km. or more, according to the latitude. (3) There is also a feeling that the temperature should decrease with height because the pressure does.

In regard to (3), the only permanent relevant relations are the gas law $p=R\rho T$, and the dynamical relation $\delta p/\delta z=-g\rho$. From this equation it follows that p must decrease with height, also ρ in general decreases with height; but the distribution of temperature, given by $T=p/R\rho$, remains quite undetermined, and is not settled until some other relationship is introduced, depending, for example, on the relationship between temperature, radiation and convexion. It is true that decreasing pressure together with convexion will result in a decrease of temperature with height, but then convexion is only one factor out of several which are concerned, and in the stratosphere it is almost if not entirely negligible.

The argument based on (2) is solely an extrapolation from observed facts, and cannot be considered to have much merit as the conditions of the stratosphere in regard to convexion and the amount of water-vapour are so different from those of the troposphere.

As to (1), that argument no longer applies, as recent work on the ozone layers has led to the conclusion that the temperature at a height of 50 to 100 Km. is actually higher than at the earth's surface, being in the neighbourhood of 300° to 400° absolute. On this account the temperature must on the whole increase from the tropopause to the first ozone layer, which is centred at about 50 Km. above the surface.

The factors controlling the distribution of temperature therefore change considerably with height. In the troposphere the most important are (i) convexion, (ii) radiation, (iii) latent heat released by condensation of water-vapour, (iv) the transfer of heat horizontally by wind and convexion. In the stratosphere (iii) is zero, (i) and probably (iv) unimportant, and (ii) less potent than at lower levels; while at still greater heights the ozone is of paramount importance. The stratosphere appears to be an inactive region (as regards heat) in which nothing much happens. The isothermal condition, which has been observed only over a few kilometres, and sometimes even then shows a slight increase of temperature with height, may be regarded as just a rather flat bend in the temperature-height curve, as the gradient changes slowly from negative to positive.

A. F. Crossley.

Ballooning

It is opportune to recall the outstanding ballon ascents made for the furtherance of meteorology by Dr. J. Glaisher, F.R.S., and others which take their place in the story of aerial exploration, beginning with the early efforts of the brothers Montgolfier with their hot-air balloons in 1783, and culminating in the recent ascents to the stratosphere made by Belgian professors and the scientists of the U.S.S.R.

Dr. Glaisher's name is probably most widely known to-day owing to the utility of his hygrometrical tables. But we are reminded by a paragraph in the *Sussex County Magazine* that there is a tablet in the church at East Blatchington, Seaford, commemorating the fact that in September, 1862, Henry Tracey Coxwell " reached an altitude of seven miles, the greatest height ever attained by man." Now this historic ascent of September 5th, 1862, was one of a series of 28 ascents made in the years 1862-6 in which Mr. Glaisher was the observer and Mr. Coxwell the " aeronaut." The events and enterprise which led up to these ascents are worth recounting:

In April, 1837, a letter appeared in the *Morning Advertiser* over the signature of Charles Green, aeronaut, discussing the difficulties of attaining a height of 10 miles owing to the expansion of the gas in the balloon; he had found that the reading of his barometer fell to half its value at 3½ miles up and the gas had of course expanded to about double its size. The discussion was provoked by statements of other writers that if Mr. Green would *inflate fully* the great Vauxhall balloon with pure hydrogen " it might be made to attain an elevation of fifteen miles; or, in other words, about three times the altitude of the highest mountain in the world." Mr. Green estimated that on reaching 10 miles the gas would have expanded to six times its original volume, and as the 70,000 cubic feet required to fill the balloon at ground level cost £240 it would be obviously economical to start with the balloon only one-sixth filled. But the " lift " then available would be insufficient to take up one man. For comparison it should be remembered that the capacity of the Soviet stratostat was 859,700 cubic feet, and the envelope was filled only one-tenth of its capacity at the ground so that it would be fully expanded at about 10½ miles. At the record height of 12 miles it was practically a perfect sphere, although at the start its shape was anything but spherical.

In the first ascent with their *Nassau* balloon in September, 1838, Mr. Green and two others reached 19,335 feet, and were so encouraged that they decided to make a second attempt with two passengers instead of three. This time, starting from Vauxhall with the barometer at 30·5 in. and temperature 61°F., they reached 27,146 feet, and at this height the barometer was 11 in. and the temperature 5°F. Mr. Green had made a number of balloon ascents commencing in 1824, and so frequently found a wind between N. and W. at about 10,000 feet that he contemplated crossing the Atlantic from the American shore!

In 1852 Mr. John Welsh of Kew Observatory made four ascents with Mr. Green in the great *Nassau* balloon, and reached heights of 19,500, 19,100, 12,640 and 22,930 feet. Illness prevented Mr. Welsh from continuing the work.

In 1861 a Committee of the British Association, including Mr. Glaisher, considered the decrease of temperature with altitude and arranged with Mr. Green for the use of his balloon. Mr. Glaisher instructed two observers in the particular work but the arrangements fell through. The Committee then approached Mr. Coxwell, who generously undertook to construct at his own cost a new balloon of greater capacity to attain the high ascents they desired. Thus the *Mammoth* balloon was made of 93,000 cubic feet capacity compared with the 70,000 cubic feet of the *Nassau*. A large and comprehensive programme was drawn up and Mr. Glaisher got together a collection of instruments to determine the temperature of the air and its hygrometrical state up to the greatest heights possible. The cost of each special ascent with Mr. Glaisher and Mr. Coxwell as the only occupants was about £50. Out of the 28 ascents made under these arrangements the highest reached 37,300 feet and six exceeded 20,000 feet. The balloon was usually in the air for two hours.

The following details illustrate the work done:

	Ascent.	Greatest Altitude.		Temperature.	
Date.	*Time.*	*Place.*	*Feet.*	*Start.*	*Lowest.*
1862.				°F.	°F.
17 July	9·43	Wolverhampton	26,177	59·0	16·0
18 Aug.	13·02	,,	23,377	67·8	19·0
21 Aug.	4·30	Mill Hill	14,355	60·8	19·3
5 Sept.	13·03	Wolverhampton	37,300	59·5	5·0
1863					
31 Mar.	16·16	Crystal Palace	22,884	49·2	1·0
18 April	13·16	,, ,,	24,163	61·5	11·5
26 June	13·03	Wolverton	23,200	66·0	17·0
29 Sept.	7·43	Wolverhampton	16,590	48·0	0·0
1864					
29 Aug.	16·06	Crystal Palace	14,581	72·5	28·5

During the ascent on September 5th, 1862, Dr. Glaisher was rendered insensible and Mr. Coxwell's hands were frozen so that he was only able to open the valve by tugging the rope with his teeth.

When the balloon was in cloud at 4 miles high, a railway train was heard, but with clouds far below nothing was heard; the barking of a dog was audible at 2 miles.

While these observers were exposed in an open basket to the rigour of the atmospheric changes shown above, the Soviet adventurers of 71 years later travelled in an enclosed gondola whose shell was composed of 12 sheets of an aluminium alloy 2 mm. thick. At the highest point of the Soviet ascent on September 30th, 1933, when the atmospheric pressure had fallen to about 68 mb. at nearly 12 miles above the ground, and the temperature to $-90°F.$, the temperature inside the gondola had risen to above $+70°F.$

Dr. Glaisher found that his pulse increased from 76 before starting to 100 at 20,000 feet, and 110 at higher elevations; he became insensible at 29,000 feet. The latter figure is a normal value. It would be expected, however, that the pulse, which is usually about 70 near sea level, would be doubled at 18,000 feet, where the barometric pressure is halved; from observation on people on the Plateau of Pamir at 15,600 feet, pulse-rates between 110 and 124 were found and these may be compared with 68 to 76 at sea level.

R. M. POULTER.

Royal Meteorological Society

The Symons Memorial Lecture of the Royal Meteorological Society will be given this year on March 21st by Mr. J. M. Stagg, M.A., Leader of the British Expedition which occupied Fort Rae in Canada during the Second International Polar Year, 1932-3. The site of Fort Rae is of exceptional interest, as it lies near the zone of maximum frequency of aurora, and auroral photography was one of the most important objects of the expedition. Extensive studies were also made in meteorology, including upper air investigation, atmospheric electricity and terrestrial magnetism. The expedition occupied a site very near to that of the Canadian and British expedition during the first International Polar Year of 1882-3, and this gave an opportunity for obtaining valuable determinations of secular change of the magnetic elements. Mr. Stagg will also describe some of the practical difficulties and interesting or unusual experiences which the expedition met with. As the lecture this year is of unusual interest, the Council has obtained the use of the hall of the Royal Geographical Society, Kensington Gore, which accommodates an audience of 800. The lecture will begin at 7.30 p.m., and the Chair will be taken by Lt.-Col. E. Gold, D.S.O., F.R.S., President of the Royal Meteorological Society.

An additional meeting of the Royal Meteorological Society will be held on March 28th, at 5.30 p.m., at 49, Cromwell Road, South Kensington, when Prof. W. Schmidt, Director of the

Central Meteorological Institute, Vienna, will deliver a lecture on Micro-climatological work in Austria.

The monthly meeting of the Society was held on Wednesday, February 21st, at 49 Cromwell Road, South Kensington, Lt.-Col. E. Gold, D.S.O., F.R.S., President, in the Chair.

Chang-Wang Tu, M.Sc.—China Rainfall and World-Weather. (Memoirs, Vol. IV, No. 38.)

The objects of this investigation were to discover the relationship between the rainfall of China in the rainy season and world weather; and to find some regression formulæ for foreshadowing China rainfall in the rainy season. Sir Gilbert Walker's shorter method has been used for the calculation of the correlation coefficients and his criteria have been applied for testing the reliability of the coefficients. Four fairly homogeneous regions have been chosen and the rainfall of each region is correlated with the pressure, temperature and rainfall of different seasons at various important stations of the world. It is found that increased circulation of the Southern Oscillation is generally responsible for heavy rainfall during the rainy season in China. The total correlation coefficients obtained from the equations for the North China Coast, Yangtze Delta, Yangtze Valley and south-east China Coast are respectively 0·78, 0·62, 0·68 and 0·68.

C. E. P. Brooks, D.Sc.—The Variation of the Annual Frequency of Thunderstorms in Relation to Sunspots.

A possible relation between thunderstorm frequency and variations of solar activity is of considerable interest, and the author set out to determine statistically whether such a relation exists. Annual frequencies of thunderstorms were formed for 22 groups of stations in all parts of the world over periods up to 66 years and were compared with the annual sunspot numbers. It was found that when sunspots are numerous thunderstorms are more frequent than usual in high northern latitudes and in the tropics, but in temperate latitudes the relation, if any, is small. The 11½ year "thunderstorm cycle" was then compared with the sunspot cycle, and the two were found to run parallel in Sweden and Siberia, but in maritime tropical areas the thunderstorm cycle lags about five months behind the sunspot cycle. Over the earth as a whole the frequency of thunderstorms at sunspot maximum averages about 22 per cent. greater than the frequency at sunspot minimum.

Correspondence

To the Editor, *The Meteorological Magazine.*

In Lighter Vein

Many inquiries have been made as to the cause of the abnormal drought: and various tentative suggestions have been put forward to explain it. One school attributes it to a change in the volume of the Gulf Stream drift: another suggests that radio-broadcasting has used up most of the ions previously available as nuclei of condensation.

A more plausible reason has recently come to my notice. It is well known that rain in England is mainly derived from evaporation from the Atlantic Ocean; and further that evaporation from spray is much more effective than evaporation from a water surface. A most effective producer of spray is a spouting whale: but there has been so great a reduction in the number of whales in the North Atlantic that this source of rainfall has been nearly cut off—hence the drought.

E. GOLD.

An Unusual Glazed Frost

A curious example of glazed frost occurred here on the morning of February 24th last. During the previous night there had been continuous thick fog (visibility 25-55 yds.) accompanied by heavy rime; the minimum temperature in the screen was 26·9°F., and on the grass 24·3°F. When the regular observations were taken at 9h. a fine drizzle had just set in, and slight glazed frost was beginning to form. The dry bulb then read 29·5°F., and the grass thermometer 31·0°F., while the subsoil temperatures were, at 4 ft. 39·5°F., at 1 ft. 35·5°F., at 6 in. 34·3°F., and at 1 in. 33·0°F. Weather, slight drizzle with persistent thick fog (visibility 55 yds.), wind, S., force 1; relative humidity, 93 per cent. During the next hour it was noticed that the rime was slowly disappearing, from the ground upwards. A special series of observations made at 10h. gave the following readings: dry bulb, 30·8°F.; grass thermometer, 34·3°F.; earth thermometers, at 4 ft. 39·5°F., at 1 ft. 35·9°F., at 6 in. 34·7°F., at 1 in. 34·2°F. Weather, continuous drizzle with persistent thick fog (visibility 55 yds.), wind, SSW., force 1; relative humidity, 94 per cent. By this time the ground and all objects within about 2 ft. of it were quite wet with the drizzle, which had been falling steadily since 9h.; above that level everything was still coated with ice, in the one form or the other. The line below which the rime had melted was remarkably well defined, and with their curtailed mantles of white the trees, bushes and wire fences at the bottom of the valley presented a most striking appearance.

There seemed to be little change in the phenomenon until shortly after 11h., when the screen temperature rose above the freezing point, and both rime and glazed frost quickly vanished. At 11h. 10m. the thermometer on the grass still read 2·1°F. higher than the dry bulb. Weather, cloudy, moderate fog (visibility 550 yds.); wind. SSW., force 2; relative humidity, 91 per cent. The thaw then progressed normally.

It is supposed that the cessation of outward radiation when the sky grew overcast in the early morning was followed by gradual conduction of warmth from the subsoil (sand and gravel over chalk) to the layer of air next the ground, and that the effect of this process extended in the course of a few hours to an elevation of about 2 ft.

The incidence of drizzle and the evidence of the 7h. synoptic chart combine in suggesting that a marked temperature inversion existed higher up, so that here, it seems, was an instance of an apparently stable layer of cold air sandwiched between warmer layers vertically above and below it.

E. L. HAWKE.

Caenwood, Rickmansworth, Herts. March 1st, 1934.

Travel of Thunderstorms

Referring to the article in your February number by R. C. Sutcliffe on the above subject, I have noticed that storms travelling in a north-east direction, which is frequently the case, usually seem to pass on our south-east and sometimes on our north-west.

If they are travelling from south or south-east to north or north-west, we usually get one overhead. I attribute this to the configuration of the high land which lies north and east of us, The Roaches, Buxton, Peak District, and Weavers.

M. A. BOLTON.

Oakamoor, North Staffordshire. February 21st, 1934.

In the February number of the magazine Mr. Sutcliffe raises the question of the influence of topographical features on the movements of thunderstorms and quotes three examples of local belief that the rivers have a controlling influence. There is no doubt that such beliefs are widely held. In the British Rainfall Organization we have very frequently been assured by observers that an apparently low total of rainfall at their station is accounted for by a tendency for thunderstorms to avoid their locality. In some cases the observer adds the further information that the storms tend to follow some definite track such as the line of a river valley.

Like Mr. Sutcliffe I have always found it difficult to accept these statements but I have also felt that it would be a very difficult matter to prove or disprove them. One could say quite positively that the type of thunderstorm associated with the passage of a cold front would take no notice of minor topographical features, but I am doubtful if one could be so definite in regard to the slow-moving storms which occur in what the

French call a *marais barométrique*. We are concerned not so much with the narrow river itself as with the valley drained by the river, and the valley may be many miles wide. It is now, I believe, generally admitted that the formation of clouds of the lenticular variety, which occur at heights comparable with the height of the summit of well-developed cumulo-nimbus, is related to the ground contours. If that be the case we have evidence to show that the ground contours may affect the movement of the air at heights many times greater than the height of the surface irregularities.

On the other hand the evidence afforded by rainfall maps of thunderstorms is conflicting. In some (*e.g.*, the thunderstorm of June 14th, 1914, studied by Mr. J. Fairgrieve*) there does seem to be a tendency for the rain-field to lie along the river valley; in others (*e.g.*, the thunderstorm of May 31st, 1911, also studied by Mr. Fairgrieve†) there is no such tendency.

This is a question the answer to which might be obtained from an intensive study of the data now being accumulated by Mr. S. Morris Bower.

E. G. Bilham.

Dr. Sutcliffe's remarks on this subject in the February issue remind me that while living at Bedford I found prevalent a belief that thunderstorms have a preference for travelling along the low ridges of hills which rise at some three to eight miles' distance to a height of two or three hundred feet above the river valley. It is said that bad storms rarely if ever pass over the town itself. The river Ouse passes through the centre of the town, but I have not heard it mentioned in connexion with thunderstorms. I was unable either to verify or disprove this belief during the three years in which I was stationed at Cardington. It is interesting to observe that the alleged movement is not in disagreement with that mentioned by Dr. Sutcliffe for other towns, and the explanation may be the same. It is possible, however, that there is some truth in the belief at Bedford, as the hills might be effective in initiating or localising convection. On the other hand the area of a storm is generally large enough to allow of ample latitude in the placing of its "centre" by unpractised or prejudiced observers. I might remark also on the curious habit some people indulge in when they experience a slight weather phenomenon (such as a threatening sky or slight thunder) of assuming that "someone's getting it very badly." Thus at Bedford a slight storm over the town can easily be projected in the imagination into a severe storm over the neighbouring hills.

A. F. Crossley.

**British Rainfall*, 1914, pp. 48-56.
†*British Rainfall*, 1911, pp. 26-39.

Whenever a thunderstorm occurred at Felixstowe during my sojourn there I wondered if the residents of Walton-on-Naze or elsewhere, according to the direction of drift of the storm, were referring to their own comparative immunity and the influence of the river Stour or Deben. The map on page 21 of "Summer Thunderstorms" will illustrate the opportunities one is afforded in this respect. Incidentally this same map prompts me to ask if the people of Norwich appreciate the distinction of being specially favoured by the visitation of thunderstorms during that particular period, if not generally.

Traditions that thunderstorms are specially associated with the configuration of the country in the vicinity of the district are cherished by local observers and occasionally appear in the public press. The author of *Geophysical Memoir* No. 24 writes: "considerations of relief, of soil and vegetation, and of geological structure, all combine to give one locality an excess above, and another neighbouring locality a deficit below, the general average of the district." In this particular case it seems more appropriate to me to quote Sir Napier Shaw: "Nature is not at all unwilling to suggest things that turn out not to be true."* He also warns the student of weather not to believe all that he thinks he sees.

I think Mr. Sutcliffe has over-estimated the limit at which storms become noticeable. To verify my own impression a number of publications were examined and the following result obtained; in favourable circumstances thunder can be heard for a distance of twelve to fifteen miles, there are isolated cases of thunder being audible over a distance of thirty-six miles. A mass of thundercloud can be seen for a distance of sixty miles or more but I do not think the ordinary observer associates the cloud with a thunderstorm until he hears the thunder.

J. S. SMITH.

Coronx, Highview Road, Farnborough, Hants. *February 26th*, 1934.

Dr. Sutcliffe's letter in your February issue under the above heading raises an interesting point. The suggested influence of rivers in controlling storm travel has been reported from several parts of the country, but more particularly from East Anglia.

The storm travel maps for England, which have been prepared from the summer data for 1931 and 1932, appear to confirm the reputed facts that the direction of the river coincides with that of storm travel near Lowestoft and at Wellingborough. There is, however, nothing whatever to suggest that the river is the cause of the coincidence. Storms are sometimes reported to habitually follow a railway, and reasons are added for the control of the railway, but the most that one can assume from such records is that the direction of the railway and that of

*"The Drama of Weather," page 13.

the general drift of storms approximately coincide in the particular district. Nevertheless it is a useful piece of information. At Felixstowe the general direction appears to be more at right angles to the coast, but there are frequently local deviations when a coast line is much indented.

The maps suggest the deflection of storms where relief is marked, but the effect of the hills is probably an indirect one. The reputation of a locality to miss storms is quite frequently reported. Sometimes it is real, but more often it is mainly due to a combination of circumstances such as—distribution of population, visibility, the difficulty of knowing how the rest of the storm is situated with regard to the portion one is observing, etc. These are points which only the co-ordination of triangulated observations over large areas can hope to elucidate.

S. Morris Bower.

Langley Terrace, Oakes, Huddersfield. March 1st, 1934.

Travel of Thunderstorms and Effects of Lightning

During nine years, from 1910 to 1919, when I lived at Althorpe Rectory, on the bank of the Trent in north Lincolnshire, there a broad tidal river, flowing directly from south to north, I formed the conclusion that thunderstorms, which were frequent, undoubtedly tended to follow the course of the river. Never elsewhere have I so frequently experienced alarmingly close lightning. During my residence there, two houses in Althorpe, and one in the neighbouring village of Keadby, were struck by lightning, in each case close to the river bank, though, strange to say, the church, a large conspicuous building of the 15th century, also on the river bank, with a tower 80 feet high, the roof covered with sheet lead and three large bells in the tower, has never in living memory been touched by lightning, although devoid of any conductor. One of the houses struck in Althorpe was a low barn quite close to the church.

In the case of the house at Keadby the details were so extraordinary as to be worth recording. The flash struck a disused chimney, and deviated to the head of an iron bedstead in an upper room, upon which two boys were lying, followed the iron frame underneath the bed, setting the bedding on fire, but without injuring the occupants, descended the further leg of the bedstead, making a hole in the floor into which one's finger could be inserted, and penetrating to the room below. There it travelled straight downwards in the corner until half-way to the floor, when it turned sharply at right angles and passed horizontally along the wall to the next corner, making a blackened score in the wall paper. Again it pierced a hole, big enough to put a finger into, through the wall into a larder behind, fused together some cake tins which lay on a shelf, fitted one inside the other, and then it passed through the open door of the larder, across the kitchen, and out through the open entrance door of the cottage. In the kitchen four persons were seated round a square table at supper. The flash passed across the table and burned to a blackened cinder a piece of ham which was on a dish in the centre, and on which lay the carving knife and fork, again without injuring any of the four persons. I could not have believed these details true if I had not personally examined the house and the various objects mentioned, and questioned the inhabitants just after the storm. I collected the sum of £5 to replace the bedding and other articles belonging to these poor people, which were destroyed by the lightning, and the block of fused cake tins I presented to the Lincoln Museum.

ALLAN ELLISON.

Washfield Rectory, Tiverton, Devon. February 26th, 1934.

NOTES AND QUERIES

80th Birthday of Sir Napier Shaw

On March 4th Sir Napier Shaw, F.R.S., Director of the Meteorological Office from 1905 until 1920, celebrated his 80th birthday. The following letter was sent to Sir Napier by the Staff Council of the Meteorological Office :—

Dear Sir Napier,

May we offer you on behalf of the staff of the Meteorological Office, and in particular on behalf of those who served under you in the Office and its Observatories, our best wishes on the anniversary which you celebrate on Sunday, 4th March, 1934?

We assure you that you are in the thoughts of many of us on the occasion of your eightieth birthday and we trust that you will enjoy good health during the coming years.

Yours sincerely,

C. E. P. Brooks,
Chairman.

R. M. Poulter,
Secretary.

An account of Sir Napier's work as Director appeared in the *Meteorological Magazine* for September, 1920, p. 161, and the issue for July, 1921, contained a reproduction of his portrait, which was presented by the Staff and a copy of which hangs in the Library of the Meteorological Office.

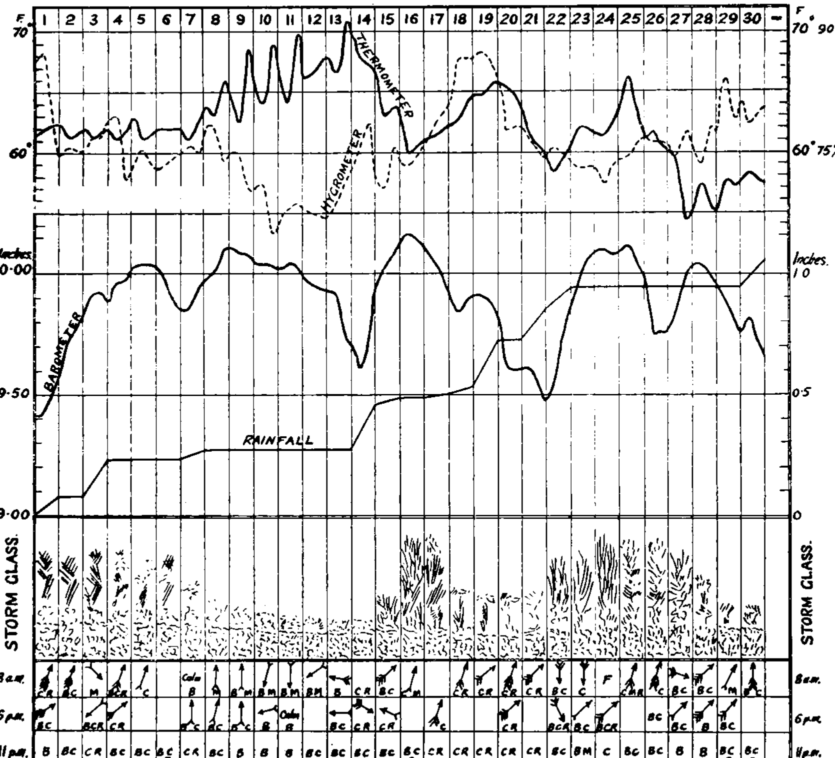
The Storm Glass and Weather

The reference to the storm glass by Mr. E. L. Hawke in his review of Sir Napier Shaw's beautiful book, "The Drama of Weather," recalls to my mind a series of observations of this instrument made by my father in the year 1891. Since copies of the crystal patterns formed in this curious instrument are seldom seen, the attached chart for the month of September may be of interest. The chart shows clearly the form of crystallisation observed from day to day, together with the associated curves of pressure, temperature, humidity and rainfall, the direction and force of the wind and the state of the sky.

The barometer used was a type of sympiezometer and this instrument, the rain gauge, hair hygrometer and storm glass were all made by my father in his home workshop.

WALTHAM CROSS.

METEOROLOGICAL CHART FOR THE MONTH OF SEPTEMBER 1891.



My father died when I was seven years of age and since he left no drawings or other data, I have no details of construction or exposure of the other instruments, but still have in my possession the sympiezometer and attached storm glass which have, however, not functioned for many years.

The storm glass consisted of a solution of camphor, nitre and sal-ammoniac in absolute alcohol, contained in a glass test-tube, the orifice of which was sealed with a cork and sealing wax. The sympiezometer and storm glass were hung on a wall, indoors, in such a way that they were exposed to little change of temperature and free from direct sunlight.

The storm glass seems to have been most active during high winds from the SW. quadrant, with both positive and negative changes of pressure; and more quiescent with a steady barometer. Changes of temperature and humidity seem to have had little effect on the instrument.

DONALD L. CHAMPION.

The Largest Thermometer in the World

We learn from *The Observer* that an enormous illuminated thermometer has been placed on the Eiffel Tower to display the night temperature of Paris. A year ago the enormous face and moving hands of a clock outlined in light were set up on the tower, where they were visible from a large part of Paris. The new thermometer is placed above the clock and extends to the top of the tower. It is graduated from −10°C. to +20°C. (14° to 68°F.).

Rainfall Record at Mogador, Morocco

With the closing of the British Vice-Consulate at Mogador, Morocco, a rainfall rcord which has been maintained for nearly thirty years comes to an end. The observations commenced in September, 1903, and ended with May, 1933, but there have been short gaps totalling 47 months. Mogador lies on the west coast, in 31½°N., in the dry region under the influence of the NE. trade winds, and the average annual rainfall from 1903 to 1933 was only 13·09 in. The monthly averages in inches and the average number of rain-days are as follows:—

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall	1·56	1·92	2·30	0·94	0·35	0·15	0·00	0·02	0·29	1·15	2·94	1·50
Rain-days	3·7	5·1	5·6	3·7	2·0	0·4	0·0	0·1	0·8	3·5	6·0	4·4

The double maximum in November and March is interesting: in winter the effect of the anticyclone over the Sahara introduces a minor dry period. The wettest complete year was 1919 with 19·50 in., but in 1912 the total for January, February and September to December was 19·57 in., the observations for March to August being missing. The driest year was 1910 with only 3·56 in. The wettest month was March, 1923, with 10·56 in.—a large fraction of the average annual fall. July was rainless throughout, August was rainless in 21 years out of 23, and June was rainless in 19 years out of 23, but experienced an abnormal total of 1·97 in. on four days in 1930. All months were rainless at least once.

As would be expected, the number of rain-days is small, the annual average being only 35. Falls of 0·5 in. or more in a day have occurred in every month except July and August, the two heaviest being 8·27 in. on March 31st, 1923, and 5·20 in. on November 14th, 1919, the latter being followed by 3·00 in. on the 15th. These remarkable downpours are typical of the rare and violent storms which occur at long intervals in dry climates.

Reviews

The Climate of the Netherlands. A (continued). Precipitation. First part. By Dr. C. Braak, K. Ned. Meteor. Inst. No. 102. Med. en Verh. 34a. Pp. 76 (Dutch) + 24 (English Summary). Illus. 's Gravenhage, 1933.

This publication supersedes volume No. 15 published in 1913, which deals with rainfall records in Holland up to 1910. There are twenty-three pages of text in English, while the fuller information given in the Dutch text can be readily followed, the headings of the tables being invariably also given in English. Monthly and annual normals are given for 143 stations. In each case the values are based on the period of observation 1891 to 1930.

The distribution of the monthly seasonal and annual amounts is shown in a series of maps on a scale of about 48 miles to 1 inch (1 to 3 million). The annual averages vary little over Holland. The driest station is said to be Kampen, on the east coast of the Zuider Zee, with 597 mm. (23·5 in.), but it is noted that in the table three stations near Roermond in the south-east give weighted normals of 587, 590 and 591 mm. The wettest station is Naals, on the high ground in the extreme south near Aix-la-Chapelle, with 863 mm. (34 in.).

The records at the island stations and along the low-lying west coast of Holland are of interest in defining, in conjunction with similar observations along the east coast of Great Britain and at the Danish Lightships, the probable rainfall over the North Sea. The rainfall in the islands to the north of the Zuider Zee is about 700 mm. (27·6 in.) and further south about 600 mm. (23·6 in.). The rainfall along the east coast between the Humber and the Thames Estuary, on the other side of the north sea, varies from about 23 to 20 in.

Difficulties have been encountered in determining the duration of rainfall, owing to uncertainties during light rain, and Köppen's *Stichproben* method is preferred. In this method the number of hours of rain are deduced from the number of records of rain made at the fixed hours of observation. Mr. Bilham discussed this method in the *Journal of the Royal Meteorological Society*, 1932, p. 38.

It is a little disconcerting to find on p. 82 details of the number of " ' cloudbursts ' with at least 0·2 mm. a minute and 4 mm. an hour," but this is obviously a slip in translation (which occurs elsewhere in the text) for "showers." The question of the frequency of showers is dealt with in a thorough manner, the records being examined from self-recording gauges for four stations covering altogether 84 years. The details given include those for each shower, as defined above, of the greatest mean intensity during periods of 1-5, 6-10, 11-15 minutes, and so on, and of heavy showers with at least 1 mm. a minute. Of the 93 heavy showers on record, 73, or more than three-quarters, occurred during June, July and August.

Details are given of the general rainfall over Holland for each year back to 1849, and the decadal means are compared below with those for England :—

	1850-9	1860-9	1870-9	1880-9	1890-9	1900-9	1910-9	1920-9
England	95	101	108	103	96	98	107	106
Holland	92	98	104	100	97	100	108	100

The values for England are percentages of the mean for the period 1881 to 1915 and for Holland 1849 to 1930. In the case of the decade 1920-9 it is of interest to note that the excesses occurred mainly in the west, while the rainfall along the east of Great Britain was about the normal and therefore similar to that of Holland.

Many other points of equal interest are dealt with in this publication, which discusses the rainfall of a neighbouring country from many aspects. J. GLASSPOOLE.

The Place of Obseration in Astronomy. An inaugural lecture delivered on April 28th, 1933, by H. H. Plaskett. Size 9 × 6 in., pp. 32. Oxford: Clarendon Press, 1933. Price 2s. net; and

The Composition of the Stars, being the Halley Lecture delivered on June 1st, 1933, by H. N. Russell. Size 9 × 6 in., pp. 31. Oxford: Clarendon Press, 1933. Price 2s. net.

Although these two lectures deal solely with astronomy, they are not without interest to meteorologists. This applies especially to the lecture by Professor Plaskett, in which he traces through the history of astronomy the achievements of observation and theory. They have advanced together, hand in hand, but not abreast, for now one leads, now the other. The most famous example of the leadership of theory is the prediction by Adams and Leverrier of the existence of the planet Neptune, which was subsequently found in the predicted position. This is described as an achievement unique in the annals of science; meteorologists might have rivalled it if they could have predicted the discovery of the stratosphere, but here observation led, though perhaps only by a short length.

Observations are divided into "passive" and "active." Passive observation is the observation of a phenomenon merely because it is observable; active observation is the observation of a phenomenon because it enables a question to be put or a difficulty cleared up. As a science advances observation becomes almost entirely active; astronomy has reached this stage, but it is to be feared that much meteorological observation is still passive.

The second paper, on the composition of the stars, is more technical—and also more astounding. The word is used advisedly, for the discovery of so much reasoned information about the internal constitution of bodies, the distance of which can only be measured in light years, is an astounding feat of human intelligence. There are many gaps, it is true, but the limitations to which these are due are mostly natural, such as the earth's atmosphere, which interposes an impenetrable barrier of ozone to the shorter wave-lengths in the ultra-violet.

Books Received

Ergebnisse Aerologischer Beobachtungen, 1931. K. Ned. Meteor. Inst. (No. 106 A). Utrecht, 1932.

Scouting for a site for a solar-radiation station, by A. F. Moore. (Smiths. Misc. Coll., Vol. 89, No. 4). Washington, 1933.

Obituary

Mr. C. A. Bracey.—We regret to record the death on February 15th of Mr. Bracey, at the age of 67, after a long and painful illness, borne with great fortitude and patience. The funeral took place at Hemel Hempstead cemetery on the 21st and was attended by Mr. E. G. Bilham, B.Sc., Superintendent of the British Climatology Division (representing the Director of the Meteorological Office), and by several of Mr. Bracey's old colleagues.

Mr. Bracey retired from the Office in November, 1931, after just over 50 years' service, mainly in the British Climatology Division. He prepared a list of the greatest daily falls at some 116 stations in the British Isles from the date of their commencement up to 1915, which are preserved in two volumes in the library of the Office. He also compiled a detailed summary of the daily rainfall observations at Brixton from 1871-1910.

After his retirement he left Apsley End where he had lived for many years and went to reside near Bristol. The climate and quietness of the country did not suit his energetic spirit, and he returned to Apsley again in the summer of 1933 with a view to taking part in the civic life of Hemel Hempstead once more (in his early years there, he had served on the local council), but the fatal illness had already seized upon him and he took to his bed in September of that year.

We regret to learn of the death on December 29th, 1933, at the age of 73, of Baron Alphonse Berget, professor of physical oceanography in the Institut Océanographique, Paris, who published many works on physics and meteorology.

News in Brief

We learn that Mr. D. Brunt, M.A., B.Sc., Superintendent since 1919 of the Army Services Division of the Meteorological Office, has been appointed to the University Chair of Meteorology (Imperial College—Royal College of Science) from October 1st, 1934.

Dr. J. Keränen was appointed Director of the Meteorological Office of Finland by the President of the Republic on November 10th, 1933.

We learn that Mr. Willis Ray Gregg has been appointed Chief of the United States Weather Bureau as from January 31st, 1934, in place of Dr. C. F. Marvin, who is retiring.

The Weather of February, 1934

Pressure was below normal over San Francisco, Alaska, north-west Canada, northern Greenland, Jan Mayen, Spitsbergen, northern Norway, northern Sweden, Russia and Madeira, the greatest deficits being 9·4 mb. at Barrow and 14·1 mb. at Waigatz. Pressure was above normal over most of the United States and Canada, the North Atlantic, south Greenland, Iceland, western, central and south-eastern Europe and the Mediterranean, the greatest excesses being 17·2 mb. at the Scilly Isles and 5·8 mb. at 50° N. 120° W. Temperature was above normal at Spitsbergen and in north Europe and below normal in central and southern Europe, while rainfall was deficient at Spitsbergen and in excess in northern Norway and Sweden (except Gothaland).

February, 1934, in the British Isles was sunny and dry with much mist or fog in south-east England and the Midlands. Many places experienced between 16 and 27 days of absolute drought, the total fall at Inchkeith being only 0·01 in., while Ross-on-Wye, Cranwell and Gorleston with 119 hrs., 99 hrs. and 114 hrs. respectively, established new record durations of sunshine for the month. Temperature was generally above normal in the north but below in the south. On the 1st an intense anticyclone was situated to the west of the British Isles, but small secondaries crossing the country gave north-easterly gales on the east coast of England on the 1st and slight general drizzle (or sleet locally) on the 1st and 2nd, though the weather was mainly fair with some mist or fog. Much sunshine was experienced in the south on the 2nd, when 8·5 hrs. were recorded at Penzance and 8·4 hrs. at Weymouth. This was followed by a night of severe frost, 9°F.

being registered on the ground at Collumpton and 10°F. at Greenwich. On the 3rd much mist or fog, dense in places, persisted locally during the day in England. From the 4th the anticyclone gradually decreased in intensity and the depressions moving from Iceland to Scandinavia came further south until on the 7th the whole country came under the influence of a deep depression centred off south Norway. During this time the weather had been fair to cloudy with much sun in north England and Scotland on the 5th and in England on the 6th. Gales occurred at Lerwick on the 5th. On the 7th there was a change to dull rainy weather with gales generally in the north and Midlands both then and on the 8th, while in the south the conditions were dull with local mist. As this depression moved north-east the anticyclone which was by this time centred over the Bay of Biscay gradually spread north covering the whole country by the 11th and fair sunny conditions were experienced in most areas though mist or fog prevailed generally morning and evening especially in parts of the Midlands and south-east, where occasionally it persisted all day. Owing to fog the maximum at Kew did not rise above 35°F. on the 12th and at Marlborough 36°F. on the 17th. Among the larger amounts of sunshine recorded during this period were 9·0 hrs. at Bognor on the 11th, 8·9 hrs. at Aberystwyth on the 12th and 9·3 hrs. at Jersey on the 14th. A thunderstorm occurred in the Orkneys on the 10th, while pressure reached a record height for February when a value of 1049·7 mb. was registered at Sealand (Chester) on the 15th. From the 19th to 23rd Scotland came under the influence of the depression to the north and moderate to strong westerly winds with cloudy showery weather prevailed while the south was mainly influenced by the anticyclone and had warm sunny days on the 19th-21st but with much persistent mist and fog on the 22nd and 23rd. Ross-on-Wye had 9·7 hrs. bright sunshine on the 21st and Calshot 9·5 hrs. on the 20th. A trough of low pressure crossed the country on the 24th and 25th causing drizzle generally and in the rear of this cold northerly winds, strong at times, swept over the country. Snow occurred locally from the 25th-28th and precipitation was heavy in north England on the 27th, 1·40 in. being recorded at Kildale (Yorkshire), but there were long sunny periods generally. The general distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	44	—14	Liverpool	17	+ 9
Aberdeen	84	+10	Ross-on-Wye	119	+48
Dublin	82	+ 9	Falmouth	105	+22
Birr Castle	68	+ 1	Gorleston	114	+33
Valentia	91	+22	Kew	77	+17

The special message from Brazil states that the rainfall was plentiful in the northern and southern regions with 3·34 in. and 1·85 in. above normal respectively, and scarce in the central regions with 3·11 in. below normal. Three anticyclones passed across the country and temperature was generally high in the south. Cereals, beans and tobacco crops were affected by lack of rain in the first period in the north and south, but conditions were good for the cane and cotton in all regions. At Rio de Janeiro pressure was 0·3 mb. above the normal and temperature 0·4° F. below normal.

Miscellaneous notes on weather abroad culled from various sources. Temperature in Lisbon and north of the Tagus fell below freezing point on the night of the 3rd-4th. Several people were killed as the result of avalanches falling on the mountain villages of Montefortino and Bolognola in the southern part of the Marches near Rome at the beginning of the month, and the snowstorms were followed by heavy rain on the 4th and 5th. Owing to an exceptionally low tide at Venice on the 13th most of the canals inside the city ran dry. Severe easterly gales occurred off the southern coast of Spain about the 14th and south-easterly gales over Madeira on the 17th. Gales were also experienced over southern Norway and Denmark on the 19th and 20th. No snow or rain fell for nearly three weeks in parts of Switzerland early in the month and the sunshine melted much of the snow below the 3,000 ft. level. Some snow, however, fell on the Alps at the end of the month. Severe weather has occurred in Spain throughout most of the winter (*The Times*, February 5th-March 3rd).

A heavy fall of snow occurred in Tetuan (Spanish Morocco) about the 12th (*The Times*, February 13th).

General light to heavy rains fell in Queensland and New South Wales between about the 19th and 23rd (*The Times*, February 24th).

During the first three weeks of the month temperature was generally below normal in the eastern United States and much above normal in the western States, being as much as 27°F. above normal at Havre (Montana) for the week ending the 13th, while precipitation was deficient in the west and variable along the eastern coasts. During the last week temperature was below normal except in the States along the Pacific coast, while precipitation was variable. Intense cold was experienced in eastern Canada and the eastern United States about the 9th, −14°F. was recorded at New York on the 9th, the lowest temperature recorded there since 1868, when records began, but the temperature rose on the 11th. On the 19th and 20th a severe snowstorm occurred throughout the eastern States dislocating all traffic but the 21st was sunny and less cold. Another severe snowstorm occurred on the 25th and 26th. In the south of the States a series of tornadoes, earlier than usual, caused the death of many persons and did much damage in Mississippi, Louisiana, Alabama and Georgia. The Pacific coast had torrential rains on the 25th. The weather was also very cold and snowy in Canada throughout the month. The fall of 17 in. of rain in 36 hours near Santos, Brazil, about the 20th started landslips which caused 20 deaths (*The Times*, February 10th-28th and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin and Daily Weather Report*).

After many sunny and comparatively mild days the weather turned stormy and bitterly cold in the Bay of Whales, Ross Sea (*The Times*, February 8th).

Daily Readings at Kew Observatory, February, 1934

Date	Pressure, M.S.L. 13h	Wind, Dir., Force 13h	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain	Sun	Remarks (see p. 1)
	mb.		°F	°F	%	in.	hrs.	
1	1033·9	NE.5	38	40	42	0·01	4·1	pr_0 2h.-ps_0 12h.
2	1038·4	NE.4	28	36	46	—	4·4	x early. m. 18h.
3	1033·3	WSW.2	24	39	94	0·02	0·0	f 9h.-18h. d. 12h.-19h.
4	1030·5	NE.4	38	41	79	trace	0·0	d_0 9h. & 21h.
5	1030·6	NE.4	39	43	74	—	0·0	
6	1028·4	N.2	37	50	66	—	6·4	f 9h. f_0 21h.
7	1026·8	W.3	35	46	68	—	0·3	f_0 18h.
8	1022·3	NW.4	37	49	40	trace	6·6	r_0 9h.
9	1032·0	WSW.4	31	48	55	—	7·6	x early. f_0 9h.
10	1027·6	W.2	35	48	71	trace	0·5	pr_0 17h. f_0 18 h.
11	1036·1	SW.2	34	44	95	trace	3·2	x early. f F all day
12	1041·0	SW.1	29	35	99	trace	0·0	x early F all day
13	1040·5	ESE.2	28	45	78	trace	0·0	F 0h.-12h. $f_0$17h.-22h.
14	1038·8	SSW.1	26	45	96	trace	3·3	x F 0h.-16h.
15	1048·3	E.1	34	46	87	—	0·6	f_0-F all day
16	1045·1	WNW.1	30	53	77	trace	5·2	F 0h.-13h. f 18h.
17	1043·5	Calm	35	41	95	trace	0·0	F 0h.-15h.
18	1040·6	S.2	37	39	78	trace	0·0	f_0 9h. f 10h.-12h.
19	1036·6	W.2	30	48	72	—	2·3	x f 7h.-11h. f_0 21h.
20	1036·0	NW.3	31	50	61	—	7·3	f 9h. f_0 18h.
21	1033·1	NW.3	35	50	62	—	4·9	f_0 x 18h.-24h.
22	1030·0	W.2	34	49	72	—	6·7	f x 20h.-24h.
23	1027·1	SW.2	30	39	91	trace	0·0	fx0h.-10h. & 20h.-24h.
24	1016·3	S.2	29	44	90	trace	0·4	f x 0h.-13h. r_0 18h.
25	1008·4	SSW.3	43	46	93	0·04	0·0	r_0 2h.-5h. & 15h.-17h.
26	1017·3	N.4	36	37	34	trace	4·9	ps_0 7h. 22m.
27	1007·3	NNW.3	28	40	59	—	8·0	ps_0 early.
28	1006·0	N.3	36	37	80	0·15	0·0	is to irs 8h.-17h.

General Rainfall for February, 1934

England and Wales ...	22	per cent of the average 1881-1915.
Scotland	42	
Ireland	11	
British Isles	24	

Rainfall : February, 1934 : England and Wales.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	·20	12	*Leics.* .	Thornton Reservoir ...	·75	45
Sur .	Reigate, Wray Pk. Rd.	·34	16	,, .	Belvoir Castle............	·52	31
Kent .	Tenterden, Ashenden...	·15	8	*Rut* .	Ridlington	·49	30
,, .	Folkestone, Boro. San .	·19	...	*Lincs* .	Boston, Skirbeck	·52	36
,, .	Eden'bdg., Falconhurst	·12	5	,, .	Cranwell Aerodrome ...	·48	32
,, .	Sevenoaks, Speldhurst	·18	...	,, .	Skegness, Marine Gdns	·76	50
Sus .	Compton, Compton Ho.	·05	2	,, .	Louth, Westgate	1·14	59
,, .	Patching Farm	·00	0	,, .	Brigg, Wrawby St. ...	1·49	...
,, .	Eastbourne, Wil. Sq.	·04	2	*Notts* .	Worksop, Hodsock ...	·94	61
,, .	Heathfield, Barklye ...	·24	10	*Derby* .	Derby, L. M. & S. Rly.	·41	25
Hants .	Ventnor, Roy. Nat. Hos.	·04	2	,, .	Buxton, Terr. Slopes	·32	9
,, .	Fordingbridge, Oaklnds	·04	2	*Ches* .	Runcorn, Weston Pt...	·34	18
,, .	Ovington Rectory	·14	5	*Lancs* .	Manchester, Whit. Pk.	·32	17
,, .	Sherborne St. John ...	·06	3	,, .	Stonyhurst College ...	·31	9
Herts .	Welwyn Garden City...	·46	28	,, .	Southport, Hesketh Pk	·09	4
Bucks .	Slough, Upton	·13	8	,, .	Lancaster, Greg Obsy.	·15	5
,, .	H. Wycombe, Flackwell	·13	7	*Yorks* .	Wath-upon-Dearne ...	·55	33
Oxf .	Oxford, Mag. College...	·24	15	,, .	Wakefield, Clarence Pk.	·34	20
Nor .	Pitsford, Sedgebrook...	·46	28	,, .	Oughtershaw Hall......	·43	...
,, .	Oundle....................	·42	...	,, .	Wetherby, Ribston H.	·65	38
Beds .	Woburn, Exptl. Farm..	·39	26	,, .	Hull, Pearson Park ...	1·81	109
Cam .	Cambridge, Bot. Gdns.	·29	23	,, .	Holme-on-Spalding ...	1·01	60
Essex .	Chelmsford, County Lab	·19	13	,, .	West Witton, Ivy Ho.	·11	4
,, .	Lexden Hill House ...	·24	...	,, .	Felixkirk, Mt. St. John	1·42	84
Suff .	Haughley House.........	·27	...	,, .	York, Museum Gdns.	1·68	111
,, .	Campsea Ashe............	·38	28	,, .	Pickering, Hungate ...	1·86	107
,, .	Lowestoft Sec. School	·41	29	,, .	Scarborough	1·87	111
,, .	Bury St. Ed. Westley H.	·31	21	,, .	Middlesbrough	·75	58
Norf .	Wells, Holkham Hall	·72	49	,, .	Baldersdale, Hury Res.	...	...
Wilts .	Calne, Castleway	·12	6	*Durh* .	Ushaw College	·43	27
,, .	Porton, W.D. Exp'l. Stn	·06	3	*Nor* .	Newcastle, Town Moor	·43	27
Dor .	Evershot, Melbury Ho.	·17	5	,, .	Bellingham, Highgreen	·15	6
,, .	Weymouth, Westham .	·03	1	,, .	Lilburn Tower Gdns...	·53	27
,, .	Shaftesbury, Abbey Ho.	·08	3	*Cumb* .	Carlisle, Scaleby Hall	·16	7
Devon .	Plymouth, The Hoe ...	·11	4	,, .	Borrowdale, Seathwaite	2·50	22
,, .	Holne, Church Pk. Cott.	·33	6	,, .	Borrowdale, Moraine...	1·01	11
,, .	Teignmouth, Den Gdns.	·18	7	,, .	Keswick, High Hill...	·22	4
,, .	Cullompton...............	·41	15	*West* .	Appleby, Castle Bank	·18	6
,, .	Sidmouth, Sidmount...	·13	5	*Mon* .	Abergavenny, Larchf'd	·29	9
,, .	Barnstaple, N. Dev. Ath	·36	13	*Glam* .	Ystalyfera, Wern Ho.	·77	15
,, .	Dartm'r, Cranmere Pool	·50	...	,, .	Cardiff, Ely P. Stn. ...	·59	20
,, .	Okehampton, Uplands	·28	6	,, .	Treherbert, Tynywaun	·94	...
Corn .	Redruth, Trewirgie ...	·35	9	*Carm* .	Carmarthen, Priory St.	·67	18
,, .	Penzance, Morrab Gdn.	·21	6	*Pemb* .	Haverfordwest, School	·53	15
,, .	St. Austell, Trevarna...	·32	8	*Card* .	Aberystwyth	·50	...
Soms .	Chewton Mendip	·45	13	*Rad* .	Birm W.W. Tyrmynydd	·44	8
,, .	Long Ashton	·41	17	*Mont* .	Lake Vyrnwy...........	·38	8
,, .	Street, Millfield.........	·20	10	*Flint* .	Sealand Aerodrome ...	·16	10
Glos .	Blockley	·53	...	*Mer* .	Dolgelley, Bontddu ...	·81	18
,, .	Cirencester, Gwynfa ...	·28	12	*Carn* .	Llandudno	·27	14
Here .	Ross, Birchlea...........	·39	19	,, .	Snowdon, L. Llydaw 9	1·81	...
Salop .	Church Stretton.........	·33	15	*Ang* .	Holyhead, Salt Island	·26	11
,, .	Shifnal, Hatton Grange	·31	19	,, .	Lligwy.....................	·35	...
Staffs .	Market Drayt'n, Old Sp.	·42	24	*Isle of Man*			
Worc .	Ombersley, Holt Lock	·41	25		Douglas, Boro' Cem. ...	·25	8
War .	Alcester, Ragley Hall..	·44	27	*Guernsey*		[illegible]	[illegible]
,, .	Birminghm, Edgbaston	·29	17		St. Peter P't. Grange Rd	·09	4

Rainfall: February, 1934: Scotland and Ireland.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per cent. of Av.
Wig	Pt. William, Monreith	·44	14	*Suth*	Melvich	2·82	94
,,	New Luce School	·72	19	,,	Loch More, Achfary	9·20	139
Kirk	Dalry, Glendarroch	·58	11	*Caith*	Wick	1·66	73
,,	Carsphairn, Shiel	1·15	17	*Ork*	Deerness	3·82	127
Dumf	Dumfries, Crichton, R.I	·28	9	*Shet*	Lerwick	3·33	105
,,	Eskdalemuir Obs.	·41	8	*Cork*	Caheragh Rectory	·38	...
Roxb	Branxholm	·20	8	,,	Dunmanway Rectory	·25	4
Selk	Ettrick Manse	·40	9	,,	Cork, University Coll.	·32	9
Peeb	West Linton	·37	...	,,	Ballinacurra	·34	9
Berw	Marchmont House	·19	9	*Kerry*	Valentia Obsy	·74	14
E.Lot	North Berwick Res.	·04	3	,,	Gearhameen	·70	8
Midl	Edinburgh, Roy. Obs.	·09	5	,,	Darrynane Abbey	1·00	22
Lan	Auchtyfardle	·38	...	*Wat*	Waterford, Gortmore	·29	9
Ayr	Kilmarnock, Kay Pk.	·63	...	*Tip*	Nenagh, Cas. Lough	·39	13
,,	Girvan, Pinmore	·84	20	,,	Roscrea, Timoney Park	·20	...
Renf	Glasgow, Queen's Pk.	·52	18	,,	Cashel, Ballinamona	·27	8
,,	Greenock, Prospect H.	·92	16	*Lim*	Foynes, Coolnanes	·30	9
Bute	Rothesay, Ardencraig.	1·41	...	,,	Castleconnel Rec.	·19	...
,,	Dougarie Lodge	·64	...	*Clare*	Inagh, Mount Callan	·73	...
Arg	Ardgour House	4·16	...	,,	Broadford, Hurdlest'n.	·26	...
,,	Glen Etive	5·00	58	*Wexf*	Gorey, Courtown Ho	·44	16
,,	Oban	1·40	...	*Wick*	Rathnew, Clonmannon	·05	...
,,	Poltalloch	1·47	35	*Carl*	Hacketstown Rectory	·12	4
,,	Inveraray Castle	3·18	47	*Leix*	Blandsfort House	·17	6
,,	Islay, Eallabus	·84	20	,,	Mountmellick	·14	...
,,	Mull, Benmore	...	...	*Offaly*	Birr Castle	·17	7
,,	Tiree	·69	20	*Dublin*	Dublin, FitzWm. Sq.	·03	2
Kinr	Loch Leven Sluice	·09	3	,,	Balbriggan, Ardgillan.	·09	5
Perth	Loch Dhu	1·70	23	*Meath*	Beauparc, St. Cloud	·11	...
,,	Balquhidder, Stronvar	·55	...	,,	Kells, Headfort	·11	4
,,	Crieff, Strathearn Hyd.	·17	5	*W.M*	Moate, Coolatore	·23	...
,,	Blair Castle Gardens	·53	19	,,	Mullingar, Belvedere	·19	7
Angus	Kettins School	·08	3	*Long*	Castle Forbes Gdns.	·29	10
,,	Pearsie House	·26	...	*Gal*	Galway, Grammar Sch.	·26	...
,,	Montrose, Sunnyside	·16	9	,,	Ballynahinch Castle	·56	11
Aber	Braemar, Bank	·44	15	,,	Ahascragh, Clonbrock.	·18	6
,,	Logie Coldstone Sch.	·40	19	*Mayo*	Blacksod Point	1·00	25
,,	Aberdeen, King's Coll.	·65	32	,,	Mallaranny	1·25	...
,,	Fyvie Castle	1·62	72	,,	Westport House	·92	23
Moray	Gordon Castle	1·29	67	,,	Delphi Lodge	1·66	20
,,	Grantown-on-Spey	·93	44	*Sligo*	Markree Obsy	·63	18
Nairn	Nairn	·54	30	*Cavan*	Crossdoney, Kevit Cas.	·23	...
Inv's	Ben Alder Lodge	1·90	...	*Ferm*	Enniskillen, Portora	·30	...
,,	Kingussie, The Birches	·72	...	*Arm*	Armagh Obsy	·27	12
,,	Inverness, Culduthel R.	·31	...	*Down*	Fofanny Reservoir	·15	...
,,	Loch Quoich, Loan	11·20	...	,,	Seaforde	·07	2
,,	Glenquoich	6·60	64	,,	Donaghadee, C. Stn.	·19	8
,,	Arisaig, Faire-na-Sguir	1·94	...	,,	Banbridge, Milltown	·13	6
,,	Fort William, Glasdrum	2·75	...	*Antr*	Belfast, Cavehill Rd.	·46	...
,,	Skye, Dunvegan	2·25	...	,,	Aldergrove Aerodrome	·29	12
,,	Barra, Skallary	1·48	...	,,	Ballymena, Harryville	·61	19
R&C	Alness, Ardross Castle	2·07	63	*Lon*	Garvagh, Moneydig	·57	...
,,	Ullapool	3·04	71	,,	Londonderry, Creggan	·98	31
,,	Achnashellach	6·32	87	*Tyr*	Omagh, Edenfel	·53	18
,,	Stornoway	2·59	58	*Don*	Malin Head	·39	...
Suth	Lairg	3·46	112	,,	Milford, The Manse	·76	23
,,	Tongue	3·00	86	,,	Killybegs, Rockmount.	·59	...

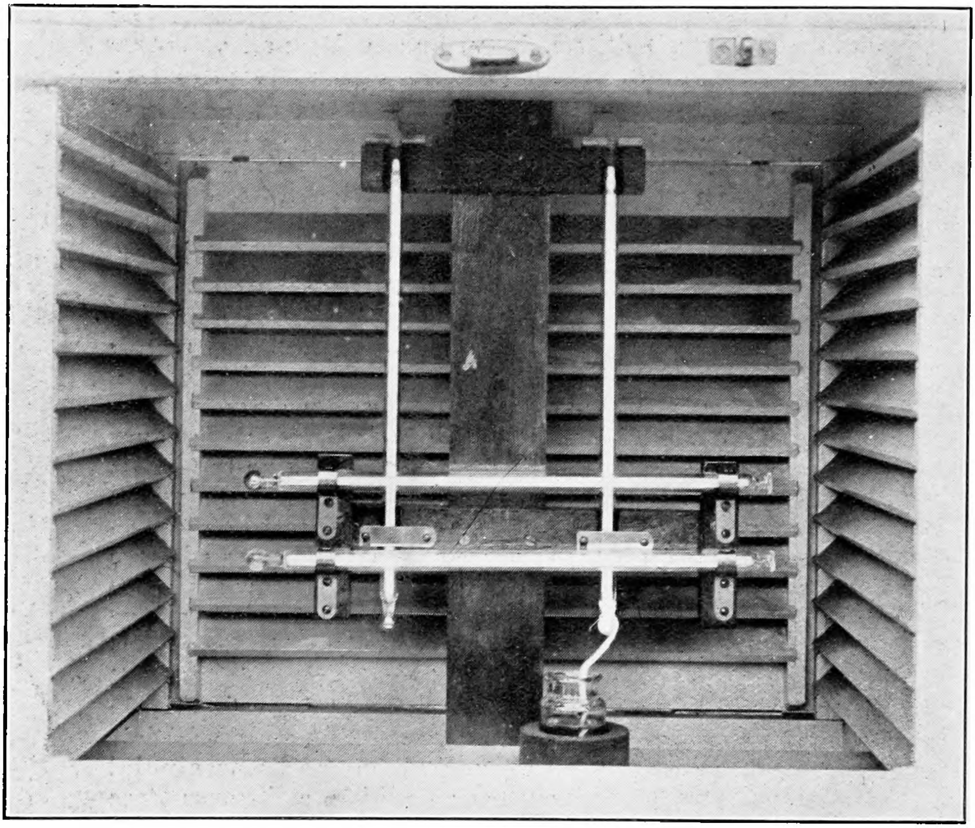
Errata: Loch Leven Sluice, January, for 3·48 \| 110 read 3·67 \| 116.

Climatological Table for the British Empire, September, 1933

STATIONS	PRESSURE Mean of Day M.S.L.	PRESSURE Diff. from Normal	TEMPERATURE Absolute Max.	TEMPERATURE Absolute Min.	TEMPERATURE Mean Values Max.	TEMPERATURE Mean Values Min.	TEMPERATURE Mean Values ½ max. and min.	TEMPERATURE Mean Values Diff. from Normal	TEMPERATURE Mean Wet Bulb	Relative Humidity	Mean Cloud Am'nt	PRECIPITATION Am'nt	PRECIPITATION Diff. from Normal	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F	°F.	%	0—10	in.	in.			
London, Kew Obsy.	1017·5	+ 0·1	79	42	68·9	53·8	61·3	+ 4·2	54·5	89	6·3	2·72	+ 0·85	12	6·3	50
Gibraltar	1015·6	— 1·6	86	56	79·8	65·2	72·5	+ 0·1	66·1	79	3·3	0·00	— 1·31	0	..	..
Malta	1017·9	+ 1·6	86	65	79·8	69·1	74·5	— 1·5	68·1	71	2·5	0·08	— 1·19	2	10·5	85
St. Helena	1015·2	— 0·3	62	53	59·4	54·0	56·7	— 0·7	54·8	95	9·8	1·11	..	16	..	..
Freetown, Sierra Leone	1014·7	+ 2·5	86	63	83·4	67·2	75·3	— 3·8	75·2	89	6·7	15·63	— 12·85	25	..	..
Lagos, Nigeria	1013·6	+ 1·4	87	69	83·0	74·1	78·5	— 0·2	74·4	88	9·4	5·49	— 0·10	12	4·1	34
Kaduna, Nigeria	1013·2	— 1·1	88	65	84·7	67·6	76·1	+ 0·8	71·1	87	7·7	10·94	— 0·56	21	6·1	50
Zomba, Nyasaland	1014·6	+ 0·9	90	50	78·0	57·6	67·8	— 1·7	57·9	49	4·2	0·21	— 0·13	3	..	..
Salisbury, Rhodesia	1016·4	+ 0·1	85	42	77·1	50·3	63·7	— 2·7	52·7	45	1·5	0·22	— 0·06	2	9·0	75
Cape Town	1021·0	+ 1·9	81	38	67·2	50·9	59·1	+ 1·2	52·0	79	4·9	1·22	— 1·02	9	..	..
Johannesburg	1017·3	+ 1·1	80	37	72·4	47·6	60·0	+ 0·6	47·8	47	1·7	0·38	— 0·58	1	10·0	84
Mauritius	1021·0	+ 0·8	79	56	74·7	62·6	68·6	— 1·5	63·3	67	7·1	1·79	+ 0·49	19	6·6	55
Calcutta, Alipore Obsy.	1004·4	— 0·1	93	76	88·4	78·4	83·4	+ 0·2	78·9	89	6·9	10·49	+ 0·48	16*	..	..
Bombay	1005·9	— 2·1	90	74	86·0	76·3	81·1	+ 0·2	76·4	86	6·2	12·31	+ 1·63	13*	..	..
Madras	1006·0	— 0·5	99	75	93·6	78·5	86·1	+ 0·9	76·0	70	7·6	1·20	— 3·65	5*	..	..
Colombo, Ceylon	1010·3	+ 0·4	84	73	83·2	76·5	79·9	— 1·3	76·3	81	7·5	4·13	— 0·63	19	5·8	48
Singapore	1009·4	— 0·4	92	69	87·0	73·8	80·4	— 0·7	76·6	80	6·6	6·03	— 0·76	18	5·9	49
Hongkong	1008·0	— 0·3	92	74	87·1	78·3	82·7	+ 1·7	76·7	76	6·0	12·58	+ 2·89	18	6·5	53
Sandakan	1009·5	..	92	72	88·4	74·5	81·5	— 0·2	76·7	82	7·6	10·81	+ 1·48	21	..	..
Sydney, N.S.W.	1017·9	+ 1·8	80	42	65·9	51·9	58·9	— 0·3	53·2	67	5·6	2·78	— 0·08	16	6·6	55
Melbourne	1017·9	+ 2·1	71	34	61·5	45·2	53·3	— 0·8	49·9	69	5·9	1·20	— 1·24	13	4·7	40
Adelaide	1018·6	+ 1·1	75	39	64·9	47·7	56·3	— 0·8	50·8	59	6·6	2·89	+ 0·84	16	5·4	46
Perth, W. Australia	1018·6	+ 0·6	87	44	68·6	50·4	59·5	+ 1·3	53·6	60	4·1	2·62	— 0·80	10	7·9	66
Coolgardie	1018·4	+ 1·3	89	38	70·8	45·7	58·3	— 0·4	51·6	56	3·3	0·38	— 0·29	5	..	..
Brisbane	1018·6	+ 1·0	80	45	72·9	56·2	64·5	— 0·7	58·9	64	5·6	4·27	+ 2·27	9	6·7	57
Hobart, Tasmania	1013·4	+ 2·4	69	37	59·8	44·8	52·3	+ 1·3	47·2	64	6·5	1·65	— 0·42	12	5·6	47
Wellington, N.Z.	1018·2	+ 3·6	65	37	56·1	45·1	50·6	— 1·0	47·6	74	6·2	2·97	— 1·00	14	6·4	54
Suva, Fiji	1015·5	+ 1·2	88	65	81·5	70·8	76·1	+ 1·6	70·7	76	7·6	1·53	— 6·16	19	4·8	40
Apia, Samoa	1012·5	+ 0·3	87	69	84·6	73·2	78·9	+ 0·7	75·9	76	5·5	10·70	+ 5·59	19	7·2	60
Kingston, Jamaica	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1012·8	— 5·0	90	39	71·8	53·7	62·7	+ 2·4	57·0	82	5·9	1·35	— 1·32	14	6·5	52
Winnipeg	1008·9	— 4·9	79	32	66·0	47·1	56·5	+ 2·8	47·5	89	4·5	2·69	+ 0·47	10	6·1	48
St. John, N.B.	1011·9	— 5·5	72	40	63·9	49·9	56·9	+ 1·0	52·9	85	7·2	5·44	+ 1·70	16	4·7	37
Victoria, B.C.	1012·0	— 4·4	68	40	60·2	48·3	54·3	— 1·8	51·6	89	7·1	2·86	+ 1·05	19	5·7	45

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

facing page 57



Glass Sheathed Thermometers in Screen (see page 68)

M.O. 371.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 69

April 1934

No. 819

LONDON: PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

Travel of Thunderstorms

The correspondence that has been received on this subject, following Dr. Sutcliffe's letter in the February issue of this magazine, indicates that popular and widespread notions exist that the tracks of storms are related to topographic features. These generally take the form either that the storms regularly follow a river or range of hills, or that they rarely cross a river or pass over a particular locality. It is almost impossible for single observers to determine the motion of a storm accurately; co-ordination of observations from many observers is essential, but this does not yet appear to have been done in this country in sufficient detail to determine the soundness of these popular beliefs, although it is to be hoped that the collection of observations by Mr. S. Morris Bower will soon enable the question to be settled. Nevertheless two or three conclusions, which have been brought out in the correspondence, emerge from general considerations. These are best stated in relation to the two main types of thunderstorms, which are (*a*) those which occur in association with a cold front or cold occlusion, and which usually move moderately fast; and (*b*) those due to local instability which form in a region of little or no pressure gradient and have no very definite movement. Concerning the (*a*) type of storms, the conclusions are (i) that they would not be much affected by minor topographical features; (ii) that the general air motion may cause the storms to move on the whole in a certain direction, and

(5925) 32/91 1.000 4/34 M. & S., Ltd. Gp.303

this direction sometimes happens to coincide with that of a river valley or a range of hills. Such a case is described by Mr. Kruisinga in a letter received too late for inclusion in the magazine for March; the general directions of storms, river and range of hills near Heerde, Holland, are all from south-west to north-east. (iii) At any place the number of storms which appear to be approaching is necessarily much greater than the number which pass overhead, whatever the neighbouring topography may be. The storms of type (*b*) are more difficult to deal with as their motion is so often irregular, but it appears (iv) that when they are diffuse it is not easy to determine the centre or its motion, and (v) that with these storms even minor surface features as affecting temperature and humidity probably help to determine which way a storm is going to move or spread, or where one is going to develop. Mr. Kruisinga invokes a down draught of air over a river to explain why such a storm should not cross it, but this introduces another popular belief which would require a separate investigation. However, the relatively low temperature of a large enough water surface might have some such effect.

The collection and investigation of observations on thunderstorms has been undertaken in great detail in Germany over a number of years by the Prussian Meteorological Office.* The publications contain numerous diagrams of individual storms, which show that they generally extend over a " front " of about 50 to 150 or more miles in length, and that the front advances across country irrespective of the topography, often with little or no deformation. Several such fronts may be propagated over the same parts of the country within a few hours. A particular investigation† on the localities where the fronts originate or disappear further discredited any suggestion of topographic influence. Attention may also be drawn to " The Rainfall of the British Isles,"‡ part of Ch. X of which is devoted to the distribution of thunderstorm rain; fig. 79 (reproduced from *British Rainfall*, 1918, p. 50), is a good example of storm tracks lying across England in narrow belts from south-west to north-east, regardless of hills or valleys.

In conclusion, it appears that while it is everywhere only too easy for misconceptions to arise, the beliefs at some places do bear some relation to the facts; but that usually this relationship is itself in the nature of a coincidence and throws no light on the connexion between natural features and thunderstorms. Topography on a sufficiently large scale may exert some influence on the motion or intensity of thunderstorms, but it is clear that hills of only a few hundred feet in height and rivers a few hundred feet in width can have very little effect on the majority of storms.

---

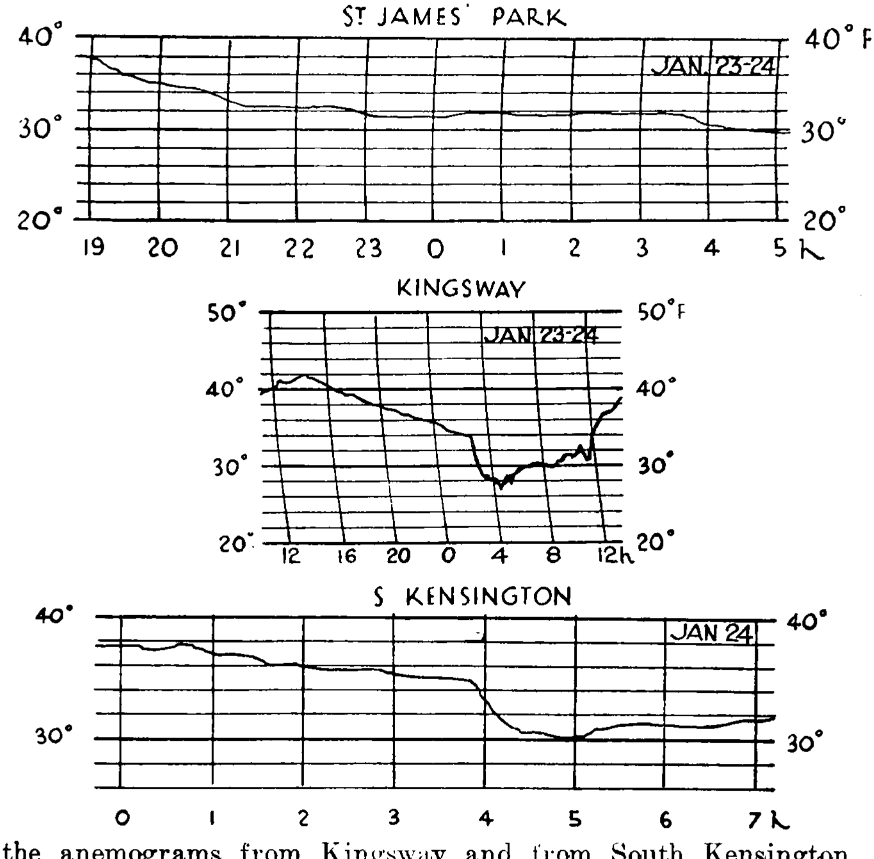
* K. Preuss. Meteor. Inst., Ergeb. Gewitterbeob., 1896-1921.

† loc. cit. 1908-9, p.8. ‡ by M. de C. S. Salter, London, Univ. Press, 1921.

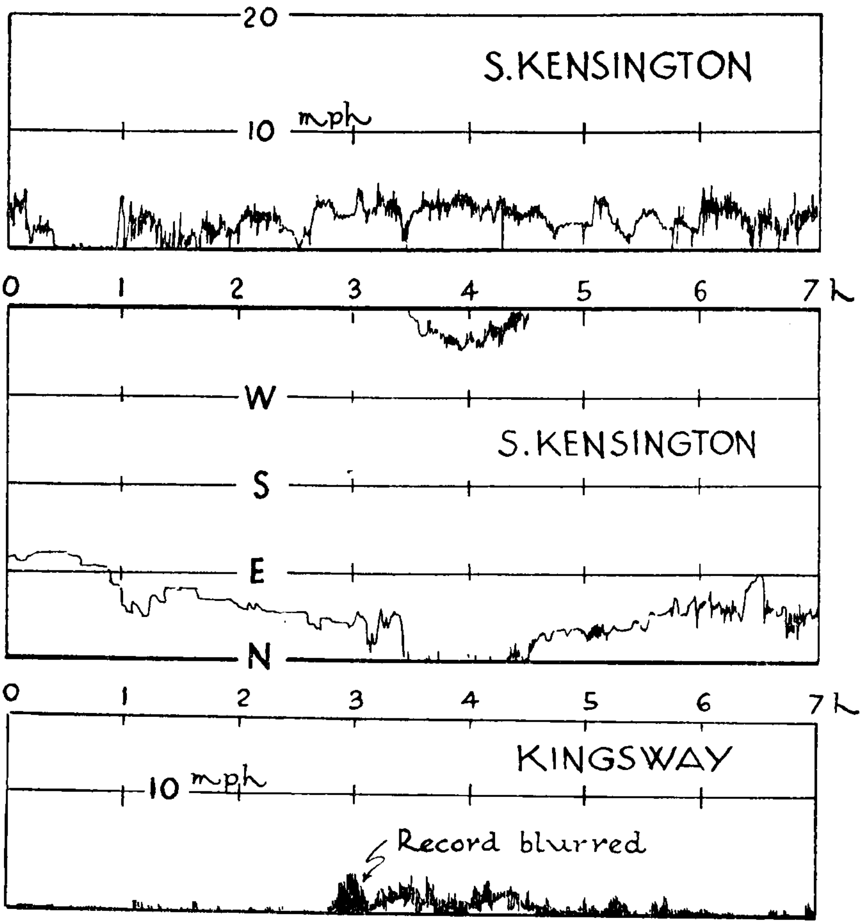
A sudden fall of Temperature at Kingsway. January 23rd-24th, 1934

During the night of January 23rd-24th, 1934, there occurred a very sharp fall of temperature in the thermograph record on the roof of the Air Ministry, Kingsway. Temperature fell a matter of 4°F. in about 10 minutes between 2h. 50m. and 3h. and a further 2° during the next 20 minutes. A fall of about 4° in half an hour occurred at South Kensington between 3h. 50m. and 4h 20m. but there was no such marked fall shown on the thermogram in St. James's Park.

The three thermograms are shown in the figure below and also



the anemograms from Kingsway and from South Kensington. The former of these anemograms shows that at the time when temperature began its abrupt fall puffs of air of two or three m.p.h. began to be felt (but it must be remembered that a Dines pressure tube anemometer does not record velocities with precise accuracy at such low speeds). These puffs went on till about 5h. 30m. and during that period there were small fluctuations of temperature after the main fall had occurred. At Kensington there was a light north-easterly drift up to 3h. 30m. but at that time the wind backed to north-north-west for the space of an hour, *i.e.*, while the temperature was falling abruptly. Inquiry was made of the forecaster on duty at Kingsway as to the conditions with regard to fog and he stated that, while he did not notice the exact time at which fog formed, he observed that at 2h. 30m. there was no fog while at 5h. 30m. it was thick enough to be visible streaming past the street lamps and at that



time the wind was from the north. At 7h. thick fog was recorded at Kew with visibility less than 220 yards but only mist at Croydon. A suggestion was made that the fall in temperature was due to the arrival of a slow moving mass of cold air but this suggestion would seem to be contradicted by the absence of the fall of temperature at the surface in St. James's Park. Another suggestion was that a sudden clearance of the sky occurred with rapid cooling by radiation. Again the St. James's Park thermogram seems to contradict this. The writer would, however, put forward the theory that it is due to a similar cause as that suggested to explain certain sudden falls of temperature at Cardington.* The explanation there given is that the fog drops at the upper surface of a fog are cooled by radiation and that as they are stirred up they cool higher and higher layers of the atmosphere, so that the sudden fall in temperature is due to the upward propagation of the fog surface. In the Cardington records it was seen that the fall was not abrupt at the surface but became more so with increase of height. The same phenomenon is also present in this case where there is no abrupt change at the surface in St. James's Park but the fall was abrupt at South Kensington 60 feet above the street level and even more so at Kingsway 90 feet above street level.

If this view is correct some explanation is necessary of (*a*) the change in wind direction at Kensington as the fall occurred, and (*b*) the upspringing of puffs of air at Kingsway. When cooling is occurring over the Kensington area there will be a tendency for the air to be canalised from Kensington Gardens along Exhibition Road, especially when the inversion is sharp; this would give a flow from north-north-west down the hill. As I picture it the inversion was confined to the surface of the fog, and hence when the inversion had risen well above the tops of the buildings, there was no longer the same tendency to canalisation and the wind once more returned to north-east. The puffs of wind at Kingsway may be due to a similar cause, but alternatively in conjunction with the thermal fluctuations between 3h. and 5h. 30m. it is possible that their explanation may be the formation of a cellular structure in the fog as I suggested in the article to which I have already referred.

C. S. Durst.

The prediction of minimum screen Temperatures at Larkhill on winter nights

By R. T. Andrews.

A demand for the issue of frost warnings from the Meteorological Office at Larkhill has led to the consideration of statistical methods for predicting night minimum temperatures. In the *Monthly Weather Review Supplement No.* 16 are given empirical formulæ which are used for this purpose at various stations in the United States. In this country formulæ have been given by W. H. Pick and others† which are applicable to Cranwell and Calshot. The formulæ used in the United States are discussed by Ellison‡ who is careful to point out that these formulæ are

*A Note on Radiation Fog. *Meteorological Magazine*, June, 1933, p. 108.

† W. H. Pick and J. Paton, *Meteorological Magazine*, February, 1928, p. 20, and W. H. Pick and D. F. Bowering, *Meteorological Magazine*, June, 1929, p. 114.

‡ E. S. Ellison, *Monthly Weather Review*, December, 1928.

only likely to be valid on level ground, the subsidence of cooled air on hill tops into the valleys complicating the phenomena in hilly country.

The station at Larkhill is situated on a ridge 440 feet high which runs from north-west to south-east. The ground falls away gradually to about 200 feet on the east side and 300 feet on the west. Owing to the undulatory character of the ground it was decided at the outset to abandon any attempt to construct a prediction formula, which *a priori* would be unlikely to hold good except on level ground. In place of the formulæ the construction of a table was proposed which would show for given temperature and humidity conditions at 15h., the probable fall of temperature during the night, provided that the sky would clear and that the wind strength during the night would be between certain limits. The 15h. observations were selected

TABLE I.

Mean difference between 15h. temperature and minimum screen temperature. Clear or partly clear nights—Larkhill, October to March, 1920-1933.

Temperature 15h.	25°—34°F.		35°—44°F.		45°—54°F.		55°—64°F.		>65°F.	
Wind Vel.(m.p.h.)	0—10	10—20	0—10	10—20	0—10	10—20	0—10	10—20	0—10	10—20
Rel. Hum. 15h.										
90—100%	12	...	10	9	11	12	...	...	...	...
80— 89%	11	10	13	10	14	9	12	...	...	...
70— 79%	14	7	15	11	16	13	19	13	...	...
60— 69%	12	10	14	13	17	16	19	15	21	...
50— 59%	14	11	16	12	18	17	20	...	20	...
40— 49%	...	...	16	18	19	20	29	21	24	...
30— 39%	...	...	...	...	20	15	26	27	28	...
20— 29%	...	...	...	...	...	...	26	...	...	...

because, in order to be of any practical utility the frost warnings had to be issued soon after 15h. The limits selected for wind strength were (i) 0-10 m.p.h. (ii) 10-20 m.p.h. In the use of such a table the temperature and humidity at 15h. would be known quantities, the unknown quantities which would have to be predicted being the state of sky during the night and the mean strength of the surface wind.

In order to construct this table observations were extracted on all occasions during the winter months October to March, 1920-33 when the sky cleared at any time between 15h. and 9h. No special significance was given to an occasion when frost actually occurred. In the first place a table was made of the temperature at 15h., the relative humidity at 15h., the night minimum temperature and the mean strength of the surface wind during the night. The next stage was to find the differences between the 15h. and night minimum temperature representing the fall in temperature during the night below the 15h. reading, and to group these differences for specified ranges of temperature and humidity. Two sets of groups were formed according to whether the mean strength of the wind during the night was below or above 10 m.p.h. Finally the mean of the values entered in each group was derived and the resulting table was of the form which it was sought to construct. This table is reproduced as Table I.

It is interesting to note that when the temperature at 15h. is between 35° and 44°F. the frequency of frosts with light winds is only very slightly greater, about 10 per cent., than with moderate winds.

The fall in temperature overnight must depend very largely on

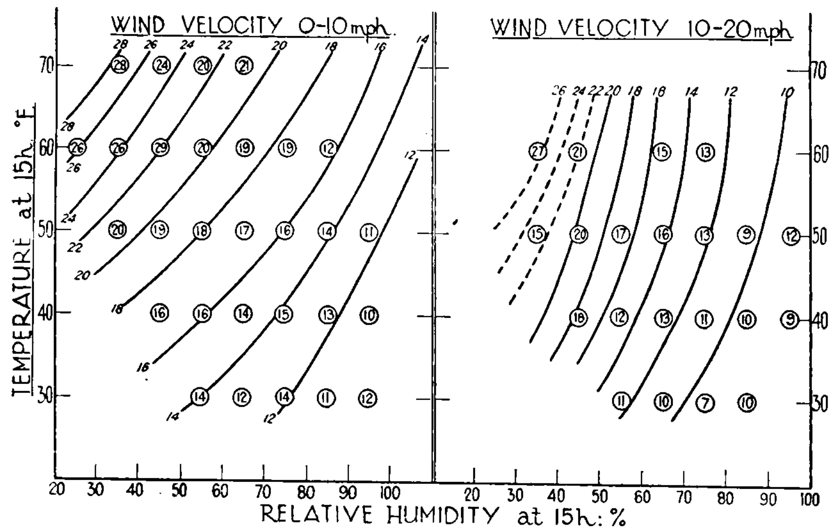


FIG. 1

the length of time for which the sky was cloudless. For the data which form the subject of this analysis it is known that the sky was free from cloud at some hour during the night but it is not known for how long the sky remained unclouded. In the one extreme case of a sky continuously free from cloud the fall of temperature will be greater than in the other extreme case when the sky cleared for only a short time. These considerations may be adduced in explanation at any rate in part, of the divergence of individual observations from the mean. A further contributory cause of scatter may be the subsidence of cooled air emphasised by Ellison. Subsidence may be expected to offset the effects of radiative cooling and the fall in temperature would therefore be diminished.

A more detailed investigation of those occasions when the fall in temperature is much greater than the mean has shown that it is associated with one or more of the following conditions.

(1) A neutral area between two anticyclones or between two shallow depressions.
(2) Clear sky both day and night.
(3) Clear sky at night with snow lying.
(4) Passage of cold front after 15h.

In Fig. 1 isopleths of the differences between the 15h. and night minimum temperature have been drawn in order to show the varying magnitude of the fall with temperature and humidity, for both light winds (0-10 m.p.h.) and moderate winds (10-20 m.p.h.). From the isopleth diagram for light winds it may be seen that the temperature and humidity are of nearly equal importance. For moderate winds the isopleths approximate more closely to the vertical thus showing that with appreciable turbulence humidity is of greater importance than temperature. In both sets of curves there is congestion for high values of temperature and low values of relative humidity.

In conclusion it may be added that the fall in temperature which has been utilised in the foregoing analysis is not greatly different from the diurnal range of temperature. Thus any conclusions which may be drawn from the data as to the variations of the difference between the 15h. and night minimum temperature may be applied without serious error to the diurnal range of temperature.

Correspondence

To the Editor, *The Meteorological Magazine.*

Summer Thunderstorms and Summer Time

The annual census of summer thunder in the British Isles is being continued between April 1st to September 30th of the present year. I shall again very much appreciate the valuable help of your readers in the work of observation. The main details required are the place, date and time of the occurrence of thunder, lightning or hail, with direction in which the lightning is seen, especially at night. In the case of actual thunderstorms additional information of the following character will be welcome:—

1. Time of first observation of thunder or lightning, with direction and estimated distance.
2. Time of commencement of very heavy rain or hail, or approximate time of nearest approach of storm, with direction and estimated distance.
3. Approximate time of final observation of thunder or lightning, with direction.
4. Severity of storm; changes in direction or strength of wind, change in temperature, &c., during the storm.

It is essential that the position from which the observation is made should be specified by mentioning the approximate distance and direction from a railway station or by the use of an observing station number.

After the clocks have been " advanced " on April 22nd, great care must be taken in regard to reporting times. The 24-hour clock to be introduced experimentally by the B.B.C. on April 22nd is based on British summer time, whereas the 24-hour clock in current meteorological use reads Greenwich mean time. Both systems have their zero-hours in the night. The practice has unfortunately grown up of assuming in many cases that a 24-hour clock reads G.M.T., and that a 12-hour clock employs B.S.T. It therefore becomes especially important that the identification letters B.S.T. or G.M.T., as the case may be, should be added on every record, and that a.m., or p.m., should also be included whenever a 12-hour clock has been used.

S. MORRIS BOWER.

Langley Terrace, Oakes, Huddersfield. March 29th, 1934.

A "Fireball"

I think I have read somewhere recently, or heard on the wireless, that anyone observing a " fireball " is invited to report it to the Meteorological Office.

We have just been having a sharp thunderstorm with much hail, lasting about ½ hour. At 10.7 p.m., I was watching the lightning from a north window and saw, immediately after a flash had blacked out, a ball (looking about the size one sees the moon) passing from west to east in a low arc—travelling relatively slowly (visible 1 second)—for a distance which I judge to have been perhaps 200 or 300 yards. The thing may have been ¼ mile away from me, or less, and below, because we stand on the ridge of a steep hill. It was not very luminous—not enough to light up anything, to fix its position; and very heavy hail was entirely blotting out the lights of the houses lower down the hill, so my estimate of ¼ mile away may be quite wrong. Its colour was yellow, whereas the lightning proper was conspicuously violet, and very intense.

E. M. WISHART.

92, *StewartonDrive, Cambuslang, Glasgow. March 5th*, 134.

A Rainbow in Cirro-Stratus

On the morning of March 24th last an optical phenomenon unique in the writer's experience was visible from this part of Hertfordshire. At 9h. the sky was flecked near the zenith with thin cirrus filaments moving rapidly southward, while to west and north-west a bank of cirro-stratus, or cirro-nebula, forming the advance-guard of a warm front which brought slight but steady rain 2½ hours later, had reached an elevation of about 15°. No medium or low cloud was within sight, though the valley in which the Rickmansworth climatological station is situated contained some dispersing ground-fog. Just after 9h. a faint, whitish arc, about 1½° wide, was noticed in the north-west, with its apex close to the top of the cirro-stratus pall. During the next few minutes this arc brightened considerably, and at the same time developed a reddish-brown tinge at both outer and inner margins. Measurements made with a prismatic clinometer-compass at 9h. 10m. left no room for doubt that the phenomenon was actually some species of rainbow. The angles subtended by arc and sun agreed, as nearly as could be determined, with those demanded by theory. That the bow was not a product of the ground-fog rather than of the cirro-stratus was ascertained from another series of observations made at 9h. 20m. on a neighbouring hill-side, where the atmosphere was quite clear. Towards 9h. 30m. the spectacle suddenly faded.

In the "Meteorological Glossary," 2nd edition, s.v. Clouds, it is written: "there are certain very delicate forms of cirrus and cirro-stratus (with no long threads) which may cause brilliant coronæ and iridescence, and probably consist of very small spherical globules, and not of ice crystals." It seems necessary to infer that the cirriform clouds which gave rise to the phenomenon just described were of some such type. The absence of the normal spectrum colours can be explained on the assumption that the super-cooled water droplets which generated the arc were, as in the case of a fog-bow, of the order of only 0.05 mm. in diameter. Even if the cirro-stratus mass under discussion was at no greater altitude than 25,000 ft., the bow seen on it must have been at a distance of fully 20 miles from the point of observation.

E. L. HAWKE.

Caenwood, Rickmansworth, Herts. March 27th, 1934.

Austausch

In preparing a paper recently, I have had occasion to look for a complete English equivalent of the German word *Austausch.* This word, in its full form *Massenaustausch* was, I believe, introduced into continental meteorological literature by Dr. Wilhelm Schmidt, and it has certainly proved a boon in a language in which, generally speaking, brevity and learning do not often go hand in hand. When the German meteorologist talks of "Austausch in der bodennahen Luftschicht," for example, he means a consideration of the processes which give rise to our three terms "eddy conductivity, eddy viscosity, and eddy diffusivity." To replace *Austausch* by its literal equivalent "exchange" seems to me hardly to be recommended in view of the limited meaning which the noun "exchange" has in ordinary usage. The only other word that suggests itself at the moment is "interchange," but this is hardly a happy alternative. Finally there is a suggestion that meteorologists should take the word *Austausch* into the English language much in the same way as the mathematical physicist has recently adopted *Eigenwerte.* We should then have a single word specifying that aspect of turbulent motion which gives rise to the transfer of heat, momentum or mass from one layer of the atmosphere to another.

It seems to me that the need is a real one. In continental literature, I believe I am right in saying that *Austausch* is a sufficiently general term to indicate that the writer is not thinking of the transfer of any specific entity or of any particular theory or model of the eddy structure of the atmosphere. There is no such single word in English, unless it be Dr. Richardson's "turbilivity," but this does not appear to have passed into general use, and in any case, refers to the coefficient of eddy conductivity, viscosity or diffusivity and not to the whole process itself.

It would be of interest to have the opinion of those who are better qualified than myself to discuss this matter of the formation of the technical terms of a young science.

O. G. Sutton.

W.D. Experimental Station, Porton, Wilts. March 25th, 1934.

A Disregarded Condition for Dew and Hoar-frost

It is remarkable that in nearly all text-books it is virtually implied that the deposited moisture which we call dew and hoar-frost (as distinct from fog-drip and rime) results only through nocturnal cooling by radiation in clear, calm weather. But the formation of dew and hoar-frost in cloudy weather when a damp wind comes in contact with cold ground is not at all uncommon even in lowland country, and among mountains is of great meteorological importance. We are familiar with the "sweating" of London pavements in cloudy winter weather when no rain or drizzle has fallen, and I remember a case of hoar-frost being similarly formed one evening during the cold December of 1925 when a damp SW. wind sprang up.

In one of the late Canon Rawnsley's vivid Lake Country sketches he describes how when the death-like stillness of intense cold was reigning on the high fells the springing up of a damp wind off the Irish Sea caused the mountain sides to become virtually snow-clad though no flakes were in the air and there was no mist to deposit rime. Similarly huge spears of hoar-frost forming on projecting rocks have been observed at mountain observatories like Ben Nevis and Mount Fanaraken in Norway. As regards the latter mountain, H. W. Ahlmann refers to huge " snow-drifts " in the vicinity of the observatory that have consisted almost entirely of hoar-frost which he considers plays a much more important part than actual snowfall in the nourishing of the glaciers of the Horunz Massif in Jotunheim. In this estimate, however, he says nothing about rime which is technically distinguished from hoar-frost as frozen fog-drip. At any rate there can be no doubt that deposited moisture is an important feature in mountainous regions, and one wonders to what extent it swells the big precipitation figures in the rainy upland districts of Great Britain.

L. C. W. BONACINA.

35, *Parliament Hill, London, N.W.*3. *March* 3*rd*, 1934.

NOTES AND QUERIES

Sheathed Thermometers

For some time past the Meteorological Office has adopted thermometers in which the stem is protected by a glass sheath instead of by a porcelain or wooden mount for use in Stevenson screens. A set of these thermometers, comprising dry and wet bulbs, maximum and minimum, mounted in a screen, is shown in the accompanying illustration.

Long experience with the thermometers of the older pattern had brought to light certain defects in their design. In order that the scales of the dry and wet bulb thermometers should be visible over the range of temperature likely to be experienced, the maximum and minimum thermometers which are placed in front of them in the screen had, owing to their large mounts, to be spaced far apart, the one near the top and the other near the bottom of the screen. Such an arrangement left much to be desired. There exists some evidence of a temperature gradient within the screen which renders it desirable that the bulbs of the four thermometers should be placed as close together as possible.

It was during the discussion of these and kindred problems that, in 1927, the idea occurred to Colonel E. Gold, F.R.S., of making the maximum, minimum and dry and wet bulb thermometers similar in pattern to the grass minimum thermometer by protecting their stems with a glass sheath and so doing away with their several mounts. This change was beneficial also in another way in that the trouble which so frequently arises from the black coming out of the stem markings owing to " weathering " on the old thermometers was overcome. It was this defect that, about 90 years ago, led G. Leach to surround stems of his thermometers with a glass tube sealed with cork and 30 years later caused G. Symons to suggest the use of a glass sheath fused to the stem.

Extensive trials of the new sheathed thermometers were made from 1928 to 1930 during which time a suitable support for mounting them in the screen was devised. The results of the tests proved satisfactory and warranted making this type of thermometer standard for official use at land stations, where they have been adopted since 1931. A further advantage accrued in that the grass minimum thermometer no longer needed to differ from the screen minimum, one pattern of instrument serving for both purposes.

In addition to preserving the black in the stem graduations and to ensuring that in the screen none of the graduations of the dry and wet bulb thermometers are hidden, both of which factors contribute to the accuracy of temperature observations, other advantages arising from the use of these sheathed thermometers may be mentioned. No longer does there exist the danger when reading a thermometer of a large error due to the stem working loose in the mount and becoming displaced. Glass, unlike wood and porcelain, does not deteriorate with age and it is easy to clean. As a result the appearance of the thermometers and the legibility of their scales are preserved. The small width of the sheath also allows the bulbs of the maximum, minimum and dry bulb thermometers to be situated near to each other as will be apparent in the illustration which forms the frontispiece of this number of the magazine.

Sheathed thermometers have, in spite of their apparent fragility, proved to be eminently satisfactory and have fully justified the decision of the Meteorological Office to adopt them as the standard pattern for use in the Stevenson screen.

The late Mr. W. Pilkington, M.P.S.

We regret to record the death on March 12th, 1934, of Mr. W. Pilkington, Borough Meteorologist of Buxton from 1899 to 1923. Mr. Pilkington was born in Buxton in February, 1868, and spent most of his life in his native town. He qualified as a chemist and druggist in 1889 and immediately afterwards opened the business in the Market Place which is still carried on by his son. He was always specially interested in meteorology, and after his retirement in December, 1923, when his daughter, Miss E. W. Pilkington, M.P.S., succeeded him as Borough Meteorologist, he continued to act as deputy observer.

Besides being a keen and able meteorologist Mr. Pilkington had a strong sense of humour, and he tried to brighten " dull " days by displaying in the window of his chemist's shop a local daily weather forecast couched in humorous language, which gained for him a fame extending far beyond the limits of his own town. His daughter, Miss E. W. Pilkington, has carried on this tradition "of enlivening the dullest day." By a curious coincidence our attention was drawn to these forecasts quite recently by Mr. H. Everard, and a typical example was printed in the February, 1934, number of this magazine. The following report refers to Saturday, April 29th, 1933, the day of the Cup Final at Wembley:—

BUXTON WEATHER PROSPECTS.

(Local Meteorological Forecast.)

Date: Saturday, April 29th 1933. Sun Rises, 5.37 a.m.
Sun Sets, 8.19 p.m.
Buxton Time 7.6 minutes later.

Temperature.—A fairly big party of therms has left this district, en route to Wembley.

Pressure.—Playing steadily, without rushing up or down the field.

Rainfall.—Is likely to score several goals during the day.

Winds.—Supporters are arriving from all quarters.

Current Notes.—A depression from the Hebrides and an anticyclone from Greenland are the opposing teams.

Further Outlook.—Neither side gains a complete victory even after extra time.

Propitious Features.—The steady playing of the pressure.

Ominous Symptoms.—Captained by the winds.

TO-DAY'S LOCAL WEATHER HANDICAP.

Maximum Points For or Against.		+	–
10	Pressure: Unmoved	4	0
3	Humidity: Rising	0	1
8	Winds: Variable; moderate	1	3
5	Local Trend: Full of interest	2	1
5	Distant Influences: The struggle is not yet over	2	1
		+9	–6
	Points in favour ...	3	

Inference—All the players, sun, rain and wind, give a good account of themselves during the week-end; clouds referee throughout the match; the destination of the Cup will be in doubt until the last.

Shortly before his death Mr. Pilkington perfected and patented an ingenious weather forecaster, a specimen of which has been forwarded to us by Miss Pilkington. By means of a number of concentric rotatable discs "handicap values," for or against fine weather, due to barometric pressure, wind direction and barometric change, are read off. From the resultant figure the forecast is ascertained by reference to a table. The "forecaster" is obviously the result of a thorough analysis of statistics and seems likely to yield a high percentage of successes. It is being placed in the museum in the Meteorological Office Library.

Tornado at Carbis Bay, Cornwall

The following account of a small tornado is abridged from one given in the *Cornish Post and Mining News*, which was forwarded to the Meteorological Office by Mr. E. W. Newton. The tornado appeared at Carbis Bay, near St. Ives, a few minutes before 8h. on Saturday, January 13th, 1934. Its track lay down a valley, but at one point it turned and retraced its path for about 100 yards and then resumed its original direction. In its passage it carried with it what is described as a swirling mass of tree branches, stones and corrugated iron, which were tossed about in the air with amazing force. The branches of trees were caught up and screwed around the trunk, and huts were wrenched off their foundations. At one house the tiles were stripped off the roof, one of them being found about a hundred yards away; the chimney was carried away and panes of glass were smashed. A spectator having first noticed a "loud rushing sound, as if it were hailing," then saw "a large black mass like a dark cloud, twice the size of a house, and in the shape of an inverted cone. As it approached, branches of trees and large stones were seen swirling around in the midst of it. They were spinning around at the top, and then would fall towards the ground, only to be caught up again and sent whirling to the top." It was preceded by heavy rain, but it is not stated whether rain fell within the limits of the tornado.

Similar miniature tornadoes have occurred previously in the British Isles, and descriptions of two of these, the south Wales tornado of October 27th, 1913, and the London tornado of October 22nd, 1928, have been published in this magazine (February, 1914, and November, 1928, respectively). On the occasion of the present one the pressure situation at 7h. was characterised by a deep depression centred between Iceland and Scotland (Thorshavn 965 mb.) with a gradient for moderate to strong west-south-westerly winds over the British Isles. A small secondary was indicated to the south-south-west of Ireland and this subsequently developed and moved east-north--east. The place of occurrence of this and previous English tornadoes resembles that of the violent tornadoes of the United States, which develop in the south-east quadrant of large depressions.

Reviews

Pilot Balloon Observations at Mauritius. By R. A. Watson, B.A., and N. R. McCurdy, B.Sc. *The Cyclone Season* 1929-1930 *at Mauritius.* By R. A. Watson, B.A., and N. R. McCurdy, B.Sc., and *The Cyclone Season* 1930-31 *at Mauritius.* By M. Herschenroder, B.Sc., Royal Alfred Observatory, Mauritius, Publications Nos. 11, 12 and 13.

Publications Nos. 12 and 13 deal with the " cyclone seasons " of 1929-30 and 1930-1 at Mauritius, and are on similar lines to Publications Nos. 7 and 10 (1927-8 and 1928-9) which have previously been reviewed in this magazine.

During the season 1929-30, which is stated to have been anomalous in the complexity of its daily weather maps, numerous " lows " were observed of considerable depth but not vigorous enough to be classed as tropical cyclones, and some difficulty was experienced in deciding which of the disturbances should be included in the statistics of cyclones. The cyclone of September 23rd-27th, 1929, formed nearer the equator than usual and filled up in lat. 10° S.; it is only the second September cyclone in 119 years.

The season of 1930-1 was on the whole less disturbed, six cyclones being recorded, but the cyclone of March 3rd-9th, 1931, so far as the Observatory records go, was second in intensity only to the historic storm of April, 1892. The data and charts given in these memoirs will be found useful by those who are interested in the problem of the cyclonic storm.

In Publication No. 11, Part I, is given the results of observations in the period July, 1928, to December, 1929, and also these results combined with earlier work into frequency tables of velocity and direction of wind at various altitudes.

The structure disclosed of the atmosphere between the ground and 8,000 metres is briefly :—

(*a*) A surface layer of light to moderate easterly winds.

(*b*) A layer of light and rather indefinite winds.

(*c*) A layer of moderate to strong westerly winds.

At all levels the winds are stronger in mid-winter. In the lowest layer there is a considerable southerly component in mid-winter and a small northerly component in mid-summer, layer (*b*) extends in mid-winter between 2,000 and 3,000 metres, but in mid-summer between 2,500 and 6,000 metres. These statements refer to average conditions and individual cases may differ considerably.

In Part II a discussion of the results is given. By differentiating the ordinary hypsometric equation and introducing various assumptions the authors derive a formula for the height at which occurs the separation between lower easterly and upper westerly winds, between about 5° and 20° of latitude. (The authors consider that in practice the ordinary geostrophic wind formula may be used to 5° latitude) and the agreement between theory and observation appears fairly good. The number of places remote from large masses of land, at which upper wind observations have been made is, however, small. A study has also been made of the temperature gradients at various levels as calculated from individual ascents. This is regarded as a promising line of investigation.

This work is a praiseworthy attempt to give something beyond the usual bare tables of figures associated with so many year-books and similar publications.

S. T. A. MIRRLEES.

Solar Radiation. By C. G. Abbott, Washington, D.C., Smiths. Rep., 1932, pp. 107-20; and *Sunspots and Weather*, by C. G. Abbot, Washington, D.C., Smiths. Misc. Coll., Vol. 87, No. 18, 1933, pp. 1-10.

In these two short papers Dr. Abbot continues his account of his investigation of solar radiation and its relation to terrestrial weather. The first gives a general description of the solar radiation, its constitution and periodicities, and its effects on terrestrial weather and plant growth.

The second paper deals in greater detail with solar and terrestrial periodicities. The author finds that changes of phase and amplitude in short weather cycles are related to the number of sunspots, the phase of the 11-month temperature cycle at Bismarck, North Dakota, being five months later when spots are few than when they are numerous. Cycles of solar radiation, and many weather cycles, are sub-multiples of the double sunspot cycle to which a length of exactly 23 years is assigned. This cycle is also found in the annual layers of glacial clay deposited at the end of the Quaternary Ice Age. Finally a brief reference is given to weather forecasting by the aid of solar variations.

Books Received

Thunderstorms in the Peninsula during the premonsoon months April and May. By S. P. Venkiteswaran, B.A., India Meteor. Dept., Sci. Notes, Vol. iv, No. 44. Calcutta, 1932.

Obituary

Dr. J. P. Van der Stok.—We regret to learn of the death of Dr. Van der Stok, which occurred on March 29th last. Dr. Van der Stok was born at Zuylen near Utrecht, on January 14th, 1851, and was educated at the University of Utrecht, receiving the degree of doctor in 1874. Shortly afterwards he was appointed Vice-Director of the Batavia Observatory and was sent to Kew Observatory to study the photographically recording instruments there before he proceeded to Batavia in 1877, taking with him a number of these instruments. On the retirement of Dr. P. A. Bergsma in 1882, Dr. Van der Stok was appointed Director. In 1899 he returned to Holland and until his retirement in 1923 he was Director of the Section of Oceanography and Marine Meteorology in the Netherlands Royal Meteorological Institute. He was the author of numerous papers, especially on the subjects of climatology and marine meteorology.

The Rev. Walter Edward Stewart, M.A.—We regret to learn of the death of the Rev. W. E. Stewart, on January 24th, 1934, in his 76th year. Mr. Stewart had forwarded for inclusion in *British Rainfall* rainfall records covering 43 years, from Oundle, Northants, 1866, Hurworth, near Darlington, 1890 to 1903, Longney to the south-west of Gloucester, 1905 to 1911, and Scalby, near Scarborough, 1912 to 1933. In three cases the records were sufficiently long to enable estimates of the average annual rainfall in those localities to be made. From 1887 to 1904 Mr. Stewart was Vicar of Eryholme, and by his efforts the fine little Norman Church was restored. From 1904 to 1912 he was Vicar of Longney, where, as at Eryholme, he won the hearts of the people by his kindliness and consideration. Owing to ill-health, Mr. Stewart retired in 1912 to St. Phillips, Scalby, near Scarborough, where he continued the rainfall record.

News in Brief

The Council of the Royal Society of Edinburgh has awarded the Keith prize for the period 1931-3 to Dr. A. Crichton Mitchell for his paper on "The diurnal incidence of disturbance in the terrestrial magnetic field."

We learn from *Nature* that a conference is to be held in Leningrad in April at which the study of the stratosphere is to be discussed.

Corrigendum

With the issue of the Piccard balloon stamps described in the March number of this magazine p. 30, there should have been mentioned also one for 2f. 50c. in violet.

The Weather of March, 1934

Pressure was above normal over most of North America and across the North Atlantic to Portugal and north-west Africa and also over northern Scandinavia and Russia, the greatest excesses being 5·2 mb. at 50° N., 120° W., 10·8 mb. at 40° N., 40° W., and 11·9 mb. at Waigatsch. Pressure was below normal over Baffin Land, Greenland, Spitsbergen, Iceland and the rest of Europe, the greatest deficit being 8.1 mb. at Jan Mayen.

Temperature was above normal in Spitsbergen, Scandinavia and central Europe, being as much as 23·9° F. above normal at Spitsbergen, but below normal in south-west Europe. Rainfall was considerably above normal in Svealand, but about normal elsewhere in Sweden.

The weather of the British Isles during March was generally unsettled with gales during the middle of the month and an excess of rainfall in most districts but a deficiency in parts of Scotland and north-west England. Pressure was considerably below normal while sunshine was much above normal in north Scotland but below normal in the south of England. From the 1st to 9th the British Isles were under the influence of troughs secondaries associated with low pressure systems passing to the north of these islands and from then until the 22nd complex depressions passed directly across the country. As a result unsettled weather was experienced in all ditricts with many bright periods but also periods of continuous rain or drizzle and showers of snow, sleet or hail. Thunderstorms were experienced in Scotland on the 3rd, in Scotland and the Midlands on the 5th and 10th, in south and east England on the 15th and in north Ireland on the 17th, while gales prevailed in various parts from the 11th to 19th reaching Beaufort force " 9 " at Inchkeith on the 12th and 13th. The heaviest rainfall occurred on the 11th, 12th, 14th, 16th and 17th, 1·58 in. being measured at Blaenau-hydfer, Brecon, on the 17th, 1·53 in. at Borrowdale, Cumberland, on the 16th, and 1·43 in. at Eggleston, Durham, on the 11th. There were, however, many intervals of fair to fine conditions, particularly so on the 3rd, 7th, 9th (in south only), 18th, 19th (in Scotland) and 21st (except in the south), 9·9 hrs. bright sunshine occurred at Ross-on-Wye and Plymouth on the 3rd, 10·1 hrs. at Oxford on the 7th, at Inverness and Nairn on the 19th and at Inchkeith and Leuchars on the 21st. Frosts occurred locally at times, among the lowest readings recorded being 12° F. in the screen and 5° F. on the ground at Rhayader on the 1st, and 14° F. in the screen and 7° F. on the ground at Dalwhinnie on the 14th. Mist or fog occurred locally in England from the 1st to 14th and again on the 21st and 22nd. From the 23rd to 26th pressure was high to the south but troughs of low pressure passed across the country so that the fair weather was interrupted by periods of rain or drizzle. Day temperatures rose above normal during this period, 61° F. being recorded at Dundee on the 24th and at Collumpton on the 25th, while several places in Scotland and the Midlands also reached 60° F. on the 24th and 25th. On the 27th and 28th under the influence of an anticyclone which had spread in from the Atlantic fine conditions prevailed though day temperatures were lower and over 10 hrs. bright sunshine was enjoyed at many places, 11·5 hrs. at Aberystwyth and Morecambe on the 27th, and 11·6 hrs. at Armagh on the 28th. From the 29th to the end of the month pressure was high to the north-east and low to the south and west with mainly cloudy to dull weather and day temperatures below normal. On the 31st brighter conditions prevailed though the temperature still remained low. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	146	+41	Liverpool	95	— 9
Aberdeen	142	+35	Ross-on-Wye	112	+ 4
Dublin	..	..	Falmouth	113	—22
Birr Castle	118	+ 8	Gorleston	130	+ 7
Valentia	117	+ 2	Kew	110	+ 7

The special message from Brazil states that the rainfall in the northern regions was abundant with 3·50 in. above normal but scarce in the central and southern regions with 2·16 in. and 1·73 in. below normal respectively. Five anticyclones passed across the country and several depressions, while high winds were experienced in the south. The crops were generally in good condition owing to favourable weather conditions. At Rio de Janeiro pressure was 1·2 mb. above normal and temperature 0·4° F. above normal.

Miscellaneous notes on weather abroad culled from various sources.

The snowfall in Switzerland during the 11th to 13th was said to be the heaviest of this winter; in the Engadine about 4 ft. fell, but in the western regions the average fall was about 2 ft. making ski-ing conditions again good generally. Bad weather prevailed in north and central Italy on the 12th and 13th; high seas caused extensive damage along the Italian Riviera and three people were killed at Savona, whilst the Arno overflowed its banks. A violent storm accompanied by hail swept the province of Brabant, Belgium, on the 17th and much damage was done; after the storm rain continued to fall until the 20th. (*The Times*, March 3rd-21st.)

A strong gale caused a fire which had started in Hakodate, Japan, at 7 p.m. on the 21st to spread throughout most of the city—700 people were killed. After the gale subsided, sleet began to fall and then heavy snow. (*The Times*, March 23rd.)

Severe bush fires occurred in South Australia during the early part of the month, but by the 11th they were under control. A heat wave passed across South Australia from about the 3rd to 11th, 110·5° F. is said to have been recorded in Adelaide on the 9th which is the highest temperature ever recorded there in March. Thick fog occurred at Sydney on the 9th and 16th. (*The Times*, March 10th-12th.)

A thaw set in in eastern Canada about the 4th, but on the 20th from Saskatchewan eastwards Canada was in the group of another cold spell. A tornado struck New Orleans soon after

8 a.m. on the 26th and many people were injured. Temperature was below normal generally in the eastern United States, but above normal along the Pacific coast and in the Mountain Region, while precipitation was mainly deficient along the Pacific coast but irregular in distribution elsewhere. (*The Times*, March 5th-27th, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Severe gales were experienced frequently on the North Atlantic between the 8th and 22nd and much fog occurred off Nova Scotia. (*The Times*, March 6th-23rd.)

Daily Readings at Kew Observatory, March, 1934

Date	Pressure, M.S.L. 13h	Wind, Dir., Force 13h	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain	Sun	REMARKS (see p. 1)
	mb.		°F	°F	%	in.	hrs.	
1	1012·9	ENE.2	31	44	68	—	4·5	ps_0 early. f 14h.-20h.
2	1012·7	SW.3	28	47	70	0·09	1·1	r_0-r 15h.30m-21h.
3	1022·1	NW.3	34	48	46	—	7·8	x early
4	1025·5	W.3	32	48	67	—	4·1	ir_0 2h.-4h. ; 18h.
5	1009·1	SW.2	42	51	89	0·09	2·8	r-r_0 5h-12h.
6	1000·0	Calm	39	46	87	0·28	0·1	r-r_0 11h.-17h.
7	1007·9	WNW.3	33	48	49	—	8·8	x early
8	1013·5	WSW.3	31	49	52	—	3·9	x early
9	1007·6	E.3	30	50	45	—	4·9	x f to 11h.
10	998·3	SW.3	39	52	63	0·11	4·9	r early ; prh 14h.30m.
11	981·4	SSW.3	43	49	83	0·11	1·2	r-r_0 morning
12	977·5	Calm	39	46	76	0·46	0·2	ir 2h.-10h. ; ir_0 21h.
13	992·3	WNW.2	38	47	81	0·10	0·0	r-$r_0$9h.-13h.&21h.-23h.
14	988·6	S.4	38	45	68	0·39	0·1	rh.-5h. & 8h.
15	980·9	WSW.4	38	48	81	0·08	5·4	prhrstl 12h.-15h.
16	991·0	SW.4	37	49	54	0·11	5·5	r17h.-22h.
17	976·6	S.3	37	47	69	0·01	3·0	pr13h.30m.
18	992·7	W.4	36	48	55	—	8·6	
19	990·9	SSE.4	35	49	90	0·08	1·1	r-r_0 8h.-13h.
20	998·2	N.2	42	48	87	0·17	0·0	r-$r_0$3h.-8h.&13h.-19h.
21	1014·4	NW.3	41	46	83	—	0·2	
22	1015·4	W.2	30	48	54	—	5·0	F till 9h.30m.
23	1021·9	W.2	32	50	63	—	2·6	F till 11h.30m.
24	1022·9	SW.2	31	51	73	0·04	1·4	fx early ; r 12h.-14h.
25	1028·8	NNE.2	46	57	45	trace	7·2	r_0 0h.-2h.
26	1021·7	S.2	36	53	84	—	3·7	f 2h.-10h.
27	1024·3	NNE.4	44	53	57	—	3·7	
28	1018·4	E.5	38	49	44	—	9·3	
29	1012·1	NE.3	39	46	55	—	0·4	d_0 9h.
30	1009·9	E.3	36	49	50	—	1·7	
31	1015·5	ENE.4	35	49	56	—	7·2	

General Rainfall for March 1934

England and Wales ...	110	per cent of the average 1881-1915.
Scotland	97	
Ireland	114	
British Isles	108	

Rainfall: March, 1934: England and Wales.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	1·96	107	*Leics.* .	Thornton Reservoir ...	2·03	110
Sur .	Reigate, Wray Pk. Rd.	2·66	114	,, .	Belvoir Castle...........	1·86	103
Kent .	Tenterden, Ashenden...	2·96	138	*Rut* .	Ridlington	1·67	96
,, .	Folkestone, Boro. San .	2·97	...	*Lincs* .	Boston, Skirbeck	1·87	120
,, .	Eden'bdg., Falconhurst	2·75	111	,, .	Cranwell Aerodrome ...	2·05	146
,, .	Sevenoaks, Speldhurst	2·12	...	,, .	Skegness, Marine Gdns	1·40	84
Sus .	Compton, Compton Ho.	3·22	116	,, .	Louth, Westgate	2·32	109
,, .	Patching Farm	2·47	115	,, .	Brigg, Wrawby St. ...	1·39	...
,, .	Eastbourne, Wil. Sq.	2·93	130	*Notts* .	Worksop, Hodsock ...	2·62	155
,, .	Heathfield, Barklye ...	3·31	132	*Derby* .	Derby, L. M. & S. Rly.	1·57	91
Hants .	Ventnor, Roy. Nat. Hos.	2·76	135	,, .	Buxton, Terr. Slopes	4·12	100
,, .	Fordingbridge, Oaklnds	3·42	147	*Ches* .	Runcorn, Weston Pt...	1·97	97
,, .	Ovington Rectory	4·08	157	*Lancs* .	Manchester, Whit. Pk.	2·22	98
,, .	Sherborne St. John ...	2·48	111	,, .	Stonyhurst College ...	2·47	67
Herts .	Welwyn Garden City...	1·99	110	,, .	Southport, Hesketh Pk	1·55	70
Bucks .	Slough, Upton	2·14	122	,, .	Lancaster, Greg Obsy.	2·16	68
,, .	H. Wycombe, Flackwell	2·22	110	*Yorks* .	Wath-upon-Dearne ...	1·75	100
Oxf .	Oxford, Mag. College...	1·62	106	,, .	Wakefield, Clarence Pk.	1·72	96
Nor .	Pitsford, Sedgebrook...	1·55	88	,, .	Oughtershaw Hall......	5·11	...
,, .	Oundle.....................	1·13	...	,, .	Wetherby, Ribston H.	2·45	126
Beds .	Woburn, Exptl. Farm..	1·53	89	,, .	Hull, Pearson Park ...	1·76	97
Cam .	Cambridge, Bot. Gdns.	1·09	74	,, .	Holme-on-Spalding ...	1·94	107
Essex .	Chelmsford, County Lab	2·09	121	,, .	West Witton, Ivy Ho.	4·80	155
,, .	Lexden Hill House ...	1·89	...	,, .	Felixkirk, Mt. St. John	2·47	125
Suff .	Haughley House.........	1·64	...	,, .	York, Museum Gdns.	1·95	116
,, .	Campsea Ashe...........	2·20	131	,, .	Pickering, Hungate ...	2·64	133
,, .	Lowestoft Sec. School	1·58	98	,, .	Scarborough	1·99	111
,, .	Bury St.Ed., Westley H.	2·16	114	,, .	Middlesbrough	1·43	91
Norf .	Wells, Holkham Hall	1·83	112	,, .	Baldersdale, Hury Res.	3·70	119
Wilts .	Calne, Castleway	2·23	104	*Durh* .	Ushaw College	3·79	172
,, .	Porton, W.D. Exp'l. Stn	3·26	165	*Nor* .	Newcastle, Town Moor	3·08	146
Dor .	Evershot, Melbury Ho.	3·44	115	,, .	Bellingham, Highgreen	4·50	153
,, .	Weymouth, Westham .	2·43	118	,, .	Lilburn Tower Gdns...	4·35	164
,, .	Shaftesbury, Abbey Ho.	2·69	114	*Cumb* .	Carlisle, Scaleby Hall	2·28	93
Devon .	Plymouth, The Hoe ...	3·86	133	,, .	Borrowdale, Seathwaite	7·75	74
,, .	Holne, Church Pk. Cott.	5·90	110	,, .	Borrowdale, Moraine...	6·95	83
,, .	Teignmouth, Den Gdns.	2·86	110	,, .	Keswick, High Hill...	2·99	66
,, .	Cullompton..............	2·72	99	*West* .	Appleby, Castle Bank	2·32	87
,, .	Sidmouth, Sidmount...	2·60	107	*Mon* .	Abergavenny, Larchf'd	3·27	108
,, .	Barnstaple, N. Dev. Ath	2·67	102	*Glam* .	Ystalyfera, Wern Ho.	5·46	102
,, .	Dartm'r, Cranmere Pool	4·80	...	,, .	Cardiff, Ely P. Stn. ...	2·20	69
,, .	Okehampton, Uplands	4·15	100	,, .	Treherbert, Tynywaun	7·14	...
Corn .	Redruth, Trewirgie ...	4·91	136	*Carm* .	Carmarthen, Priory St.	4·20	111
,, .	Penzance, Morrab Gdn.	4·57	143	*Pemb* .	Haverfordwest, School	4·10	120
,, .	St. Austell, Trevarna...	4·49	130	*Card* .	Aberystwyth	2·92	...
Soms .	Chewton Mendip	3·06	86	*Rad* .	Birm W.W. Tyrmynydd	5·87	109
,, .	Long Ashton	2·21	87	*Mont* .	Lake Vyrnwy............	5·58	130
,, .	Street, Millfield.........	2·05	100	*Flint* .	Sealand Aerodrome ...	1·67	93
Glos .	Blockley	2·30	..	*Mer* .	Dolgelley, Bontddu ...	5·49	111
,, .	Cirencester, Gwynfa ...	...	...	*Carn* .	Llandudno	1·90	93
Here .	Ross, Birchlea...........	2·43	120	,, .	Snowdon, L. Llydaw 9	10·49	...
Salop .	Church Stretton.........	2·50	106	*Ang* .	Holyhead, Salt Island	1·94	74
,, .	Shifnal, Hatton Grange	2·00	109	,, .	Lligwy.....................	2·03	...
Staffs .	Market Drayt'n, Old Sp.	1·64	77	*Isle of Man*			
Worc .	Ombersley, Holt Lock	1·65	97		Douglas, Boro' Cem. ...	2·93	98
War .	Alcester, Ragley Hall..	1·30	76	*Guernsey*			
,, .	Birminghm. Edgbaston	2·04	107		St. Peter P't. Grange Rd	4·37	177

Rainfall: March, 1934: Scotland and Ireland.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per cent. of Av.
Wig .	Pt. William, Monreith	2·70	95	*Suth* .	Melvich	3·87	136
,, .	New Luce School	3·16	89	,, .	Loch More, Achfary	6·20	96
Kirk .	Dalry, Glendarroch	2·85	63	*Caith* .	Wick	2·10	92
,, .	Carsphairn, Shiel	4·14	68	*Ork* .	Deerness	2·78	99
Dumf .	Dumfries, Crichton, R.I	2·28	81	*Shet* .	Lerwick	3·02	96
,, .	Eskdalemuir Obs.	4·46	91	*Cork* .	Caheragh Rectory	6·41	...
Roxb .	Branxholm	3·30	114	,, .	Dunmanway Rectory	7·06	144
Selk .	Ettrick Manse	3·86	76	,, .	Cork, University Coll.	4·49	150
Peeb .	West Linton	3·82	...	,, .	Ballinacurra	4·63	163
Berw .	Marchmont House	4·30	162	,, .	Mallow, Longueville	3·70	128
E.Lot .	North Berwick Res.	3·18	169	*Kerry* .	Valentia Obsy	5·59	123
Midl .	Edinburgh, Roy. Obs.	2·72	138	,, .	Gearhameen	8·70	107
Lan .	Auchtyfardle	...	...	,, .	Darrynane Abbey	6·31	154
Ayr .	Kilmarnock, Kay Pk.	2·09	...	*Wat* .	Waterford, Gortmore	3·21	118
,, .	Girvan, Pinmore	2·85	75	*Tip* .	Nenagh, Cas. Lough	3·54	116
Renf .	Glasgow, Queen's Pk.	2·81	107	,, .	Roscrea, Timoney Park	4·34	...
,, .	Greenock, Prospect H.	3·28	66	,, .	Cashel, Ballinamona	3·16	115
Bute .	Rothesay, Ardencraig.	3·07	...	*Lim* .	Foynes, Coolnanes	3·26	111
,, .	Dougarie Lodge	4·23	...	,, .	Castleconnel Rec.	3·09	...
Arg .	Ardgour House	6·07	...	*Clare* .	Inagh, Mount Callan	5.75	...
,, .	Glen Etive	6·49	82	,, .	Broadford, Hurdlest'n.	3·81	...
,, .	Oban	2·67	...	*Wexf* .	Gorey, Courtown Ho.	3·72	161
,, .	Poltalloch	3·97	104	*Wick* .	Rathnew, Clonmannon	3·20	...
,, .	Inveraray Castle	5·36	85	*Carl* .	Hacketstown Rectory	3·14	112
,, .	Islay, Eallabus	3·39	89	*Leix* .	Blandsfort House	3·05	116
,, .	Mull, Benmore	...	...	,, .	Mountmellick	3.31	...
,, .	Tiree	2·56	76	*Offaly* .	Birr Castle	2·91	121
Kinr .	Loch Leven Sluice	4·37	146	*Dublin*	Dublin, FitzWm. Sq.	2·47	127
Perth .	Loch Dhu	...	...	,, .	Balbriggan, Ardgillan.	2·19	109
,, .	Balquhidder, Stronvar	3·76	...	*Meath* .	Beauparc, St. Cloud	2·57	...
,, .	Crieff, Strathearn Hyd.	3·21	100	,, .	Kells, Headfort	2·38	87
,, .	Blair Castle Gardens	1·70	65	*W.M* .	Moate, Coolatore	2·93	...
Angus .	Kettins School	3·27	134	,, .	Mullingar, Belvedere	3·43	127
,, .	Pearsie House	3·33	...	*Long* .	Castle Forbes Gdns.	2·83	130
,, .	Montrose, Sunnyside	2·03	98	*Gal* .	Galway, Grammar Sch.	3·69	...
Aber .	Braemar, Bank	2·65	89	,, .	Ballynahinch Castle	6·24	122
,, .	Logie Coldstone Sch.	2·67	103	,, .	Ahascragh, Clonbrock.	3·50	105
,, .	Aberdeen, King's Coll.	1·09	45	*Mayo* .	Blacksod Point	...	...
,, .	Fyvie Castle	2·01	74	,, .	Mallaranny	5·07	...
Moray	Gordon Castle	2·00	86	,, .	Westport House	5·19	133
,, .	Grantown-on-Spey	2·81	106	,, .	Delphi Lodge	9·83	118
Nairn .	Nairn	2·43	130	*Sligo* .	Markree Obsy	4·14	112
Inv's .	Ben Alder Lodge	3·90	...	*Cavan* .	Crossdoney, Kevit Cas.	2·21	...
,, .	Kingussie, The Birches	2·87	...	*Ferm* .	Enniskillen, Portora	2·24	...
,, .	Inverness, Culduthel R.	2·82	...	*Arm* .	Armagh Obsy	1·79	76
,, .	Loch Quoich, Loan	1.60	...	*Down* .	Fofanny Reservoir	4·70	...
,, .	Glenquoich	4·99	51	,, .	Seaforde	1·77	61
,, .	Arisaig, Faire-na-Sguir	2·73	..	,, .	Donaghadee, C. Stn.	1·63	74
,, .	Fort William, Glasdrum	4·69	...	,, .	Banbridge, Milltown	1·81	83
,, .	Skye, Dunvegan	3·51	...	*Antr* .	Belfast, Cavehill Rd.	2·49	...
,, .	Barra, Skallary	3·32	...	,, .	Aldergrove Aerodrome	2·06	82
R & C .	Alness, Ardross Castle	4·88	149	,, .	Ballymena, Harryville	2·70	86
,, .	Ullapool	3·47	83	*Lon* .	Garvagh, Moneydig	2·29	...
,, .	Achnashellach	5·05	70	,, .	Londonderry, Creggan	2·99	93
,, .	Stornoway	3·02	74	*Tyr* .	Omagh, Edenfel	3·26	104
Suth .	Lairg	2·75	89	*Don* .	Malin Head	3·81	..
,, .	Tongue	3·13	93	,, .	Killybegs, Rockmount.	2·83	...

Climatological Table for the British Empire, October, 1933

STATIONS	PRESSURE Mean of Day M.S.L. mb.	PRESSURE Diff. from Normal mb.	TEMPERATURE Absolute Max. °F.	TEMPERATURE Absolute Min. °F.	TEMPERATURE Mean Values Max. °F.	TEMPERATURE Mean Values Min. °F.	TEMPERATURE Mean Values ½ max. and min. °F.	TEMPERATURE Mean Values Diff. from Normal °F	TEMPERATURE Mean Wet Bulb °F.	Relative Humidity %	Mean Cloud Am'nt 0—10	PRECIPITATION Am'nt in.	PRECIPITATION Diff. from Normal in.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible
London, Kew Obsy.	1012·9	— 1·1	68	32	57·9	45·9	51·9	+ 2·0	46·9	89	6·5	1·44	— 1·26	15	3·5	32
Gibraltar	1015·8	— 1·4	82	48	72·7	60·2	66·5	+ 0·1	60·0	87	6·0	4·94	+ 1·67	10	..	..
Malta	1017·7	+ 1·7	84	61	77·7	66·8	72·3	+ 1·4	66·3	76	4·5	0·29	— 2·58	4	8·4	74
St. Helena	1013·6	— 0·8	69	53	61·3	54·5	57·9	— 0·4	55·5	96	9·8	0·96	..	8	..	..
Freetown, Sierra Leone	1013·5	+ 1·9	88	64	86·3	67·0	76·7	— 3·4	75·3	82	4·5	7·78	— 4·84	23	..	..
Lagos, Nigeria	1012·1	+ 1·1	90	70	85·1	74·4	79·7	0·0	75·5	86	8·7	6·01	— 1·76	15	6·0	50
Kaduna, Nigeria	1011·9	— 1·4	96	59	90·4	63·7	77·1	+ 0·8	69·4	74	3·9	0·30	— 2·45	1	8·8	74
Zomba, Nyasaland	1008·8	— 2·1	93	53	86·4	63·1	74·7	+ 0·6	63·2	48	2·2	0·00	— 1·52	0	..	..
Salisbury, Rhodesia	1010·7	— 0·9	91	46	84·8	57·0	70·9	+ 0·2	57·0	34	1·5	0·35	— 0·78	4	10·0	80
Cape Town	1016·8	— 0·6	88	41	72·0	54·0	63·0	+ 1·8	56·3	74	4·2	1·35	— 0·30	7	..	..
Johannesburg	1011·6	— 0·2	87	36	78·8	52·0	65·4	+ 2·6	51·9	39	1·8	0·79	— 1·77	8	9·7	76
Mauritius	1018·3	+ 0·1	84	62	79·3	64·6	72·0	— 0·7	66·4	60	5·5	0·73	— 0·65	10	9·1	73
Calcutta, Alipore Obsy.	1009·1	— 0·3	93	67	88·0	74·8	81·4	+ 2·1	75·9	87	3·8	9·71	+ 4·81	9	..	..
Bombay	1008·2	— 1·6	94	72	90·0	75·9	82·9	+ 0·5	75·4	79	3·8	3·04	+ 1·37	7	..	..
Madras	1007·6	— 1·3	94	72	86·8	75·5	81·1	— 1·2	75·9	86	8·0	9·87	— 1·28	11	..	..
Colombo, Ceylon	1010·1	+ 0·1	85	72	83·1	75·1	79·1	— 1·4	76·0	80	7·2	8·43	— 4·93	25	5·5	46
Singapore	1009·2	— 0·5	92	70	86·5	74·0	80·3	— 0·8	76·8	81	6·6	7·63	— 0·44	18	5·1	42
Hongkong	1013·9	+ 0·2	90	65	82·3	73·1	77·7	+ 0·8	69·4	66	6·3	3·75	— 1·19	13	6·2	53
Sandakan	1008·7	..	91	72	87·6	74·8	81·2	— 0·2	77·1	82	7·9	14·96	+ 4·63	18	..	..
Sydney, N.S.W.	1015·6	+ 0·8	93	49	71·7	56·6	64·1	+ 0·5	60·0	66	5·6	4·06	+ 1·21	10	7·8	60
Melbourne	1015·2	+ 0·4	96	39	71·2	48·9	60·1	+ 2·4	53·9	56	5·6	1·56	— 1·07	12	5·9	46
Adelaide	1016·2	+ 0·2	99	39	73·8	51·0	62·4	+ 0·4	54·5	45	6·1	0·64	— 1·09	11	7·3	57
Perth, W. Australia	1016·4	— 0·4	83	42	69·2	53·0	61·1	+ 0·3	56·4	64	5·4	5·09	+ 2·87	14	7·3	57
Coolgardie	1014·2	— 0·9	102	37	78·5	49·0	63·7	0·0	54·6	38	2·2	0·55	— 0·11	5	..	..
Brisbane	1016·5	+ 0·3	89	55	78·6	62·2	70·4	+ 0·6	63·9	63	5·4	3·82	+ 1·29	13	8·4	66
Hobart, Tasmania	1010·1	— 2·2	82	38	64·6	47·8	56·2	+ 2·1	49·7	57	7·1	4·30	+ 2·04	14	6·2	47
Wellington, N.Z.	1015·8	+ 2·7	64	37	58·5	46·5	52·5	— 1·9	49·8	73	7·2	2·17	— 1·91	9	7·5	57
Suva, Fiji	1013·8	+ 0·6	87	64	81·6	71·1	76·3	+ 0·5	71·9	77	7·9	14·52	+ 6·23	23	4·6	37
Apia, Samoa	1011·4	— 0·1	87	70	84·6	73·5	79·0	+ 0·6	76·0	77	6·6	9·71	+ 3·33	21	7·0	56
Kingston, Jamaica	1009·3	— 2·2	90	70	85·2	72·7	78·9	— 1·6	73·0	90	6·2	17·98	+ 10·52	18	5·2	44
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1018·6	+ 1·1	69	22	55·3	40·3	47·8	— 0·8	42·8	81	5·1	2·26	— 0·31	15	5·0	45
Winnipeg	1016·6	+ 1·7	73	14	45·3	27·3	36·3	— 4·4	29·4	84	7·1	0·01	— 1·36	1	4·0	37
St. John, N.B.	1017·3	+ 1·5	66	27	54·7	41·2	47·9	+ 2·6	43·9	80	5·8	7·90	+ 3·36	19	4·3	39
Victoria, B.C.	1016·1	— 1·0	72	40	57·0	46·0	51·5	+ 1·2	49·0	86	6·0	4·98	+ 2·41	16	5·2	48

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

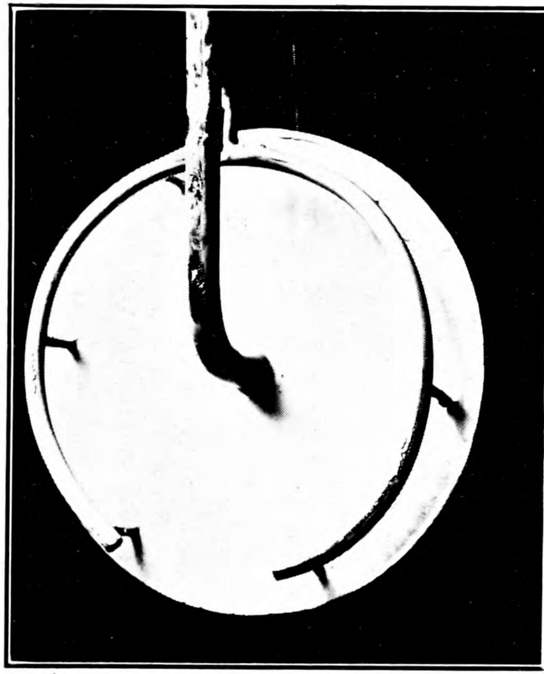


Fig. 2. Construction of the disc and tubes.

Fig. 3. A deep depression centred near the mouth of the Bristol Channel.

Fig. 4. The effect of a cyclone on smoke movement.

M.O. 371.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 69

May 1934

No. 820

LONDON: PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses; ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2: YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

An Atmospheric Disturbance illustrated by a Working Model

By T. C. ANGUS,
Department of Industrial Physiology,
London School of Hygiene and Tropical Medicine.

It has recently been the writer's task to give instruction in the elements of climate and meteorology to students whose studies are mainly directed in quite different directions. It has been found that to such students the consideration, in a very limited time, of pressure systems in the atmosphere, with their rotational and translational movements, often presents some difficulty. Here is described a model in which the movements of the winds over the earth are to some extent imitated by currents of coloured water passing behind a transparent map. It has been found that such a model presents in a few minutes and in an entertaining manner ideas which would otherwise require a somewhat difficult and lengthy explanation.

A glass tank (shown in plan, Fig. 1) bears on its outer surface (A—A), facing the audience, a sketch map of some part of the world drawn plainly in Indian ink. A "cyclonic depression," passing over land and sea, is represented by a white enamelled metal disc, (D), 9 inches in diameter, placed in clear water against the side of the tank and held with its face within $\frac{1}{4}$ inch of the inside surface. The centre of the disc is pierced by a hole $\frac{3}{4}$ inch in diameter over the further side of which is attached the

(6383) 32/91 1,000 5/34 M. & S., Ltd. Gp.303

slightly coned end of a metal tube, (B). This tube, being bent at right angles just behind the entrance, passes up out of the water in the tank and forms a handle by which the whole system can be moved across behind the map traced on the glass. Near the periphery of the disc are six equally spaced bent tubes, all the ends of which are pressed so as to form flattened jets. These jets (when we are considering the Northern Hemisphere) all point in an anti-clockwise direction, while they incline towards the centre of the disc at an angle of 35 degrees from the tangent to the circle from which they start. The jets are formed from composition tubing of the smallest available size and the highest parts of the bends in the jets act as distance pieces to hold the

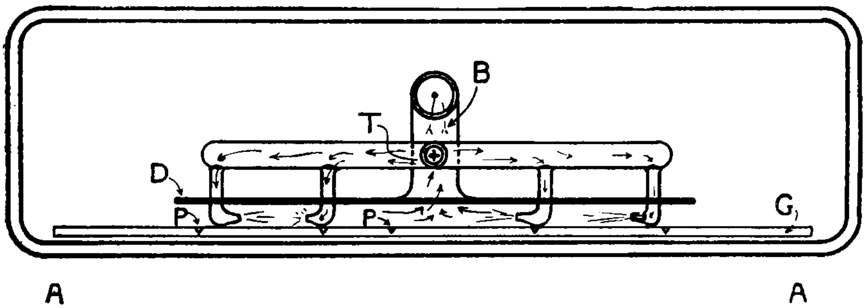


FIG. 1. PLAN DIAGRAM OF THE JETS AND DISC IN POSITION.

metal disc at the correct distance from the glass of the tank. All the jets are fed from a common supply tube, (T), behind the disc and connected to a suitable supply. Fig. 2 shows the construction of this part of the apparatus from behind.

To show a cyclonic depression water is turned on so as to flow gently from the six jets (the whole being, of course, submerged in the water in the glass tank), while a syphon is started from the tube (B), opening into the " centre of the depression," causing a flow of water towards and into this. While this invisible flow is in progress the lecturer, pointing to the " depression centred near the mouth of the Bristol Channel," begins to describe the action of the winds and, at the right moment, releases a small quantity of coloured ink into the supply to the jets by means of a small side tube and a pinch cock. The " winds," with their characteristic spiral movements, at once become visible when the ink emerges from the jets and, slowly rotating anti-clockwise, move to the calm centre of the depression, where they disappear. (Fig. 3.)

It is quite an easy matter slowly to traverse the " cyclone " across the map in an easterly or north-easterly direction, explaining the onset and progress of stormy weather and its ultimate replacement by the less windy conditions associated with a high barometer.

So far the " winds " have been made visible; to give a picture of the movement and passage of a cyclone: the next step is to show how in actual fact the passage of the invisible winds of a cyclone affect the visible weather vanes and smoke at fixed points on the earth. To produce "smoke" on the map—from cities and the funnels of steamers—a sheet of glass (G in Fig. 1) is prepared to fit snugly in the tank against the side bearing the map, the disc representing the cyclone being moved back sufficiently far to allow this new sheet of glass to be interposed. This glass sheet is made so as always to fit into the same position and on its inner surface a number of conical pits (P, P), are drilled which come behind points on the map appropriately marked to indicate cities or ships at sea. Into these pits, which are washed by the moving water, crystals of potassium permanganate or acid fuchin are stuck to rubber cement with which the pits have been treated. As soon as the glass plate is lowered into position in the tank these crystals begin to emit fine red lines into the water, which, during the passage of the "depression", clearly show how changes of wind are produced at different places. (Fig. 4.) Thus a depression passing with its centre in the Channel is heralded by south-easterly winds on the coast, whilst one approaching Scotland is announced by south-westerly winds in London, veering to north-west as the weather clears.

There are several imperfections in the model illustrated. The outline map of England is too large for the "depression" and in the small tank available adequate movements of the weather system cannot be reproduced: obvious defects in a rapidly-constructed apparatus put together to see whether a new idea will "work" The success which has attended the use of this preliminary model encourages us to the belief that its principles may be further extended to include an anticyclone, and also possibly to show the formation of "rain fronts"; by supplying inks of different colours at the top and at the bottom of the map showing by their union when drawn into a depression, how the warm, moist winds of the Atlantic meet the cold, dry winds from the north.

Perhaps this short account will encourage others interested in the teaching of meteorology to try elaborations of the methods described.

The writer wishes to express his thanks to Mr. W. R. Luxton, not only for the photography, but for several useful suggestions which have helped to make the apparatus a success.

Remarkable Cloud Movement at Leuchars

On November 21st, 1932, a report of nephoscope observations was received from Leuchars, which recorded that cirrus cloud had been seen moving from west and from north-east, both observations showing considerable velocities.

This report gave rise to considerable scepticism, but that the observations were correctly made and checked is put beyond doubt by the following account given by Mr. R. H. Mathews, who was at that time in charge of the station.

"At 15h., November 21st, 1932, Mr. L. S. Matthews reported to Mr. Plummer that he had just observed cirrus cloud travelling from 240°, and another patch from 40°. Mr. Plummer at once checked the observations and then reported to me. At 16h. on the same day we all three observed that the *same* cloud patches were moving from the same direction as at 15h., and we also saw a sheet of alto-cumulus 2/10, stretching from west to north-west, was moving from 40°. The actual observations are given :—

13h.	alto-cumulus	250°	50 secs.*	vv = 7*	
	cirrus	240°	44 ,,	,, = 8	A rapid speed-up.
15h.	cirrus	240°	24 ,,	,, = 15	
	cirrus	40°	20 ,,	,, = 18	
16h.	cirrus	240°	20 ,,	,, = 18	
	cirrus	40°	28 ,,	,, = 13	
	alto-cumulus	40°	30 ,,	,, = 12	

The apparently strange motion of the 40° cirrus was first noticed because it travelled against the pointer on the nephoscope and therefore the rake had to be rotated."

The clouds were described as being situated in two patches, one to the south (at elevations of 30° and 35° at 15h. and 16h. respectively), the other to the north-west (at 25° and 20° elevation respectively). Both patches were small (about 1/20 of the sky each) and were of similar appearance, resembling that shown in Plate 33 of the "Abridged International Cloud Atlas" (cirrus composed of irregularly arranged filaments, orientated in various directions, they are not arranged in sheets or bands and have no tendency to fuse together into cirro-stratus). That moving from north-east was the one situated to north-west of the station.

The synoptic situation at 7h. on the 21st showed a back-bent occlusion over the north of Scotland, which on the Bergen charts is marked as an upper front, while out on the Atlantic 750 miles from Renfrew there were indications of a warm front with a second warm front following it. At 13h. there was cirrus moving from 240° at Leuchars and from 340° at Renfrew, the latter having a velocity of 120 miles per hour, if at a height of five miles. At that hour there were indications that the warm front had advanced to about 50°N., 24°W., but there were no surface indications of how the upper front had moved. At 1h. on the 22nd the warm front was over the west coast of Ireland. There certainly were strong currents in the cirrus level over

* In this table the times given are those taken by the cloud to pass from spike to spike on a Besson's Comb Nephoscope; vv is the velocity-height ratio of the cloud.

western Scotland and England, as in addition to the Renfrew observation Sealand gave a north-westerly cirrus movement of 100 miles per hour at 16h. It is noteworthy, too, that at 13h. the alto-cumulus at Leuchars was moving from a westerly direction and at 16h. from a north-easterly, so that at that level, as well as in the cirrus level, there appeared to be a change in direction, though in the alto level it was spread over three hours.

There was a notable rise in temperatures at Duxford above 8,000 feet between 13h. 30m. on the 21st and 8h. 15m. on the 22nd amounting to about 10°F. at 10,000 ft. and 17° at 11,500 ft.

Two possible explanations might be given of these remarkable observations (*a*) that the clouds seen at Leuchars were at the same level and that somewhere in the high atmosphere there was a sharp discontinuity of the line squall type, (*b*) that the clouds were at different levels and that there was a great change of velocity with height. To take these in turn, in the former case it is possible that the upper front marked on the Bergen chart was sharply defined in the upper part of the troposphere; but if that were so and it were generating strong winds at that level, there would have been considerable pressure changes and these would tend to be represented at the base of the atmosphere also. But, as is stated above, there was little or no indication of the passage of this upper front. If, however, we suppose that there were two currents in different levels, it is to be presumed that the lower one was from north-east since that was also the direction from which the alto-cumulus cloud was moving. In those circumstances the probability would be that the westerly current above was warm air spreading upwards over the warm front which lay over Ireland the following night. It has been calculated that the slope of this front was of the order of 1 in 130 or 140, and since the front was about 450 miles away at the time of observation, the height of the discontinuity above Leuchars would be about 17,000 feet. It must be recognised that these measurements are very rough, but they at least show that there is a possibility that the warm front was in the neighbourhood of the clouds, though, if this explanation is the true one, it is surprising that the clouds at two different heights formed in different currents should assume so similar a form. It is not out of the question, though it seems improbable, that the lower of the two clouds was due to orography, and if that is so, it is possible that it was cloud of cirroform type, though at a much lower level than is usually associated wth cirrus.

Another alternative is that the upper cloud was in fact a stratospheric (Störmer) cloud. In that case, however, it is remarkable that a similar cloud should be in the same position an hour later. Indeed this is a serious difficulty unless we introduce topography into the explanation, for any clouds with angular velocities such as these had would have travelled out of the observer's range of vision within an hour, yet similar clouds in similar positions were in fact observed after the lapse of an hour.

At this stage it does not seem possible even to hazard a guess at what is the true explanation of these remarkable observations, but it is felt that they are worthy of record in the hope that perhaps some other observer may have some note that may be of assistance in the unravelling of a riddle, which at any rate emphasises with what discrimination and care high cloud observations must be used. As Mr. Mathews has pointed out: " It is our knowledge of cirrus cloud, its formation, height and movement which is much more doubtful " (than the accuracy of the observations) " and in the Leuchars observations in question you have an example of the general doubt concerning these matters."

[There is another possible explanation which helps to remove some of the difficulties but introduces new ones. Reference should be made to two papers by A. H. R. Goldie* in which he discusses the effect of wave-motion on the formation of clouds at a surface of discontinuity in the atmosphere. He remarks in Section 3 (*c*) of the second paper that " increased attention in recent years to nephoscope observations has revealed cases of apparently high velocities in the cirrus level, and if many of these cases are merely the effects of travelling waves and not of actual drift of air, the significance of the observations is entirely altered." The cloud patches described by Mr. Matthews are not of a typical wave pattern—according to the subscript to Plate 33 of the " Abridged International Cloud Atlas " " the irregularly arranged filaments, orientated in various directions are not arranged in sheets or bands "—but it is not altogether impossible that the parts of the cloud utilised in the observations were the result of wave-motion. If then one of the nephoscope observations gave the wave-motion, and the other the air-motion, or if both gave a wave-motion, then there would be no difficulty in the two cloud patches being at the same level. Also if both the high velocities from 240° and 40° are apparent only, then this would help to explain why the " same " patches of cloud were seen in the same positions after an hour's interval, the sameness arising from the continued wave-motions in those parts of the sky. It seems probable that the moderate velocities observed for alto-cumulus and cirrus at 13h. and perhaps also for alto-cumulus at 16h. may be genuine. If the other high velocities are fallacious, they would correspond to two wave-motions (in different parts of the sky) differing by 160° in

---

* *London Q.J.R. Meteor. Soc.* 51, 1925, p. 239. and *Edinburgh Proc. R. Soc.* XLV, 1924-5. Part II, No. 17, p. 213.

direction. Whether this is possible under the circumstances requires a separate investigation. Whatever the complete explanation, there seems to be some case for regarding one or both of the high cirrus velocities as spurious. In conclusion it may be remarked that cinematograph observations of clouds in wave-form would probably yield some useful information on this subject, which is clearly of considerable importance to forecasting.—A. F. CROSSLEY.]

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, April 18th, at 49, Cromwell Road, South Kensington, Lt.-Col. E. Gold, D.S.O., F.R.S., President, in the chair.

Mr. E. G. Bilham, B.Sc., gave a short informal talk on the rainfall of the winter half-year, October, 1933 to March, 1934. The talk was illustrated by a map of the rainfall in percentages of normal, which showed that the whole country received less than the normal amount with the exception of part of the north-east coast of England. In the Thames Valley the deficiency exceeded 50 per cent.

D. Brunt, M.A., B.Sc.—The Possibility of Condensation by Descent of Air.

From a consideration of the variation with height of the humidity-mixing-ratio it is shown that in the stratosphere condensation can occur in descending air-masses which take up the temperature of their environment. The fact that saturated water vapour produces condensation when expanded adiabatically while other saturated vapours produce condensation when compressed adiabatically, is discussed briefly.

D. Dewar, B.Sc.—An Investigation of the Statistical Probability of Rain in London.

The paper gives an account of an investigation of the frequency of rain at Kew, based on hourly tabulations of rainfall from 1872-1921.

Amounts of rain were classified as " heavy ", " moderate ", " slight ", or " no rain ", according as the quantity which fell in a 6-hr. interval of the day was 1 mm. or more, between 0·5 and 1 mm., between 0·2 and 0·5 mm., or less than 0·2 mm. The intervals were defined as early morning, forenoon, afternoon and night, each division of the day being taken to cover an interval of 6 hrs. Each month was divided into three periods of approximately 10 days. The probability of rain of a given amount in a given interval of the day during these periods was obtained by dividing the number of occasions on which rain of that amount had fallen by the number of possible occasions.

The results are given in several tables accompanied by discussions of the outstanding features.

A comparison between actual values and figures computed from the average probability shows that the frequency of "heavy" rain in 6-hr. intervals for individual days is distributed approximately according to a chance distribution.

The average probability of rain in a 6-hr. interval is :—

Approximately 1 in 9 for heavy rain.
,, 1 in 20 for moderate rain.
,, 1 in 33 for slight rain.

Caleb Mills Saville, B.A.—Some rainfall Variations, England and New England (U.S.A.).

The paper brings out some interesting points of similarity and dissimilarity between the fluctuations of rainfall experienced in England and in New England, in the east of the United States. It is shown that the maximum and minimum rainfall experienced during periods of from one to twelve consecutive months is similar in both localities. Details are given as to the extremes of rainfall recorded at West Hartford (U.S.A.) for periods of from 1 to 120 consecutive months. In this country a run of wet years persisted before the present drought but in New England dry years predominated. This marked inverse relationship is shown to hold from 1868 to 1932 in the case of residual mass curves and from 1838 to 1932 with a somewhat different set of data expressing the rainfall as 5-year means. Probability curves of the frequency of occurrence of means of specified amounts during three consecutive years are also given for both England and New England.

Correspondence

To the Editor, *The Meteorological Magazine.*

Prediction of Minimum Temperatures at Larkhill

I was much interested by Mr. Andrews' note on the prediction of minimum temperature in your April issue. His results show that the fall of temperature diminishes in amount as the humidity increases. The explanation which naturally suggests itself is that condensation of water vapour supplies part of the heat lost by radiation—and thus reduces the rate of cooling in much the same way as it reduces the vertical lapse-rate in the atmosphere.

Examination of Mr. Andrews' results shows that this cannot be the whole explanation. If it were, we should expect the cooling for 100 per cent. R.H. to diminish as the temperature increases : for a fall of temperature of 1°F. from 70°F. to 69°F. is accompanied by condensation of 3 times as much water vapour as a fall from 40°F. to 39°F. Mr. Andrews' diagram shows, however, that the cooling increases with the temperature : thus at 70°F. R.H. 100 per cent. the cooling is about 16°F., while at 40°F. R.H. 100 per cent. the cooling is only about 11°F. The explanation of this apparent anomaly is not obvious :

it seems probable that it is due, in part at least, to a greater vertical lapse-rate when the temperature is high. This would accelerate the initial cooling.

If the amount of cooling (T – M), derived from Mr. Andrews' diagram for relatively calm nights are plotted against the difference between the temperature and the dew point temperature (T – D), the resulting points lie on a series of approximately parallel straight lines: and an examination of them leads to a formula connecting T – M and T and T – D. It differs from the formula prevously suggested by Pick, in that it allows automatically both for the humidity and the initial temperature. The formula is :—

$$(T - M) = 5{\cdot}5 + \tfrac{3}{20}T + \tfrac{2}{5}(T - D)$$

where T = 15h. temperature in degrees F.
M = minimum temperature in degrees F.
D = 15h. dew point temperature in degrees F.

It would be interesting to know if the formula applies as it stands to other places than Larkhill (under the conditions of relative calm and clear nights hypothesized), or if the values of the constants depend upon the locality; *e.g.*, does it apply in Egypt and 'Iraq?

It is suggestive that the actual amount of cooling (at 100 per cent. humidity) for a temperature of 40°F. is about 20 per cent. less than that for a temperature of 70°F., while for a black body the loss of heat by radiation at 40°F. is about 25 per cent. less than at 70°F. I was inclined at first to dismiss the idea that the difference in cooling at 70°F. and at 40°F. could be due directly to the difference in the intensity of radiation at these temperatures. But on examining the figures I thought there might be some ground for the idea.

At 70°F. the loss by radiation from the earth's surface is about 9 gram calories per cm.^{2} per hour if one assumes that 25 per cent. of the radiation is transmitted freely through the atmosphere. This would amount in 10 hours to 90 gram calories per cm.^{2}, which is the heat lost by a layer of air 1,000 feet thick in cooling about 25°F.; it is also equivalent to the cooling required to condense a layer of water about 1·5 mm. thick. If a layer of air 1,000 feet thick, initially saturated, were cooled 25°F. from 70°F. to 45°F., about 3 mm. of water would be condensed. In other words, at 70°F. about one-third of the loss of heat is required to cool the air and two-thirds to condense the water. The loss of 90 gram calories per cm.^{2} would suffice to cool by 16°F. a layer of about 500 feet of saturated air at 70°F., with simultaneous condensation of water vapour. This is a point of some interest, as indicating roughly the height to which a fog might be expected to extend at Larkhill, in the course of 10 hours after it began to form at the surface.

If $T = D$, the formula given above reduces to $T - M = 5{\cdot}5 + \frac{3}{20} T$. If we assumed $T - M$ directly proportional to the radiation at temperature Y, we should get :—

$$T - M = 8{\cdot}5 + \frac{T}{14}$$

the constants being determined by the condition $T - M = 11{\cdot}5$ for $T = 42°F$. The variation of $T - M$ with T in this formula is only about half as rapid as that derived from Andrews' results. Hence, I think there is no escape from the conclusion that some other contributory cause than radiation is operative, such as a higher lapse rate.

E. GOLD.

April 27th, 1934.

Bush Fires—Smoke Haze Phenomena

Severe bush fires in Tasmania in January and February resulted in an extraordinary interference with daylight illumination by smoke haze on January 18th and February 9th, giving rise to bizarre effects such as appear to have been outside the range of previous experience.

February 9th was another "Black Friday" in Tasmania. After a period of fine weather since the middle of October broken by an occasional moderate rain, the country had become very dry. Under such conditions the wind and heat associated with certain types of depression quickly sweep bush and grass fires out of control. Outbreaks were severe on the southern slopes of the Derwent Valley, on the west coast and in the north-west and north-east of the State.

The morning was calm and sultry. A strong north-westerly wind rose suddenly at about 11.30 a.m. and reached gale force between 1.30 p.m. and 3.30 p.m. with many gusts of velocities of between 50 and 60 miles per hour. Owing to smoke haze visibility during the day did not exceed 5 miles. Between 3 and 4 p.m. it decreased to 1,000 yards and the light changed to an intense orange tint. Greens showed up in a brilliant hue. Electric lights (ordinarily pale orange) appeared white. The sun, when visible, appeared as a red ball. Between 5.30 p.m. and 6 p.m. a dense pall of smoke enshrouded Hobart, causing great discomfort, particularly to the eyes. Visibility decreased to approximately 50 yards and illumination varied in a marked degree, decreasing at intervals to that of twilight, due, apparently, to the passage of cloud across the sun. In some centres total darkness was reported. A temporary westerly change occurred at about 6 p.m. and conditions improved slightly. Electric lights were visible at 1,000 yards at 9 p.m.

The illumination effects were similar on January 18th, but the day was calm. Burnt leaves from fires some 30 or 40 miles distant were deposited over the city. The orange character of the light was more intense. On each occasion the maximum phase synchronised with a barometric trough.

The Head Teacher, State School, Campania, about 20 miles north-north-east from Hobart reported:—At 5.45 p.m. it was noted overhead that a vast volume of smoke flowing north-west to south-east was gradually swinging more towards the direction west to east, which confirmed the prediction of a westerly change. When the west to east direction of the flow of the smoke was complete almost total darkness (at 6 p.m.) ensued. A newspaper could not be read out of doors, no letter at all being distinguishable. At 7.30 it became lighter. A man was visible at a distance of 50 feet on the road. At 7.45 a paper could be read outside.

The Observer, Bushy Park, 30 miles north-west of Hobart (in the Derwent Valley) reported:—"By 5.10 p.m. it was quite dark and needed a torch to read instruments. Slowly got light till about 6 p.m., when it was twilight till 8. Thick smoke everywhere. At 4 p.m. colours of flowers in garden appeared different—blue violas were dull red, red cluster roses appeared salmon pink. Yellow appeared dirty white."

J. C. Foley.

Commonwealth Meteorological Bureau, Hobart, Tasmania. March, 1934.

A Phenomenon accompanying Lightning

This afternoon this locality was on the edge of a thunderstorm which at one time appeared to spread from north to west and later to withdraw from the west and spread from north-eastwards. In spite of this there was some electrical display close at hand. My wife and I were sitting by the open window looking west and the circumstances of one flash of lightning are, I think, of some interest. We did not see the actual discharge as it was on the other side of the house. The illumination from it was, however, brilliantly white (no rain was falling) and was accompanied by a peculiar sound as if of the noise of something swiftly rushing through the air across the garden from north to south or the swishing of a long whip. This sound was also heard by my wife, who describes it like that of a sudden rush of wind, although there was almost a calm. This was followed almost immediately by a terrific crash of thunder. I learned later that the Methodist Church in Walm Lane, about 100 yards away from here was struck, although happily without serious consequences.

J. E. Belasco.

6, *Blenheim Gardens, N.W.*2. *April 28th,* 1934.

Sun Pillar

A phenomenon of some brilliance was observed at Westcliff on

Good Friday, March 30th. At 18h. 5m. G.M.T. the sun appeared as an orange coloured ball, from which ascended for about 15° a well-defined and even column of light of a similar hue.

At the time of the first observation the sun's altitude was approximately 5°, and the width of the ascending column of light appeared to be the same as the sun's diameter. By 18h. 18m. the sun had disappeared from view behind distant clouds, leaving a column of orange light which gradually changed to a reddish hue. Fading commenced at 18h. 21m. and the pillar was finally lost to view at 18h. 26m.

During the period of observation the visibility was good, wind direction was east and force 2, and the sky was about five-tenths covered, the greater part by strato-cumulus and the remainder by cirrus.

E. J. Horrex.

Colombo, 32, Ceylon Road, Westcliff-on-Sea, Essex. April 6th, 1934.

NOTES AND QUERIES

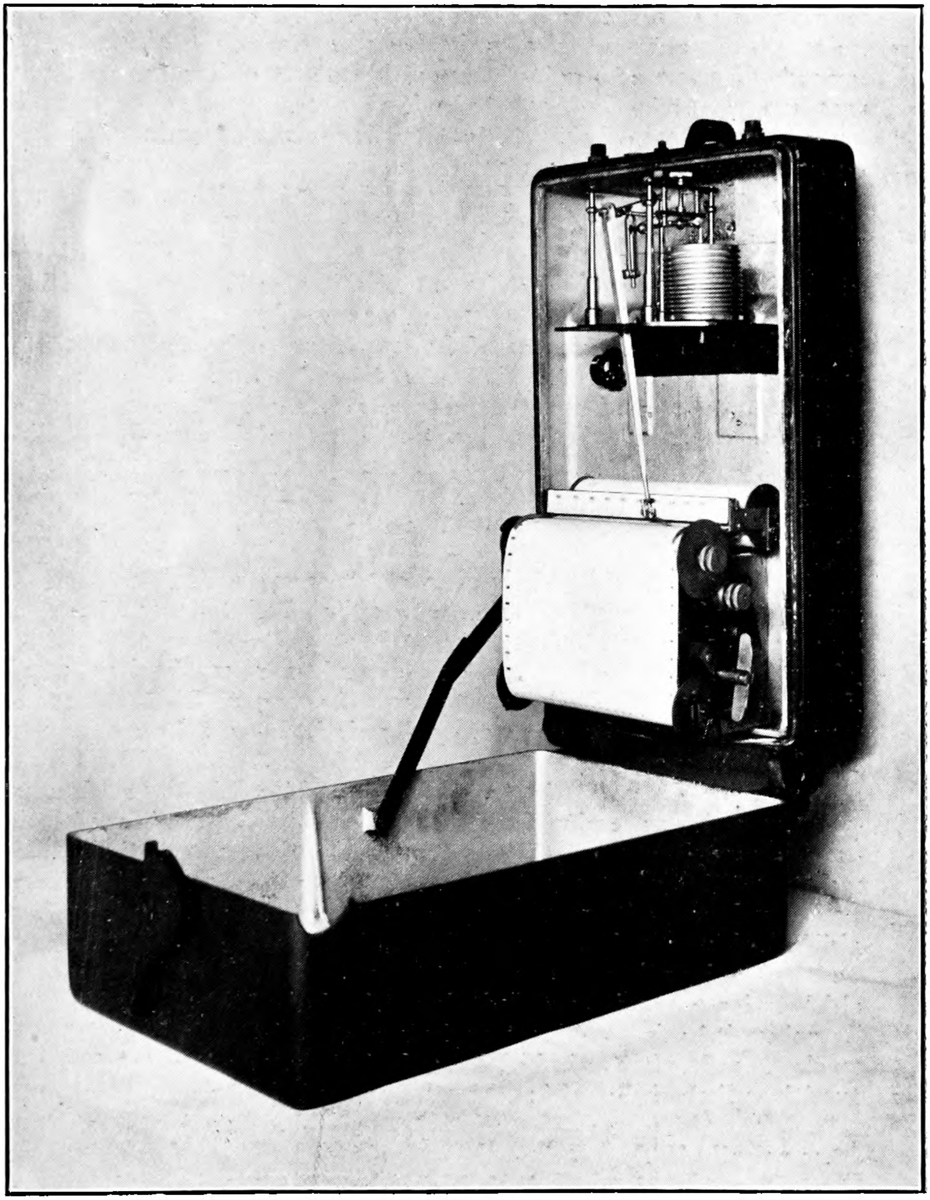
A Barograph with Yearly Chart

The view has often been expressed that the barograph would be improved if it were constructed so that the line made by the pen, if it moved up and down with the clock stopped, was a straight line and not a curved line. It has also been suggested that a further improvement would be effected if the drum on which the record is made were horizontal instead of vertical. An instrument has been designed to achieve both these purposes, and at the same time to take a chart which is changed only about once a year.

The instrument, which is shown in the accompanying illustration, has been constructed by taking the mechanism from one of Messrs. Short & Mason's well-known open scale barographs and fixing this in a Murday recorder. The Murday recorder, a recorder which is marketed by Messrs. Evershed & Vignoles and used by them with a wide variety of electrical instruments, consists of a strong cast-iron case containing a clock driving a roll type chart, the charts being obtainable either in 70 or 100 feet lengths. The records are usually made with an open time scale of ½ or 1 inch per hour, but by changing the gear wheels there is no difficulty in reducing the time scale to that normally used on large barographs and other instruments in the Meteorological Office, namely, 30 mm. per 12 hours. With this scale a chart 70 feet long would run for 357 days while a 100 feet chart would need changing only after 510 days.

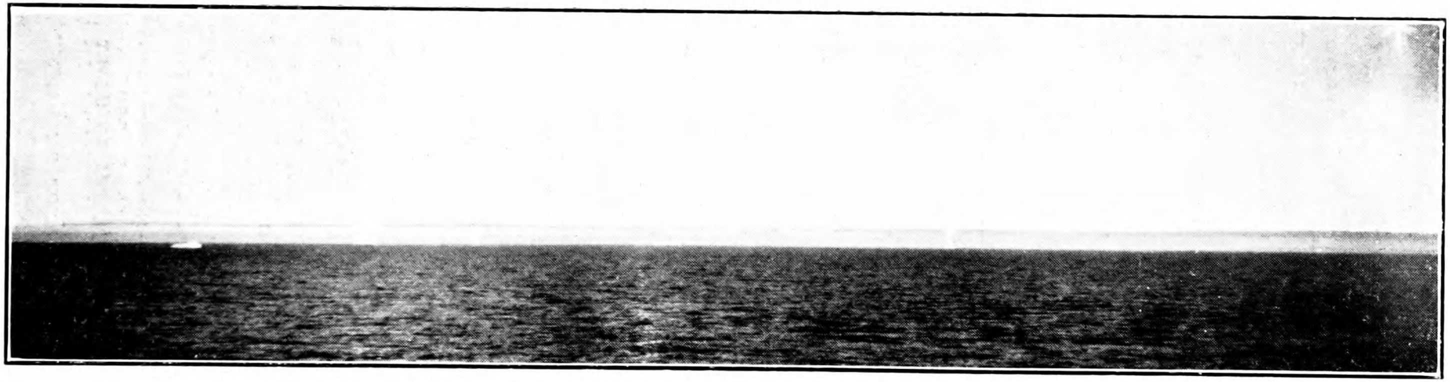
It will be seen that the aneroid mechanism has been modified by the substitution of a vertical pen arm for the horizontal pen arm usually fitted. On the bottom of the vertical pen arm the

facing p. 92



BAROGRAPH WITH YEARLY CHART

facing p. 9



Refraction at Sea on the way to Nain, Canada.

special type of pen used with the Murday recorder is fitted, the movement of the pen over the paper being linear so that a straight line time scale is given.

The instrument has been in operation in the Meteorological Office for some time and has needed no attention apart from winding the clock once a month and inking the pen at even longer intervals.

It may be stated that at the present time the instrument is purely experimental. This description is published because it is felt that a barograph with a chart which only needs changing once in 12 months is a sufficient novelty to be of some interest outside the Meteorological Office.

Refraction at Sea

The photograph which is reproduced on the opposite page is a good example of the effect of refraction on icebergs. It was taken from H.M.S. *Challenger* with a long-focus camera in the vicinity of South Wolf Island off the coast of Labrador, and was sent to the Meteorological Office by the Admiralty. Two icebergs are clearly seen both directly and inverted by refraction. The one in the middle of the picture can apparently be seen directly, and twice by refraction, the uppermost image being erect. Another small one further to the left can be seen twice by refraction, although it is not visible directly.

Following are further particulars of the observation :—Date, July 22nd, 1933, 12h. local time. Wind ESE., force 2. Temperature, dry bulb 47°F., wet bulb 46°F., sea 46°F. Relative humidity 92 per cent. Pressure 1018·2mb. Weather fine. Visibility 12 to 18 miles. The camera was directed towards north-north-west. The ship from which the photograph was taken had been in fog for some hours beforehand. This confirms the existence of a surface inversion of temperature, which is a necessary condition for the observation of refraction effects of this type.

Hail and Thunder in May

Some time ago discussion arose on the subject of whether the plentiful occurrence of thunder in May is followed by a wet summer and a letter by E. L. Hawke appeared in the *Daily Mail* of May 12th, 1932, stating that thunder in May is not usually followed by a wet summer. I have been prompted to investigate the matter in the records at Grayshott during the 34 years 1900-33.

The three months June, July and August have been taken as constituting summer, and the elements considered in this summer period are temperature, sunshine, rainfall and days of rain.

Mean values of the number of days in May on which thunder or hail occurred were worked out.

TABLE I.

	Temperature. Above aver.	Temperature. Below aver.	Sunshine. Above aver.	Sunshine. Below aver.	Rainfall. Above aver.	Rainfall. Below aver.	Raindays. Above aver.	Raindays. Below aver.
Years with hail above average (10)	6	4	5	5	6	4	6	4
Years with hail below average (24)	11	13	11	13	16	8	10	14

Table I gives the variation of the four elements above or below the mean, according as the hail in the previous May was above or below the mean.

Table II gives similar data, depending this time on thunder in May.

TABLE II.

	Temperature. Above aver.	Temperature. Below aver.	Sunshine. Above aver.	Sunshine. Below aver.	Rainfall. Above aver.	Rainfall. Below aver.	Raindays Above aver.	Raindays Below aver.
Years with thunder above average (16)	8	8	9	7	7	9	7	9
Years with thunder below average (18)	10	8	8	10	6	12	6	12

These tables throw little light on the question raised by Mr. Hawke, but it is significant that years deficient in hail in May seem frequently to be followed by wet summers; however, this is not true of days of rain, and it is likely that the rain in these wet summers is provided by isolated heavy falls of thundery type. Deficiency of thunder in May seems from Table II to be followed by a dry summer.

So far the elements have been treated separately. An attempt has now been made to correlate hail and thunder in May with what constitutes to the public mind a " good " summer and a " poor " summer. A " good " summer has been defined as one in which temperature and sunshine have both been above normal and rainfall and raindays below normal. In the period considered 13 summers satisfied these conditions and have been termed " good " summers. Conversely, the nine poor summers in the period all gave temperature and sunshine below normal and rainfall and raindays above normal.

From Table III it is seen that excess of thunder in May is followed more often than not by a good summer; the same is true for deficiency of hail in May. The converse does not hold; deficiency of thunder and excess of hail in May tend to be followed by " average " rather than " poor " summers.

It is to be noted that hail and thunder in May have been considered separately. However, on five of the occasions of " good " summers, including 1911, 1921 and 1933, excess of thunder and deficiency of hail have occurred together in the same May. This is not a common event in a spring month. Actually the correlation coefficient between hail and thunder in May was found to be +0·35.

TABLE III.

May weather	Good summers following	Poor summers following
Excess thunder	8	6
Deficient thunder	5	3
Excess hail ..	3	3
Deficient hail ..	10	6

In summarising, we can say that excess of thunder in May, especially if in conjunction with deficiency of hail, is likely to be followed by a "good" summer. This supports to some extent the statement of Mr. Hawke that thunder in May does not necessarily predict a wet summer. Deficiency of hail alone appears to predict a wet summer and deficiency of thunder a dry summer. However, none of these results can be used for attempts at prediction. Correlation coefficients between hail in May and thunder in May and rain in the following summer are quite insignificant.

S. E. ASHMORE.

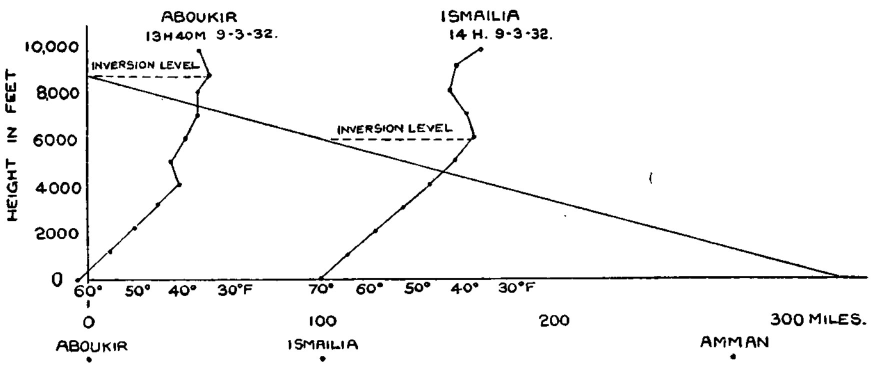
Microbarograph Oscillations

In a review in the *Meteorological Magazine*, Vol. 68, 1933, p. 293, on the influence of topography on the microbarometric observations (*Geophys. Mag.* Tokyo 7, 1933), Durst remarks that "in Japan the microbarograph may, under suitable conditions, be of considerable use in detecting the arrival of a front, especially above a mountain station, and it is not unnatural to ask whether the instrument could not be used in this way in the British Isles." In the *Meteorological Magazine*, Vol. 61, 1926, p. 112, Read attributes the formation of stationary pressure waves at Holyhead as probably due to two surfaces of discontinuity (revealed by inversions and change of wind direction), one between 2,500 and 3,000 ft. and the other about 7,000 ft. He remarks that "the formation of inversions is by no means an infrequent occurrence and one might be led to expect evidence of them on autographic records much more often than appears to be the case."

My recollection of microbarograph traces at home stations is that while waves of very small amplitude are recorded from time to time, the traces are seldom if ever "disturbed," *i.e.*, there are no regular or irregular oscillations in which the variation of pressure reaches values of 1½ to 2 mb.

In Middle East area oscillations of this magnitude are recorded with considerable frequency during the winter months. A very good case is illustrated in the *Meteorological Magazine*, 1928, p. 59, and it seems natural to conclude that if microbarograph traces are of any assistance in locating fronts and so aiding forecasting, they would be of great use in Middle East area. Actually, however, this does not appear to be the case. Examination of the records shows that "disturbed" traces on a microbarograph occur several hours after the passage of a cold front or occlusion. No good case has yet been found several hours ahead of the passage of a warm front, which is rather surprising, and presumably implies that the depressions which cross Egypt have no real warm sectors, the E.-SE. wind in front being as warm as the S.-SW. in what would normally be regarded as the warm sector.

It is obvious then that as oscillations most frequently occur after the arrival of a cold front their value from a forecasting



SECTION OF COLD FRONT MARCH 8TH-9TH 1932
DISTANCES ARE MEASURED FROM A LINE RUNNING SSW-NNE THROUGH ABOUKIR

FIGURE 1

point of view is very little. All that they give is an indication of the depth of the cold air over the station because the oscillations seem to commence when the depth of cold air lies between certain limits. In the example described below the oscillations commenced when the depth was about 2,000 feet and ceased when the depth was 5,000 feet.

An example of "disturbed" microbarograph traces at stations in Egypt and Palestine occurred on March 8th and 9th, 1932, and as a good deal of data is available for this particular case it may be of interest to describe it in some detail. A cold front passed over Egypt and Palestine as follows :—

Station.	*Time of Passage (G.M.T.).*
Aboukir	8h. 50m., March 8th, 1932
Heliopolis	14h. 45m., ,, ,, ,,
Ismailia	16h. 5m., ,, ,, ,,
Ramleh	22h. ,, ,, ,,
Amman	1h. ,, 9th, ,,

The front was orientated south-south-west to north-north-east and its speed to east-south-east was about 15 m.p.h.

Upper air temperatures are available at Aboukir and Ismailia between 13h. and 14h. G.M.T. on March 9th (see Fig. 1). At Aboukir an inversion is shown about 9,000 feet and at Ismailia about 6,000 feet. These inversions presumably occurred at the cold front. If the angle of slope is determined for these two observations, the surface of discontinuity is found to be at ground level about 70 miles east of Amman in reasonable agreement with the passage of the front at Amman at about 1h. G.M.T. March 9th.

About seven hours after the cold front passed Aboukir, Heliopolis, Ismailia and Ramleh the trace on the microbarograph

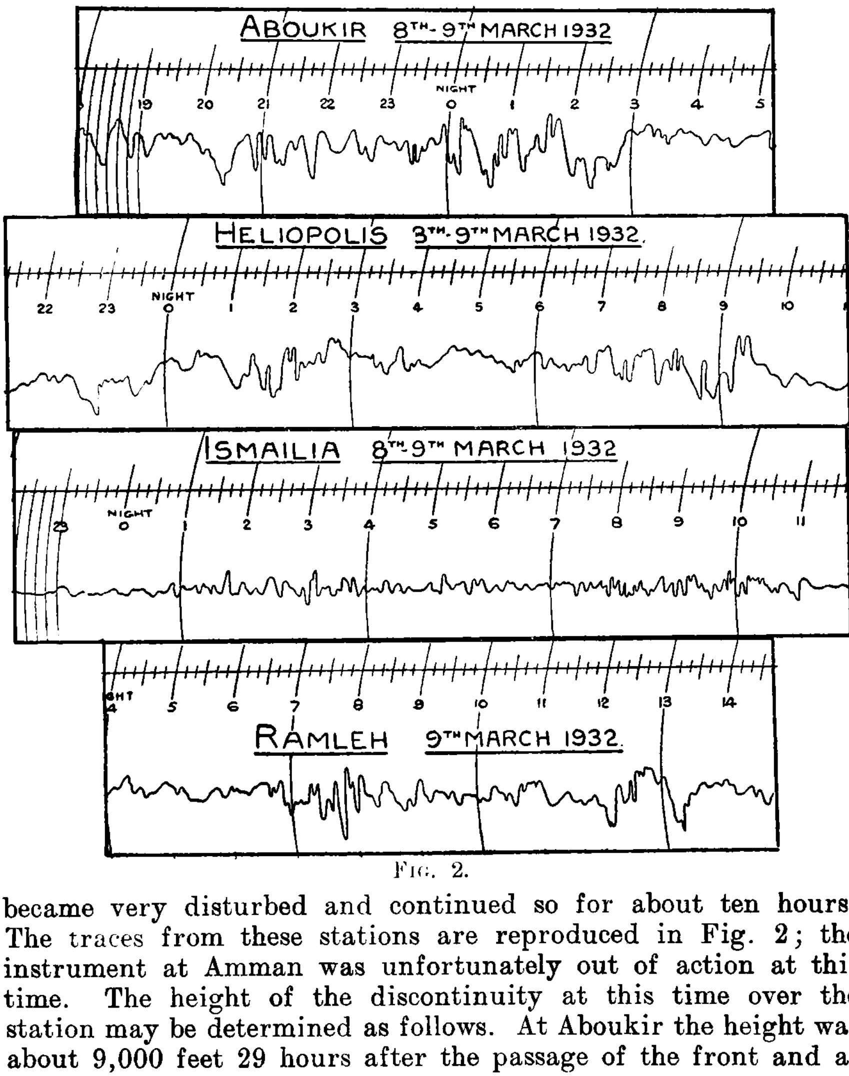


FIG. 2.

became very disturbed and continued so for about ten hours. The traces from these stations are reproduced in Fig. 2; the instrument at Amman was unfortunately out of action at this time. The height of the discontinuity at this time over the station may be determined as follows. At Aboukir the height was about 9,000 feet 29 hours after the passage of the front and at

Ismailia 6,000 feet 22 hours after. The height 7 to 17 hours after the passage of the cold front is therefore approximately 2,200-5,300 feet at Aboukir and 1,900-4,700 feet at Ismailia. Roughly then in this case a wave motion set up at a surface 2,000-5,000 feet above the ground was recorded on a microbarograph.

Additional data for determining the heights of the discontinuity can also be obtained from pilot balloon observations.

At Heliopolis at 5h. G.M.T. on March 9th, 1932, the following upper winds were measured :—

1,000 ft.	297°	25 m.p.h.
2,000 ,,	301°	25 ,,
3,000 ,,	295°	23 ,,
4,000 ,,	273°	21 ,,
5,000 ,,	255°	22 ,,
6,000 ,,	262°	31 ,,

the height of the discontinuity at this time calculated from temperature considerations was 4,275 feet and the winds show a change from about 295° 23 m.p.h. through a transitional layer to 255° 22 m.p.h. at 5,000 feet. Wind changes at Ismailia at 8h. 45m. G.M.T. were almost exactly similar.

A point which invites comment is the rather sudden appearance and disappearance of the oscillations. The theory of Goldie indicates that the oscillation should be in evidence at the surface when the wave length (λ) is large compared with the height (h) of the discontinuity on which the wave motion originates, but there is nothing to indicate that the relation between " λ " and " h " is such that the wave motion commences and ceases suddenly.

J. DURWARD.

The Effect of Tapping a Kew Barometer before Reading

On all certificates of examination of Kew pattern barometers issued by the National Physical Laboratory, the following note occurs :—

In order to obtain the highest accuracy from this instrument, it is advisable to tap both the cistern and the brass tube before taking a reading.

The question of lag in a Kew barometer has been extensively investigated at the National Physical Laboratory, as explained in the article on " Barometers and Manometers," Dictionary of Physics, Volume III, pp. 158-63. The lag depends on the variations in the accommodation of the menisci in the cistern and in the tube. On page 160 the following passage occurs: " In a given barometer tube the average variation of the angle of contact from its mean value was found to be $\pm 8°$. This does not include variation with age, but represents variations dependent on the position and cleanness of the mercury in the tube, and also to some extent on the rising or falling condition of the meniscus." On page 162, we have also the following: "It should be remarked that during an increase of pressure the tendency of a Kew barometer to read low is twofold, *i.e.*, the flattening of the cistern meniscus consequent upon mercury flowing into the barometer tube operates in the same direction as the bulging of the meniscus in the tube, due to increase of pressure. Unless the barometer is tapped there will undoubtedly be an appreciable difference between its rising and falling indications. Tapping very nearly eliminates this difference in the case of Kew barometers with unconstricted tubes."

No quantitative results for a Kew barometer are given in the article quoted above and it was felt that figures obtained from a station Kew pattern barometer would be of general interest. When the standard Fortin barometer was returned to Eskdalemuir from Casella after repair in July, 1932, an overlapping comparison was made with the Kew pattern barometer then in use as standard, prior to the Fortin barometer being reintroduced as standard. Advantage was also taken of the opportunity to test the effect of tapping the Kew barometer before reading.

The experiments were carried out in October and November, 1932, and rather more than 300 readings were taken under the following conditions:—

(1) The two barometers were read six times a day at 7, 9, 13, 15, 18 and 21h.

(2) One observer took all the readings for a week, each man taking a week in rotation.

(3) On alternate days the Kew barometer was tapped before reading. On the other days it was not tapped.

(4) A note of the barometric tendency was made at the time of observation.

The mean differences from all the readings are:—

	Kew-Fortin.
Kew barometer tapped	+ 0·096 mb.
Kew barometer not tapped	+ 0·04 mb.

Thus the Kew barometer reads slightly higher than the Fortin and the mean effect of tapping the Kew barometer is to increase the difference between the two by 0·056 mb.

The differences were then analysed according as the barometer was rising, steady or falling, and the following summary shows the effect of the barometric tendency on the magnitude of the changes due to tapping. The figures in brackets denote the number of readings:—

	Difference (Kew-Fortin).		
	Bar. rising.	*Bar. steady.*	*Bar. falling.*
Kew barometer tapped ...	+0·08 (41)	+0·09 (94)	+0·13 (30)
Kew barometer not tapped	−0·02 (34)	+0·06 (90)	+0·09 (15)
Difference (tapped—not tapped)	+0·10 mb.	+0·03 mb.	+0·04 mb.

Thus, as may be expected, the Kew barometer lags behind the Fortin, the difference being greater when the barometer is rising than when it is falling. This may be accounted for by the meniscus of the mercury in the Kew barometer tending to flatten-out when the barometer is falling fairly rapidly. For marine barometers under laboratory tests the difference between rising and falling indications varies from 0·34 mb. to 0·17 mb. for ordinary changes of barometric pressure (*loc. cit.*). The effect of tapping the Fortin barometer before reading was not investigated. The bore of the tube of the Fortin barometer is 1 in. and it was assumed that the variations in the shape of the meniscus of the mercury in such a tube would be negligibly small. (*Cf.*, p. 162; *loc. cit.*). In any case, the effect of adjusting the level of the mercury in the cistern to the fiducial point will answer the same purpose as tapping, by disturbing the menisci in the cistern and tube, thus ensuring that the normal stable shape is produced before a reading is taken.

R. E. WATSON.

Cold Spell in Egypt, February, 1934

The Report on the weather of Egypt for February, 1934, states that :—

" From the 8th until the end of the month Egypt was almost continuously under the effect of low pressure over the eastern Mediterranean, and a prolonged spell of abnormally cold weather was experienced.

" On the 10th the depression over Cyprus deepened, and the weather became very unsettled and rainy for three days. At Alexandria the wind velocity at one time reached 90 kilometres an hour, and maintained gale force for 15 hours; conditions over the eastern Mediterranean were very rough. A current of cold air from the Black Sea reaching Egypt on the 10th eventually traversed the Sudan to the extreme south.

" The weather improved on the 12th, but two days later a depression moved from Asia Minor to Cyprus and deepened. Very severe cold was prevailing at this time in the Balkans, and on the 15th northerly winds arriving from this region struck western Egypt, resulting in remarkably cold weather conditions along the coast. At Salum the temperature fell to freezing point (an extremely rare phenomenon for coastal localities in Egypt), and sleet and snow fell more or less continuously during the morning. The ground was covered, in some places about an inch deep, and the western and north-western walls of buildings were covered with snow, which remained for some hours. During this blizzard the wind velocity rose to 90 kilometres (56 miles) an hour. Freezing point was reached also on the following night. At Mersa Matruh the temperature did not exceed 4°C. throughout the day, and fell to 2°C. during the night. At Alexandria the minimum temperature was 2·8°C. (37·0° F.)—the lowest on record there since 1888 at least. Heavy rain and hail fell along the coast, the largest amount recorded being 28 mm. (1·10 in.) at Matruh and in many localities severe sandstorms occurred, seriously affecting transport. The cold wave crossed Egypt rapidly, and in the early morning of the 17th the temperature fell to freezing point at many places in the Delta and the Fayum, and even at Qena in Upper Egypt, while in the oases of Baharia, Dakhla and Kharga, temperatures of 3°, 2° and 4°C. below freezing point were registered. In the Sudan the temperature fell to 9° or 10°C. below the normal.

"Subsequently the cold became less pronounced, but on the 23rd, following the passage of a depression along the Mediterranean to 'Iraq, winds from Asia Minor again brought a sharp fall in temperature in Egypt, and the cold weather continued with gradually diminishing intensity until the end of the month."

Royal Society of Arts

On April 13th, Mr. J. H. Field, C.S.I., late Director-General of Observatories, India, read a paper on "The Meteorology of India" before the Indian Section of the Royal Society of Arts. The Chair was taken by Dr. G. C. Simpson, C.B., F.R.S. Mr. Field described recent meteorological work in India—the application of seismographs to the forecasting of cyclones, the investigation of the free air at moderate heights, the dangers, especially from turbulent currents, when flying among the mountains, and the possibilities of motorless soaring and gliding in India. Finally he referred to the part played by meteorologists in India in the investigation of the stratosphere and the general circulation of the atmosphere in the tropics.

Review

India Meteorological Department, Scientific Notes, Vol. V, No. 54—*A Note on fog and haze at Poona during the cold season.* By L. A. Ramdas, M.A., Ph.D., and S. Atmanathan, M.A., 1933.

From the top of the meteorological tower (120 feet) at Poona, the authors made observations on the development of fog and haze over the city. During the cool months it was found that the dust raised into the atmosphere during the day began to settle in the evening into a definite haze layer which persisted until sunrise. The variations in height and thickness of this layer at night were observed and in the Note are discussed briefly with reference to temperature and humidity; also the nocturnal variation of turbulance is deduced. Finally, a description is included of the effect of a katabatic wind on the haze layer; on one occasion the upper surface of the layer was seen to develop into a wave form. The paper opens an important subject which is clearly capable of further detailed investigation, both practically and theoretically, and the results of further study by the authors will be awaited with interest.

A. F. Crossley.

Obituary

Prof. Demetrius Eginitis.—We regret to learn of the death at Athens on March 14th of Professor Demetrius Eginitis. Prof. Eginitis was born in Athens on July 22nd, 1862. In 1890 he became Director of the National Observatory of Athens, a post which he retained until his death. He was also Professor of Astronomy at the University of Athens, General Secretary and at one time President of the Academy of Athens, and formerly President of the National Geodetic and Geophysical Committee. In 1917 he was appointed Minister of Public Worship and Education. He was the author of numerous publications in the field of meteorology, seismology and astronomy, of which the best known to meteorologists is his great work on the climate of Athens. He originated the network of climatological stations in Greece and published and discussed the observations in the Annales of the Observatory, which he founded in 1916 and edited himself. In all these ways he did much to promote the study of meteorology among his countrymen, and his loss will be deeply felt.

News in Brief

We learn from Athens that M. P. Roussen has been promoted to the rank of Rear-Admiral, and has retired from the post of Director of the National Meteorological Service of Greece to take up a naval command. He is provisionally succeeded by M. A. Kyriakidis.

We learn that Dr. P. L. Mercanton has been appointed Director of the Schweizerischen Meteorologischen Zentralanstalt in Zürich on the retirement of Dr. J. Maurer.

The Weather of April, 1934

Pressure was above normal over northern Canada, the Atlantic coast of North America as far south as Atlantic City and over an area on the Rocky Mountains stretching as far south as Salt Lake City; it was also above normal over the western North Atlantic including Greenland, Europe east of 20°E. and south of 60°N. and southern Italy; the greatest excess was 11·4 mb. off the east coast of Newfoundland. Pressure was below normal over most of the United States, southern and central Canada, Alaska, the eastern North Atlantic and western Europe; the greatest deficits were over the southern British Isles and northern France and north Alaska. Temperature was above normal in Spitsbergen, southern Scandinavia and central Europe, but below normal in northern Scandinavia and Portugal. Rainfall was abundant in Norrland and western Svealand but below normal elsewhere in Sweden and in central Europe.

Over the British Isles the weather of April was generally unsettled; there was excess of precipitation in England and Scotland, and more than twice the average was recorded over a broad belt along the north and east coasts of Scotland and north-east England. Aberdeen had a total of 6·15 in. for the month, being 328 per cent. of the normal and the greatest amount recorded there for April since 1871. Sunshine was deficient except in south-west Ireland. A remarkably warm spell occurred in the middle of the month.

Until the 11th, high pressure over Iceland maintained a drift of air from the north-east across the British Isles with cool weather. Secondaries moved across westwards, causing rain in many districts and snow and sleet in Scotland (heavy locally) and at some stations in the north of England on various days from the 5th to the 10th. Low minimum temperatures were recorded, particularly on the 7th; on the 11th the minimum of 29°F. at Valentia was the lowest recorded there in April since the records began in 1870. Winds were strong locally, reaching gale force on several days at stations in Scotland and in the Orkneys. Sunshine was variable, the 5th was generally the sunniest day, though many places also had good sunshine on the 8th and 9th. On the 12th heavy rain fell in the north of England and in Scotland, Aberdeen had 2·05 in. There was heavy rain in Ireland on the 12th and 13th. From the 13th to the 18th low-pressure systems on the Atlantic caused southerly to south-westerly winds over the country; temperatures rose generally and the 15th and 16th were unusually warm for the time of year in many districts. On the 15th, which was generally the warmest day of the month, high maximum temperatures were recorded, notably 70° at

Manchester, 71° at Hull, 73° at Oxford, 75° at Kew, 78° at Tottenham and 79° at Cambridge. Rain fell on most days during this period in Scotland and Ireland but there was not much in England. On the 18th a depression was centred over Ireland and as it moved eastwards winds became northerly over the British Isles and the weather became cooler. Thunderstorms occurred locally on the 17th-19th and again on the 22nd-26th, being widespread on the 24th. On the 20th, which was sunny in many districts, several stations in the west recorded 12 hours and more of bright sunshine, and Ross-on-Wye recorded 13·3 hours. Nairn had 13 hours on the 21st. Unsettled and rather cool weather continued until nearly the end of the month, but on the 29th and 30th a ridge of high pressure covered the country, giving mainly fine or fair conditions with good sunshine records except in east England and west Scotland. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	117	—40	Liverpool	140	—19
Aberdeen	128	—23	Ross-on-Wye	119	—28
Dublin	136	—26	Falmouth	131	—57
Birr Castle	136	—18	Gorleston	125	—45
Valentia	192	+33	Kew	132	—17

Miscellaneous notes on weather abroad culled from various sources.

A warm spell occurred in many parts of Europe about the middle of the month. On the 16th in Germany temperatures above 77°F. were rcorded generally except on the coast, 80°F. was recorded at Berlin and 85°F in Upper Rhineland. Strasbourg Observatory recorded 83°F. (28·4°C.), which is the highest temperature recorded in April since the opening of the Observatory in 1891. On the 18th the maximum at Frankfurt was 83°F., which is the highest April temperature recorded there since April 26th, 1862. Abnormally warm weather in Switzerland caused the snow to melt rapidly on the mountains and the rivers were as much swollen as they usually are at the beginning of June. During a thunderstorm in Belgium on the 17th a passenger train near Namur was struck by lightning. (*The Times*, April 17-19th.)

South Africa has had an unusual amount of rain during the last four months; between November 8th, 1933, and March 8th, 1934, 17½ inches was recorded in the Graaff Reinet district. The Molopo River in the Kalahari, which last had water in it 40 years ago, is now in full flood. (*The Times*, April 7th.)

Nearly 14 inches of rain fell on the 19th in Rangoon in one of the heaviest falls in the history of Burma. (*The Times*, April 23rd.)

In Canada the belated spring thaw caused floods as the rivers were still blocked with ice. Navigation opened in the St. Lawrence on the 26th, when a steamer helped by ice breakers reached Montreal. Temperature was above normal over the western half of the United States and over portions of the Atlantic coast, but was below normal in the centre. Precipitation was moderately heavy in the Atlantic States and in portions of the Gulf States, and was scanty generally in the west. *The Times* April 4th, 28th, and *Washington, D.C., U.S. Dept. Agric. Weekly Weather and Crop Bulletin.*

Daily Readings at Kew Observatory, April, 1934

Date	Pressure, M.S.L. 13h	Wind, Dir., Force 13h	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain	Sun	REMARKS (see p. 1)
	mb.		°F	°F	%	in.	hrs.	
1	1016·3	NNE.4	35	50	56	—	3·9	
2	1015·5	NNE.4	41	52	70	—	5·6	
3	1015·9	NNE.4	39	48	63	0·07	0·0	r_0-r 13h.-15h.
4	1010·0	NNE.3	40	45	87	0·14	0·0	r_0-r4h.-9h.; 15h.-17h.
5	1002·7	E.4	36	57	30	—	9·2	mist till 10h.
6	1005·0	N.3	40	43	72	—	0·0	
7	1002·1	NE.1	37	49	60	trace	0·3	f 16h.-19h.
8	999·9	Calm	28	52	41	—	3·5	x F to 9h.
9	1004·2	N.3	39	46	60	—	2·4	
10	1006·6	SE.2	32	54	53	0·05	5·5	xF till 10h. r_0 from 19h.
11	998·6	S.4	45	63	67	0·13	0·8	r-r_0 till 8h. & 23h-24h.
12	1007·0	WSW.5	51	55	53	—	4·5	r_0 7h. & 10h.
13	1018·1	SSW.4	39	60	43	—	10·5	Solar halo 9h. & 15h.
14	1012·7	SW.4	52	60	79	0·01	0·0	r_0 early & 15h.
15	1014·6	S.5	50	75	50	—	6·1	
16	1018·6	SW.2	53	67	67	—	5·7	
17	1009·2	SSW.3	49	65	58	—	10·9	
18	996·3	SW.5	46	52	73	0·11	1·5	pr 8h. pr_0 12h.30m.
19	1003·8	WNW.3	45	58	55	0·01	7·5	prh_0 10h.
20	1016·3	W.2	43	57	46	—	11·5	
21	1009·8	SSW.3	43	57	87	0·13	0·8	r_0 morning & evening
22	1004·6	NW.2	44	57	45	—	7·7	
23	1003·9	NW.4	39	55	47	0·07	3·1	r 22h.35m. to 24h.
24	987·9	WNW.2	41	53	60	0·27	5·3	tlhr 11h.; t 15h.20m.
25	996·1	SW.4	39	55	55	0·10	4·7	rr_0 evening [17h.-18h.
26	993·0	SSW.2	43	55	82	0·13	3·9	prr_0 during day; tl
27	1005·1	N.2	43	53	69	0·20	0·6	rf evening
28	1015·0	W.2	44	54	74	0·04	0·4	t 14h. fr_0 evening
29	1019·7	ESE.3	37	61	54	0·01	6·7	F morning
30	1019·3	ENE.4	43	62	65	—	9·1	

General Rainfall for April, 1934

England and Wales ...	137	per cent of the average 1881-1915.
Scotland	182	
Ireland	107	
British Isles	142	

Rainfall: April, 1934: England and Wales.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	2·24	145	*Leics.* .	Thornton Reservoir ...	4·31	253
Sur .	Reigate, Wray Pk. Rd.	2·65	159	,, .	Belvoir Castle...........	2·41	157
Kent .	Tenterden, Ashenden...	2·57	159	*Rut* .	Ridlington	2·15	137
,, .	Folkestone, Boro. San .	2·05	...	*Lincs* .	Boston, Skirbeck	1·80	133
,, .	Eden'bdg., Falconhurst	2·82	151	,,	Cranwell Aerodrome ...	2·02	153
,, .	Sevenoaks, Speldhurst	2·33	...	,, .	Skegness, Marine Gdns	2·24	167
Sus .	Compton, Compton Ho.	2·35	117	,, .	Louth, Westgate	2·25	135
,, .	Patching Farm	3·41	195	,, .	Brigg, Wrawby St. ...	2·05	...
,, .	Eastbourne, Wil. Sq.	2·40	132	*Notts* .	Worksop, Hodsock ...	2·38	162
,, .	Heathfield, Barklye ...	2·65	143	*Derby* .	Derby, L. M. & S. Rly.	2·14	131
Hants.	Ventnor, Roy. Nat. Hos.	2·46	146	,, .	Buxton, Terr. Slopes	2·57	87
,, .	Fordingbridge, Oaklnds	2·26	123	*Ches* .	Runcorn, Weston Pt...	2·10	121
,, .	Ovington Rectory	2·89	153	*Lancs*.	Manchester, Whit. Pk.	1·72	90
,, .	Sherborne St. John ...	1·74	98	,, .	Stonyhurst College ...	2·19	81
Herts .	Welwyn Garden City...	1·43	98	,, .	Southport, Hesketh Pk	2·31	125
Bucks.	Slough, Upton	1·53	107	,, .	Lancaster, Greg Obsy.	3·10	138
,, .	H. Wycombe, Flackwell	1·29	79	*Yorks*.	Wath-upon-Dearne ...	1·96	124
Oxf .	Oxford, Mag. College...	1·94	126	,, .	Wakefield, Clarence Pk.	2·37	141
Nor .	Pitsford, Sedgebrook...	...	...	,, .	Oughtershaw Hall......	4·51	...
,, .	Oundle....................	1·66	...	,, .	Wetherby, Ribston H.	3·15	179
Beds .	Woburn, Exptl. Farm..	1·37	91	,, .	Hull, Pearson Park ...	1·93	124
Cam .	Cambridge, Bot. Gdns.	...	...	,, .	Holme-on-Spalding ...	2·14	129
Essex .	Chelmsford, County Lab	2·06	161	,, .	West Witton, Ivy Ho.	3·88	180
,, .	Lexden Hill House ...	2·05	...	,, .	Felixkirk, Mt. St. John	2·61	156
Suff .	Haughley House.........	2·67	...	,, .	York, Museum Gdns.	2·39	149
,, .	Campsea Ashe............	2·16	153	,, .	Pickering, Hungate ...	2·47	148
,, .	Lowestoft Sec. School	1·97	133	,, .	Scarborough	2·39	153
,, .	Bury St. Ed., Westley H.	2·63	172	,, .	Middlesbrough	2·40	102
Norf .	Wells, Holkham Hall	2·45	191	,, .	Baldersdale, Hury Res.	3·54	146
Wilts.	Calne, Castleway	2·19	118	*Durh* .	Ushaw College	4·54	240
,, .	Porton, W.D. Exp'l. Stn	1·76	105	*Nor* .	Newcastle, Town Moor	4·67	285
Dor .	Evershot, Melbury Ho.	3·44	146	,, .	Bellingham, Highgreen	3·90	180
,, .	Weymouth, Westham .	1·63	98	,, .	Lilburn Tower Gdns...	5·20	263
,, .	Shaftesbury, Abbey Ho.	2·05	96	*Cumb*.	Carlisle, Scaleby Hall	2·64	135
Devon.	Plymouth, The Hoe ...	2·79	123	,, .	Borrowdale, Seathwaite	6·50	94
,, .	Holne, Church Pk. Cott.	5·06	140	,, .	Borrowdale, Moraine...	6·96	125
,, .	Teignmouth, Den Gdns.	3·22	161	,, .	Keswick, High Hill...	4·01	131
,, .	Cullompton..............	3·44	151	*West* .	Appleby, Castle Bank	2·71	139
,, .	Sidmouth, Sidmount...	2·86	134	*Mon* .	Abergavenny, Larchf'd	3·08	121
,, .	Barnstaple, N. Dev. Ath	2·44	115	*Glam* .	Ystalyfera, Wern Ho.	4·52	119
,, .	Dartm'r, Cranmere Pool	6·10	...	,, .	Cardiff, Ely P. Stn. ...	2·74	108
,, .	Okehampton, Uplands	4·20	132	,, .	Treherbert, Tynywaun	6·05	...
Corn .	Redruth, Trewirgie ...	3·80	132	*Carm*.	Carmarthen, Priory St.	3·55	129
,, .	Penzance, Morrab Gdn.	3·97	163	*Pemb* .	Haverfordwest, School	3·17	121
,, .	St. Austell, Trevarna...	3·63	129	*Card* .	Aberystwyth	2·60	...
Soms .	Chewton Mendip	3·37	113	*Rad* .	Birm W.W. Tyrmynydd	4·74	128
,, .	Long Ashton	2·79	128	*Mont* .	Lake Vyrnwy...........	3·80	126
,, .	Street, Millfield.........	2·09	105	*Flint* .	Sealand Aerodrome ...	1·85	125
Glos .	Blockley	2·81	...	*Mer* .	Dolgelley, Bontddu ...	4·42	121
,, .	Cirencester, Gwynfa ...	1·91	102	*Carn* .	Llandudno	1·52	90
Here .	Ross, Birchlea...........	2·11	111	,, .	Snowdon, L. Llydaw 9	7·95	...
Salop .	Church Stretton.........	3·10	143	*Ang* .	Holyhead, Salt Island	1·20	58
,, .	Shifnal, Hatton Grange	2·67	159	,, .	Lligwy.....................	1·69	...
Staffs .	Market Drayt'n, Old Sp.	2·19	127	*Isle of Man*			
Worc .	Ombersley, Holt Lock	1·63	107		Douglas, Boro' Cem. ...	2·82	114
War .	Alcester, Ragley Hall..	2·92	173	*Guernsey*			
,, .	Birminghm, Edgbaston	2·20	126				

Rainfall: April, 1934: Scotland and Ireland.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per cent. of Av.
Wig .	Pt. William, Monreith	2·95	134	*Suth* .	Melvich	6·29	270
,, .	New Luce School......	2·41	90	,, .	Loch More, Achfary...	11·17	230
Kirk .	Dalry. Glendarroch ...	3·46	113	*Caith* .	Wick	5·29	266
,, .	Carsphairn, Shiel	4·90	118	*Ork* .	Deerness	4·27	206
Dumf .	Dumfries, Crichton, R.I	3·30	149	*Shet* .	Lerwick	2·33	102
,, .	Eskdalemuir Obs.......	5·09	150	*Cork* .	Caheragh Rectory	3·40	...
Roxb .	Branxholm	4·76	252	,, .	Dunmanway Rectory .	4·27	103
Selk .	Ettrick Manse............	5·10	146	,, .	Cork, University Coll.	3·52	134
Peeb .	West Linton	4·53	...	,, .	Ballinacurra	3·29	127
Berw .	Marchmont House......	4·76	236	,, .	Mallow, Longueville ...	4·70	193
E.Lot .	North Berwick Res....	2·84	203	*Kerry* .	Valentia Obsy............	3·65	99
Midl .	Edinburgh, Roy. Obs.	4·06	276	,, .	Gearhameen	6·40	111
Lan .	Auchtyfardle	1·49	...	,, .	Darrynane Abbey	3·40	99
Ayr .	Kilmarnock, Kay Pk. .	3·07	...	*Wat* .	Waterford, Gortmore...	3·36	135
,, .	Girvan, Pinmore.........	3·00	101	*Tip* .	Nenagh, Cas. Lough ..	2·36	94
Renf .	Glasgow, Queen's Pk. .	2·62	133	,, .	Roscrea, Timoney Park	1·39	...
,, .	Greenock, Prospect H.	3·58	98	,, .	Cashel, Ballinamona ...	3·47	139
Bute .	Rothesay, Ardencraig.	3·59	...	*Lim* .	Foynes, Coolnanes......	1·85	76
,, .	Dougarie Lodge.........	4·72	...	,, .	Castleconnel Rec.......	2·21	...
Arg .	Ardgour House	6·92	...	*Clare* .	Inagh, Mount Callan...	2·33	...
,, .	Glen Etive	4·84	87	,, .	Broadford, Hurdlest'n.	2·13	...
,, .	Oban	2·66	...	*Wexf* .	Gorey, Courtown Ho...	3·02	138
,, .	Poltalloch	3·46	118	*Wick* .	Rathnew, Clonmannon	2·73	...
,, .	Inveraray Castle	5·70	124	*Carl* .	Hacketstown Rectory..	3·57	135
,, .	Islay, Eallabus	3·17	110	*Leix* .	Blandsfort House	2·00	77
,, .	Mull, Benmore	8·30	107	,, .	Mountmellick............	2·21	...
,, .	Tiree	3·35	136	*Offaly* .	Birr Castle	1·89	88
Kinr .	Loch Leven Sluice......	5·52	287	*Dublin*	Dublin, FitzWm. Sq....	2·42	127
Perth .	Loch Dhu	6·65	140	,, .	Balbriggan, Ardgillan.	1·73	87
,, .	Balquhidder, Stronvar	4·32	...	*Meath* .	Beauparc, St. Cloud ...	2·66	...
,, .	Crieff, Strathearn Hyd.	4·36	199	,, .	Kells, Headfort.........	2·30	92
,, .	Blair Castle Gardens...	2·02	96	*W.M* .	Moate, Coolatore	1·41	...
Angus .	Kettins School	4·81	264	,, .	Mullingar, Belvedere...	1·95	82
,, .	Pearsie House............	4·51	...	*Long* .	Castle Forbes Gdns....	2·37	99
,, .	Montrose, Sunnyside...	6·32	347	*Gal* .	Galway, Grammar Sch.	1·86	...
Aber .	Braemar, Bank	3·96	167	,, .	Ballynahinch Castle...	2·71	77
,, .	Logie Coldstone Sch....	6·43	319	,, .	Ahascragh, Clonbrock.	1·78	70
,, .	Aberdeen, King's Coll.	6·15	328	*Mayo* .	Blacksod Point	2·82	97
,, .	Fyvie Castle	5·75	269	,, .	Mallaranny..............	3·69	...
Moray	Gordon Castle............	4·06	232	,, .	Westport House.........	2·33	86
,, .	Grantown-on-Spey......	3·49	177	,, .	Delphi Lodge............	6·20	108
Nairn .	Nairn	4·08	272	*Sligo* .	Markree Obsy...........	2·78	105
Inv's .	Ben Alder Lodge......	5·37	...	*Cavan* .	Crossdoney, Kevit Cas.	2·70	...
,, .	Kingussie, The Birches	4·42	...	*Ferm* .	Enniskillen, Portora...	2·33	...
,, .	Inverness, Culduthel R.	5·06	..	*Arm* .	Armagh Obsy...........	2·54	121
,, .	Loch Quoich, Loan......	7·97	...	*Down* .	Fofanny Reservoir......	5·46	...
,, .	Glenquoich	6·78	104	,, .	Seaforde	2·29	87
,, .	Arisaig, Faire-na-Sguir	2·30	...	,, .	Donaghadee, C. Stn....	2·95	146
,, .	Fort William, Glasdrum	...	...	,, .	Banbridge, Milltown...	1·89	92
,, .	Skye, Dunvegan.........	7·48	...	*Antr* .	Belfast, Cavehill Rd....	3·10	...
,, .	Barra, Skallary	3·01	...	,, .	Aldergrove Aerodrome	2·49	118
R & C .	Alness, Ardross Castle	6·49	267	,, .	Ballymena, Harryville	3·37	128
,, .	Ullapool	5·21	168	*Lon* .	Garvagh, Moneydig ...	3·11	...
,, .	Achnashellach	6·82	121	,, .	Londonderry, Creggan	3·70	144
,, .	Stornoway	3·73	123	*Tyr* .	Omagh, Edenfel.........	2·43	92
Suth .	Lairg	4·96	215	*Don* .	Malin Head..............	2·58	...
,, .	Tongue	6·61	252	,, .	Killybegs, Rockmount.	1·69	...

Climatological Table for the British Empire, November, 1933

STATIONS	Pressure: Mean of Day M.S.L. mb.	Pressure: Diff. from Normal mb.	Temp. Absolute Max. °F.	Temp. Absolute Min. °F.	Temp. Mean Max. °F.	Temp. Mean Min. °F.	Temp. Mean ½ max. and min. °F.	Temp. Mean Diff. from Normal °F.	Mean Wet Bulb °F.	Relative Humidity %	Mean Cloud Am'nt 0—10	Precipitation Am'nt in.	Precipitation Diff. from Normal in.	Precipitation Days	Bright Sunshine Hours per day	Bright Sunshine Percentage of possible
London, Kew Obsy.	1013·6	− 1·0	56	31	47·5	38·7	43·1	− 0·9	40·1	89	7·5	0·94	− 1·28	10	1·6	18
Gibraltar	1012·8	− 5·2	70	44	62·6	49·3	55·9	− 4·1	49·5	82	4·6	8·55	+ 2·12	18	..	..
Malta	1013·8	− 2·1	77	52	69·2	60·6	64·9	+ 1·0	59·3	73	6·4	2·95	− 0·62	11	4·6	45
St. Helena	1012·9	− 0·8	65	53	60·5	54·2	57·3	− 2·3	55·2	95	9·4	2·08	..	24	..	..
Freetown, Sierra Leone	1012·2	+ 1·3	89	62	84·4	67·1	75·7	− 5·5	75·4	87	7·1	13·12	+ 8·00	19	..	..
Lagos, Nigeria	1009·9	− 0·2	89	70	86·7	75·2	80·9	− 0·8	76·3	86	7·4	5·31	+ 2·64	16	6·9	59
Kaduna, Nigeria	1010·0	− 3·1	96	59	93·8	65·1	79·5	+ 3·3	70·9	79	3·9	0·22	+ 0·01	2	8·5	73
Zomba, Nyasaland	1004·3	− 4·6	93	60	86·5	67·0	76·7	+ 1·1	66·1	58	5·6	3·81	− 1·27	8	..	..
Salisbury, Rhodesia	1010·6	− 1·0	91	54	79·1	60·0	69·5	− 1·2	61·8	62	6·5	9·29	+ 5·69	17	5·0	39
Cape Town	1015·0	− 0·8	91	52	75·9	58·6	67·3	+ 2·9	59·3	65	3·0	0·43	− 0·66	1	..	..
Johannesburg	1012·4	− 0·2	80	44	71·8	52·0	61·9	− 1·8	55·6	74	6·6	10·90	+ 5·94	20	7·0	52
Mauritius	1017·0	+ 0·9	86	64	82·4	67·6	75·0	− 0·5	68·7	60	6·2	0·46	− 1·12	18	9·8	75
Calcutta, Alipore Obsy.	1012·8	− 0·5	87	60	83·5	65·7	74·6	+ 1·1	65·7	80	2·0	0·00	− 0·65	0*	..	..
Bombay	1011·0	− 1·0	94	71	90·3	73·9	82·1	+ 1·5	71·5	71	2·3	0·01	− 0·44	0*	..	..
Madras	1011·0	− 0·3	87	65	84·7	72·4	78·5	− 0·4	74·8	87	6·6	5·76	− 7·85	8*	..	..
Colombo, Ceylon	1010·1	+ 0·1	89	68	84·2	72·3	78·3	− 1·7	75·1	79	5·6	8·72	− 3·04	16	6·4	54
Singapore	1008·8	− 0·6	89	70	85·2	72·4	78·8	− 1·8	75·6	83	7·9	9·12	− 0·79	23	3·3	27
Hongkong	1017·3	− 0·3	82	59	75·3	65·3	70·3	+ 0·7	63·1	64	4·3	4·13	+ 2·39	6	6·8	61
Sandakan	1008·5	..	90	72	88·4	74·6	81·5	+ 0·6	77·7	83	7·3	11·37	− 3·35	19	..	..
Sydney, N.S.W.	1016·3	+ 2·5	76	50	69·2	58·6	63·9	− 3·1	60·5	72	7·4	4·54	+ 1·69	15	5·9	42
Melbourne	1016·6	+ 2·2	88	43	72·7	51·2	61·9	+ 0·6	55·2	63	5·9	2·46	+ 0·23	9	6·8	48
Adelaide	1015·9	+ 0·7	101	42	78·0	55·5	66·7	− 0·3	56·3	39	6·1	0·18	− 0·97	5	8·6	62
Perth, W. Australia	1016·2	+ 0·8	99	48	80·3	59·1	69·7	+ 3·6	59·1	45	4·5	0·24	− 0·56	3	10·4	76
Coolgardie	1015·2	+ 2·1	100	43	81·4	54·0	67·7	− 3·0	56·8	39	3·0	0·96	+ 0·37	3	..	..
Brisbane	1012·7	− 1·9	84	58	76·6	63·3	69·9	− 3·6	65·1	68	8·5	8·41	+ 4·68	19	5·5	39
Hobart, Tasmania	1018·0	+ 8·4	80	39	64·5	47·7	56·1	− 1·1	51·8	57	6·2	2·04	− 0·43	10	7·7	53
Wellington, N.Z.	1016·9	+ 4·8	72	35	62·4	47·6	55·0	− 1·8	52·5	71	7·1	1·58	− 1·94	9	7·0	49
Suva, Fiji	1011·1	0·0	90	69	85·4	72·6	79·0	+ 1·9	74·6	77	6·4	14·76	+ 4·97	23	7·0	54
Apia, Samoa	1009·8	+ 0·3	88	71	85·1	73·9	79·5	+ 0·8	76·5	77	5·7	12·63	+ 2·80	20	7·3	57
Kingston, Jamaica	1011·4	− 1·0	87	68	84·5	70·4	77·5	− 1·8	70·8	92	4·7	6·09	+ 3·06	15	6·7	59
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1014·2	− 3·1	61	7	39·0	24·4	31·7	− 5·3	28·6	78	7·4	1·43	− 1·20	7	3·0	31
Winnipeg	1017·2	− 0·2	40	16	25·5	9·5	17·5	− 3·8	16·5	83	8·0	0·00	− 1·07	0	1·7	19
St. John, N.B.	1011·2	− 3·4	54	9	37·3	22·6	29·9	− 6·8	26·3	74	7·5	2·51	− 1·90	10	3·5	36
Victoria, B.C.	1024·2	+ 8·3	55	36	48·7	43·1	45·9	+ 1·4	44·6	96	8·6	3·88	− 1·53	19	1·5	16

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

M.O. 371.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 69
June 1934
No. 821

LONDON: PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses; ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

An analysis of Warm Spells in London from 1900-33, with special reference to the prevailing conditions of Humidity

By F. H. DIGHT, B.Sc.

Marked extremes of temperature when they occur in this country excite much popular interest. Thus the "Great Frost" of February, 1929 will long be remembered and the same is true of the more noteworthy spells of very warm weather popularly known as "Heat Waves." As far as these "Heat Waves" are concerned it is not generally understood that the degree of comfort or otherwise experienced by the human body depends on the prevailing "wet bulb" temperature* and much less so on the reading of the ordinary "dry bulb" thermometer. Several references to the subject are to be found in British meteorological literature, but more attention has been paid to it in countries where greater extremes of temperature are experienced, notably in America and by C. W. B. Normand† in India. F. C. Houghton‡ gives a scale of "Effective Temperatures" which combines the effect of the three variables into a series of single comparative temperatures as indices of the degree of human comfort. The reading of the wet bulb thermometer depends on the rate of evaporation of water from the bulb

* The Observers' Handbook.

† *London, Q.J.R., Meteor. Soc.*, 46, 1920, p. 1.

‡ *J. Amer. Soc. Heat. and Vent. Engineers, New York*, 1926, p. 737.

(6748) 32/91 1,000 6/34 M. & S., Ltd. *Gp.303*

surface and on the wind velocity and is thus controlled by the prevailing conditions of humidity and wind in the air. The human body when perspiring has thus been compared to a wet bulb thermometer.

There is an increasing demand in recent years for data of humidity and its variations which is not conveniently met by the published observations of this element. The engineers in particular, faced with the design of conditioning plants with which are being equipped many of the large and varied modern buildings now being erected in London and in other large cities at home and abroad, are finding it essential to have greater detail in humidity data.

The original purpose of this note was to provide more critical data concerning the humidity of the air, in an effort to meet some of the demands of the engineers and others. Much useful information of the mean value of the relative humidity at each hour of the day and for each month is given in a Meteorological Office publication* for five observatories and a few other stations in the British Isles. But the mean figures do not indicate the degree of humidity to be expected on a warm summer day, and although it is known to vary considerably, it is difficult to estimate the maximum value likely to be experienced with dry bulb temperatures ranging up to 90°F. or above. Practically saturated air is sometimes found in summer with temperatures of from 65°-70°F., but it is not true that in the British Isles a very hot day is also a very humid day.

The data used in this investigation were extracted from the published values of the hourly readings from the autographic records of the instruments at Kew Observatory, Richmond, for the period 1900-1933. For every occasion during the 34 years that the hourly reading of the dry bulb thermometer reached or exceeded 85.0°F. the corresponding value of the wet bulb (or relative humidity) was tabulated; the maximum temperature was also noted for each of the days concerned. On a few days a maximum temperature of 85°F. or more was shown without a corresponding entry in the hourly value column and in these instances hourly readings of the dry and wet bulb slightly below 85°F. were noted.

For any sample of air the three variables, the wet bulb temperature, the relative humidity and the dew point are all so dependent on the dry bulb temperature as to be almost meaningless without its specification, and a change in temperature of the air is accompanied by a marked change in the variables. Within limits, however, the absolute humidity or actual water content of the air sample must remain constant with temperature changes, at least so long as the temperature change is insufficient to cause

* "Book of Normals of Meteorological Elements for the British Isles," Sect. VI., H.M.S.O.

condensation and while evaporation into the sample is prevented.

For most practical purposes the absolute humidity in grams per cubic metre is equivalent to the vapour pressure, the actual relation being—

$$\text{Absolute Humidity in grm./m}^3 = \frac{1 \cdot 060}{(1 - at)} e$$

where e = vapour pressure in mm.
t = temperature in °C.
$a = \frac{1}{273}$

For this reason the available index of humidity for each hourly reading was used in conjunction with the Hygrometric tables and the International Meteorological tables to obtain the actual weight of water vapour in unit volume of air (grammes/cubic metre). This was sufficient to permit of an interpolation of the water content at the time of occurrence of the maximum temperature, and then by the reverse process for the determination of the relative humidity or wet bulb temperature at the same time. There appeared to be in general no very marked change in water content over the hourly interval embracing the time of maximum dry bulb. When a decided change was noticed, almost invariably the water content increased during and after the rise to the maximum dry bulb, presumably as a result of evaporation from the ground, etc. This necessitated a certain measure of discretion in the interpolation, but a reference to the actual records in one or two very difficult cases of recent date showed that the interpolated reading of the wet bulb corresponding to the occurrence of the maximum did not differ from the actual reading by more than a degree or so.

Warm Weather Spells

An analysis of the figures showed that London (Kew) has experienced a day temperature of 85·0°F. or more for a total duration of 232 hours embracing 61 days in 34 years, the extreme value being 93·9°F. This occurred on 9th August, 1911, the warmest day on record in London; at Greenwich a reading of 100°F. on this date is the highest in the records dating back to 1841. Notable warm spells were those of July, 1900; July, 1901; August 31st-September 2nd, 1906; July and August, 1911; July, 1921; July, 1923; August, 1930, and August, 1932. The summer of 1911 was easily the most outstanding period of prolonged heat, and 13 of the 61 very warm days occurred between July 8th and September 8th of that year. On five days in 1911 the temperature rose to 88°F. or above. For the 34 years maxima were between the limits 85°F.-87·5°F. on 30 days, between 87·5°F.-90°F. on 24 days, and 90°F. or above on 7 days. Temperature for the individual days are given in Table I, where every occurrence of a maximum temperature of 85°F. or above

TABLE I

DATES OF OCCURRENCE OF MAXIMUM TEMPERATURES OF 85°F. OR ABOVE AT KEW OBSERVATORY, 1900-33

Date	Maximum °F	Wet Bulb °F	Rel. Hum. %	Water Content grm/m³	Date	Maximum °F	Wet Bulb °F	Rel. Hum. %	Water Content grm/m³
		1900					1921		
June 11	86·5	67·9	35	10·7	July 10	89·2	66·6	26	8·6
July 16	89·4	73·0	44	14·5	,, 11	89·1	*63·1*	*18*	*5·8*
,, 19	89·4	71·7	40	13·2	,, 12	85·6	64·9	28	8·3
,, 20	89·4	75·4	51	16·9	,, 19	87·8	64·8	24	7·6
,, 24	86·0	71·8	48	14·4			1922		
,, 25	89·3	72·1	41	13·5	May 22	86·0	68·6	38	11·3
		1901			,, 23	86·4	69·1	39	11·8
July 18	85·6	69·2	41	12·2	,, 24	86·5	70·1	41	12·5
,, 19	87·6	69·1	36	11·4			1923		
,, 20	85.2	66·2	33	9·5	July 6	86·4	70·1	42	12·7
,, 21	86·9	69·4	38	11·4	,, 7	88·3	71·1	40	12·8
		1904			,, 11	88·5	73·4	47	15·1
Aug. 3	85·1	68·9	41	12·0	,, 12	90·1	73·2	42	14·3
,, 4	86·4	70·6	43	13·1	,, 13	89·6	71·6	39	13·0
		1906					1924		
Aug. 22	86·0	70·7	44	13·3	July 12	85·8	68·6	39	11·5
,, 31	90·9	70·7	34	11·8			1925		
Sept. 1	91·8	70·4	31	11·1	July 22	86·5	71·6	45	13·7
,, 2	91·7	69·5	29	10·4			1926		
		1911			July 14	85·3	70·1	44	13·1
July 8	85·1	70·7	47	13·7			1928		
,, 21	87·4	68·3	34	10·6	July 15	86·9	65·4	27	8·4
,, 22	88·3	68·6	33	10·5			1929		
,, 28	85·8	70·3	44	13·1	July 16	87·3	66·1	28	8·7
,, 29	87·8	70·9	41	13·0	,, 20	85·6	71·4	48	14·3
Aug. 8	88·0	69·4	36	11·5			1930		
,, 9	**93·9**	71·4	30	11.3	Aug. 27	88·0	75·0	**52**	16·5
,, 11	85.1	68·7	41	11·9	,, 28	88·0	73·4	48	15·3
,, 12	88·2	69·6	36	11·5	,, 29	89·1	**75·7**	**52**	**17·1**
,, 13	90·0	67·5	27	9·2			1932		
,, 14	85·6	67·0	35	10·4	Aug. 11	86·7	70·1	41	12·7
Sept. 7	87·3	69·7	39	12·0	,, 18	88·3	73·2	47	15·1
,, 8	87·8	68·6	34	10·9	,, 19	91·6	75·4	45	15·9
		1912			,, 20	86·4	74·1	**54**	16·4
July 12	86·7	71·2	45	13·7			1933		
		1914			June 5	85·5	66·2	32	9·5
July 1	89·0	70·8	38	12·4	July 26	88·3	70·8	39	12·6
		1917			,, 27	87·3	70·3	40	12·5
June 17	87·8	70·9	41	12·9	Aug. 6	89·4	72·1	41	13·7

No maximum temperatures of 85°F. or above were recorded at Kew Observatory in the years 1902-03, 1905, 1907-10, 1913, 1915-16, 1918-20, 1927, 1931.

is tabulated together with the corresponding wet bulb reading, the relative humidity and the water vapour content.

Passing now to the humidity conditions prevailing during these warm spells, at one end of the scale there is the outstanding remarkably dry heat which prevailed from July 10th-12th, 1921, and again on July 19th of the same year. On none of these days was the relative humidity above 33 per cent. during the warmest hours of the day, and it was for the most part below 30 per cent. On July 11th it fell below 20 per cent., reaching a minimum value (interpolated) of 17·7 per cent. at the time of maximum temperature (89·1°F.). Possibly this figure, low as it is, is still too high; evaporation from the wet bulb was so rapid that it was difficult to maintain it in efficient operation. The range of

TABLE II.

HOURLY READINGS OF THE HYGROMETER.

(a) Warm Humid Days.

(b) Warm Dry Day.

Hour	12h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	Max.
Date			20th July, 1900 (a)						
Dry Bulb	88·2	86·6	85·4	85·3	*	*	*	*	89·4
Wet Bulb	74·4	75·5	74·0	74·3	—	—	—	—	75·4
Rel. Hum.	50	58	57	57	—	—	—	—	51
Date			29th August, 1930 (a)						
Dry Bulb	86·2	87·6	88·0	88·7	88·2	87·8	85·1	*	89·1
Wet Bulb	73·3	72·5	73·5	75·2	75·3	72·2	74·2	—	75·7
Rel. Hum.	52	46	48	52	53	51	58	—	52
Date			11th July, 1921 (b)						
Dry Bulb	*	*	86·2	87·4	88·5	88·3	87·8	86·2	89·1
Wet Bulb	—	—	61·9	‡	62·8	‡	‡	66·0	63·1
Rel. Hum.	—	—	20	—	18	—	—	30	18

* Dry Bulb below 85°F. ‡ Wet Bulb unreliable.

hourly readings of the wet bulb during the period was from 68°F. with a dry bulb reading of 88°F. down to 62°F. with a dry bulb of 86°F. The outstanding periods of humid heat occurred in July, 1900, 30 years later in August, 1930, and a third in August, 1932. The recent spells, both of 3 days duration, as compared with only one very humid day on July 20th, 1900, are of greatest importance. The hourly readings in August, 1930, revealed a maximum relative humidity of 59 per cent. with temperatures of 86·4°F. and 85·5°F. on August 27th and 28th, with corresponding wet bulb readings of 75·6°F. and 74·8°F. A relative humidity of 58 per cent. was noted on August 29th, 1930 with dry and wet bulb temperatures of 85·1°F. and 74·2°F. respectively, and on July 20th, 1900, with thermometer readings of 86·6°F. and 75·5°F. At the time of maximum heat on these dates in turn, the figures were 52 per cent. at 88°F., 48 per cent. at 88°F., 52 per cent. at 89·1°F. and 51 per cent. at 89·4°F. August 20th, 1932 is also noteworthy; the temperature only rose above 85°F. for a short time between 1 p.m. and 2 p.m., and the interpolated reading for the relative humidity at the time is the highest in the series in Table I, *i.e.*, 54 per cent., although higher wet bulb temperatures and larger water contents are shown.

The highest wet bulb readings for the 34 years were 75·7°F. with a dry bulb reading of 89·1°F. on August 29th, 1930, and

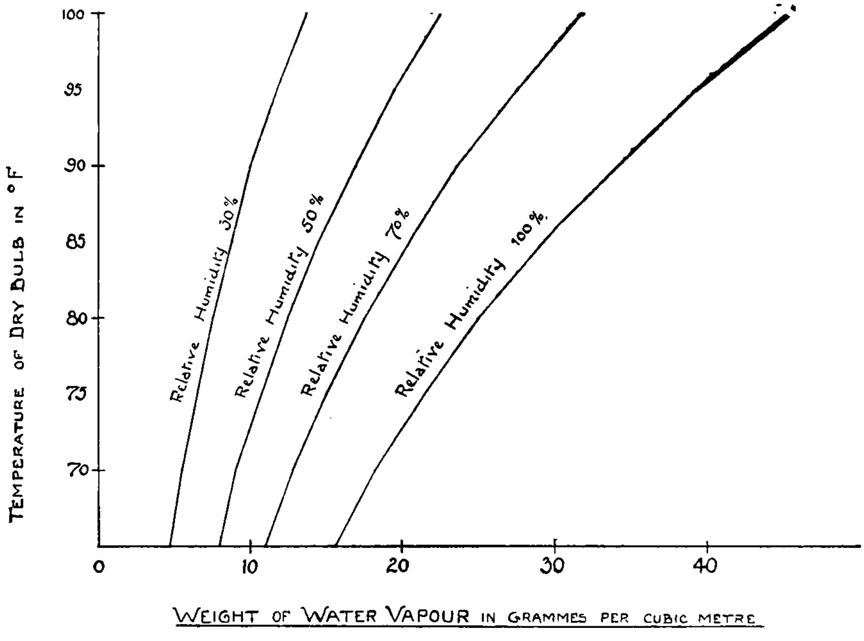


Fig 1

one of 75·4°F. with a dry bulb of 91·6°F. on August 19th, 1932. The figures indicate that the "heat wave" at the end of August, 1930 was the most uncomfortable spell of warm weather experienced in London during the present century, although again in 1932 the heat in August was only slightly less trying.

Judged from the point of view of comfort of the human body there is a strong argument for the extended use of the wet bulb temperatures, but to the engineer the exact water content of the air is probably most useful. The hourly readings of the dry and wet bulb thermometers for the two humid warm days and the warm dry spell have been set out in Table II as an indication of the limiting conditions. The relative humidity figures have also been included, and used in conjunction with the curves in Fig. 1 give an approximate figure of the actual water content of the

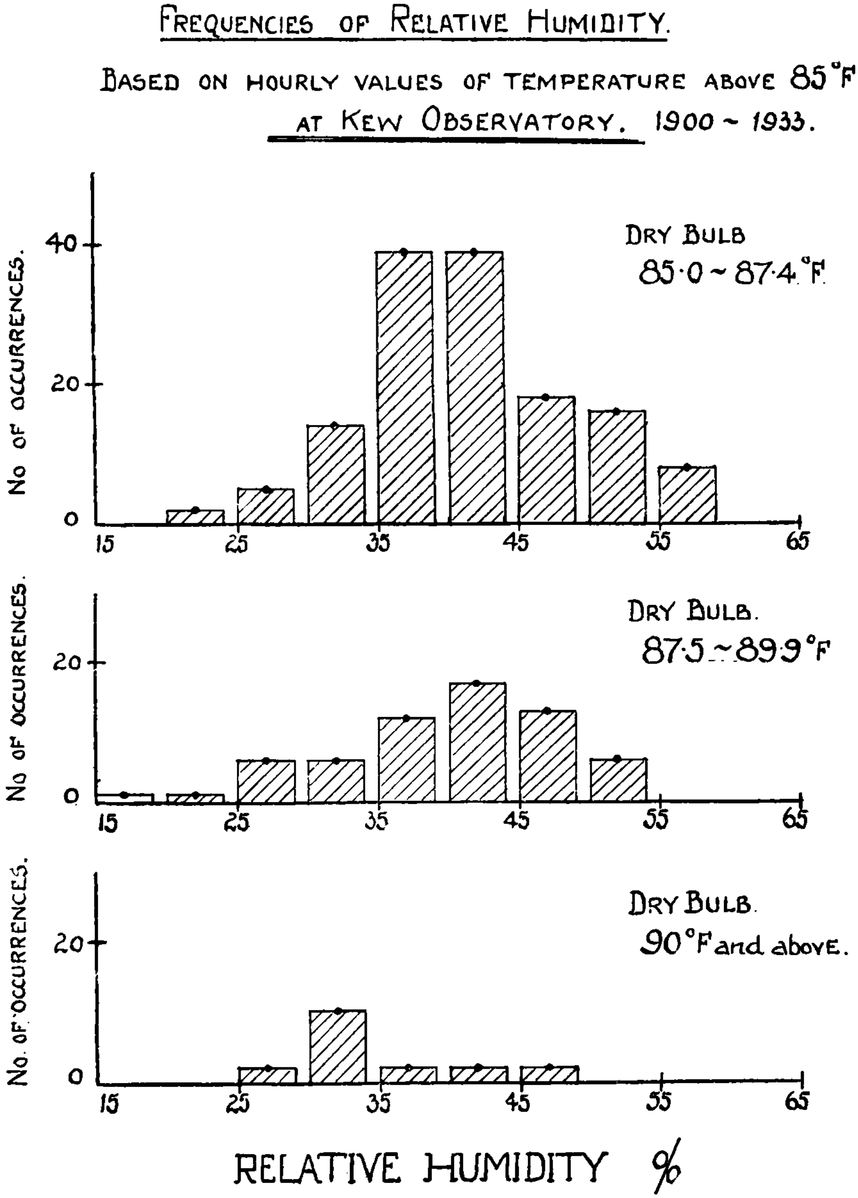


FIG. 2

air. Fig. 2 shows the frequency of occurrence of hourly values of the relative humidity for three ranges of temperature.

Generally with temperatures in excess of 85°F. the prevailing humidity ranges between 35 per cent. and 45 per cent. at the warmest part of the day. The maximum amount of water vapour contained in the air has been noted to rise to between 17·5 grm./cubic metre and 17·9 grm./cubic metre in a few of the hourly readings during the most humid spells. This is the amount necessary to produce saturation at a temperature of 69°F. Any cooling below this figure must therefore result in condensation.

As we know it is not unusual for a period of warm weather to culminate in an outbreak of thunderstorms which frequently result in a break-up of the "heat wave". In these circumstances the humidity of the air often rises rapidly almost to saturation point, and this paper would be incomplete if it did not indicate the magnitude of the rapid change in general conditions. A severe thunderstorm which broke over London in the late afternoon on July 22nd, 1925 provides one of the best examples for this purpose. At Kew the storm lasted from 5 p.m. G.M.T. until 2.30 a.m. on the following morning and gave a total rainfall of 42·6 mm. (1·68 in.). The high degree of humidity prevailing in conjunction with the high temperature has been commented on in the official records, and it is thus sufficient justification for dealing here more fully with the temperature changes that occurred. Before the diurnal fall in temperature set in soon after 2 p.m. the dry bulb had climbed to 86·5°F. with a wet bulb reading of 71·4°F. (rel. hum. 45 per cent.; moisture content 13·72 grm/m.^{3}). At 4.30 p.m. the dry and wet bulb readings were 79·7°F. and 69·8°F. respectively. With the onset of the storm rain fell heavily, and as is usual in such cases, the temperature fell rapidly. In this case a drop of 10°F. in the dry bulb to 69·3°F. occurred in less than half an hour, although the wet bulb fell only from 69·8F. to 67·0°F. The relative humidity, which had risen slowly to 58 per cent. by 5 p.m., then rose quickly to 90 per cent. before 6 p.m. It practically reached saturation point 45 minutes later, remaining there until 6.30 a.m. on the following morning. The dry and wet bulbs also remained nearly constant at about 66°F. throughout the night, the difference between the two thermometers being not more than 0·5F., indicating a water vapour content in the air of approximately 16 grm./m.^{3}, considerably greater than that prevailing in the period before the storm.

In conclusion mention should be made of two published notes which contain some interesting data bearing on the general subject of high temperatures. Dry and wet bulb temperatures together with the relative humidity, taken at Greenwich during the hot summer of 1900 are given in the *Q.J. R. Meteor. Soc.*, Vol. 27, p. 99, and provide a useful comparison with the figures for Kew shown in Table I. The second paper is a note by Marriott in the same journal, Vol. 37, p. 359, describing experiments made to determine the temperature of various objects exposed to the sunshine during the hot weather of August, 1911, when a temperature of 112°F. was recorded on a bar of iron railings exposed to the sunshine. Values of the "mean wet bulb" for a number of stations in different parts of the Empire have been published regularly in this magazine since March, 1921.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, May 16th, at 49, Cromwell Road, South Kensington, Professor S. Chapman, F.R.S., Vice-President, in the Chair.

H. J. Bigelstone.—Sixty Years Rainfall at Liverpool Observatory.

The average rainfall over the 60-year period, 1871-1930, is 28·97 in., and when the rainfall in each of the six decades is examined it is seen that the range of fluctuation is comparatively small. In three out of six decades the average fall is within two per cent of the long-period mean. The first and last decade are the only wet ones of the series, and the overall percentage of range between any two decades is only from 95 to 107 per cent of the mean. General examination of the various tables prepared stresses the abnormality of the heavy rainfall of 1872, in which year 45·66 in. were registered. This year of unparalleled wetness was followed by one of the driest years of the series, and in fact, 1872 exerts very little influence on the grouping of consecutive wet years. Grouping of the rainfall in monthly, quarterly, and half-yearly periods exhibits a marked increase in the third or autumn quarter of the year, and in the half-yearly grouping the last six months have an appreciably larger average fall than the first. A seasonal grouping—that is from April to September and from October to the following March—gives a much more uniform distribution of annual rainfall, and in so far as the development of crops and so on is affected, this seasonal grouping is a much more reasonable one. In the sixty years, August and October have the unenviable distinction of having been most frequently the wettest months of the year. April in spite of its showery reputation has never been the wettest month in any one year.

A. T. Doodson, F.R.S., and H. J. Bigelstone.—The Frequency Distribution of Rainfall at Liverpool Observatory.

The distribution of rainfall at Bidston has been examined by statistical methods and the frequency curves have been deduced for various periods. These curves have been compared with those derived from similar periods of observation at Southport (Lancs.), and North Craig (Ayrshire). In all cases it is found that the frequency distribution is skew, there being a tendency for the more frequent rainfalls to be less than the mean.

The frequency curve representing rainfall on a 59 years' basis has been tabulated, and from it conclusions can be drawn with regard to the probability of rainfall.

W. A. L. Marshall.—The mean frequency of thunder over the British Isles and surrounding areas.

The paper gives a chart showing the average annual frequency of thunder over the British Isles and neighbouring parts of the continent over a period of years, and also a series of smaller charts showing the average frequency in the individual months. The charts are briefly described.

Dr. G. C. Simpson, C.B., F.R.S.—World Climate during the Quaternary Period.

If the solar radiation were to increase from its present value there would be a general rise of temperature, increased winds, cloud and precipitation. At first the increased precipitation would result in greater accumulation of snow and the increased cloud would prevent summer melting. The polar ice caps and the ice fields on mountains would extend, spreading into lower latitudes in one case and to lower heights in the other. The steady increase of temperature, however, would soon prevent further advance of the ice and would finally lead to a disappearance of the ice owing to melting. On a subsequent reduction of solar radiation the reverse sequence would be followed: appearance and advance of ice, then a retreat of the ice due to decreasing precipitation and so back to present conditions with small ice fields both at the poles and on the mountains. Thus such an oscillation of solar radiation would give rise in high latitudes to two glacial epochs, and to two interglacial epochs, one of which would be warm and wet and the other cold and dry; while in low latitudes there would be a single pluvial period with its maximum synchronous with the maximum of the solar radiation and with the warm and wet interglacial.

Two such cycles of solar radiation have occurred during the Pleistocene Period. In high latitudes the first cycle gave rise to the Günz glacial epoch; the Günz-Mindel interglacial, which was warm and wet; the Mindel glacial; and the Mindel-Riss interglacial, which was cold and dry. The following cycle gave rise to the Riss glacial; the warm and wet Riss-Würm interglacial; the Würm glacial, and finally the present cold and dry inter-glacial.

The polar ice sheet in the glacial epochs was not symmetrical about the North Pole, but extended much further south in the Atlantic than the Pacific segment. This was due to the fact that the vast accumulations of ice in the Arctic Ocean were discharged into the Atlantic through the gap between Greenland and Norway with the consequence that the Atlantic became full of floating ice. There was no such discharge into the Pacific, where owing to the increased solar radiation the temperature was higher than at present. The geological record gives evidence of this sequence of climate. The four glacial epochs are well marked in the Alps and can be recognised in many other localities. That the Günz-Mindel and the Riss-Würm interglacial epochs were warmer than the Mindel-Riss and the present interglacials is clearly shown by the occurrence in both the former of fauna and flora which now live in much lower latitudes and did not exist in the same localities in the Mindel-Riss interglacial epoch. The increase in the precipitation during the Riss-Würm interglacial is shown by the great spreads of gravel in the terraces of the Thames and continental rivers associated with the " warm " fauna and flora and the Acheulean artifacts which are characteristics of this interglacial.

In low latitudes each oscillation of solar radiation gave rise to a pluvial period, so that there were two pluvial periods associated with the four glacial epochs. The first pluvial period corresponded with the Günz and Mindel glacial epochs and the intermediate Günz-Mindel warm and wet interglacial; the second pluvial period corresponded with the Riss and Würm glacial epochs and their intermediate interglacial. The minimum of solar radiation between the two oscillations corresponded with the long cold and dry Mindel-Riss interglacial epoch, and we are at present approaching a minimum and our climate is again cold and dry.

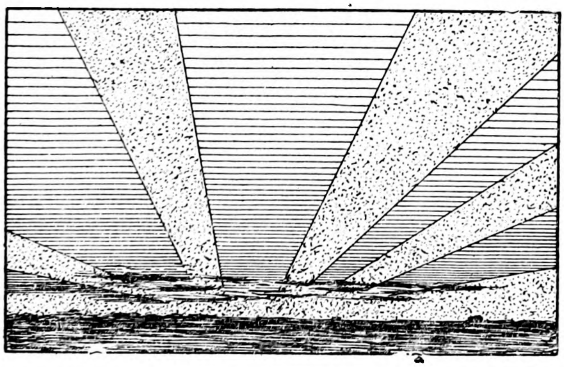
From the geological record it is estimated that at the maximum of the solar radiation the temperature was between 5°C. and 10°C. warmer than at present, and that the cloud amount was increased from the present ·5 to between ·7 or ·8. From these data it is calculated that the sun is a variable star with an amplitude of 20 per cent (range 40 per cent) in the intensity of the radiation and a period of the order of 100,000 years.

Correspondence

To the Editor, *The Meteorological Magazine.*

Strange Sunset Effect

On October 11th, 1933, a strange sunset effect was observed at 17h. 35m. G.M.T. Shafts of pale-rose light alternating with blue shadow-beams, radiated from a point on the eastern horizon diametrically opposite the sun (now set some 20 minutes). The light was registered on what appeared to be a nebula of false-cirrus homogeneously diffused over the sky. The effect did not extend beyond the zenith and there was no comparable phenomenon in the west. The radial spacing of the beams in the diagram taken from a sketch made at the time is accurate.



W. L. BAXTER.

R.A.E., South Farnborough, Hants. March 17th, 1934.

Optical Phenomena seen from Birmingham

Below is a description of optical phenomena which I observed yesterday, May 7th. I think the display justifies mention on account of the extreme brilliance. Observations were made from the ground of the Cymric Tennis Club at Handsworth Wood, on the outskirts of Birmingham and due north of it. After midday the halo of 22° was almost continuously visible, and at 16h. 36m. G.M.T. the left parhelion shone out and lasted for four minutes. At this time there was a gentle W. wind and the sky was nearly covered with cirro-stratus, below which was a little low cloud.

At 17h. 10m. the halo of 46° showed faintly outside the 22° halo, and a slight trace of what I took to be the circumzenithal arc appeared. This last soon faded out. The clouds were now getting thinner, and at 17h. 35m. in a patch of sky apparently quite free of cloud the circumzenithal arc made its appearance. It was brighter than any halo I have ever seen, even the 22° halo (I should mention that my experience of chionisms only began in 1926). The angle subtended at the zenith must have been fully a radian, and the colours were of the extreme purity associated with this arc. The violet showed up particularly well, even against the deep blue background of the sky.

Besson states that the length of time the arc is observed is about 5 minutes. On this occasion it lasted about 19 minutes. From 17h. 35m. to 17h. 45m. it was visible alone, the halos having disappeared; at 17h. 45m. parts of the 46° halo were seen, and at 17h. 55m. the 22° halo. After 18h. only the 22° halo remained, as is usual after a display of the more unusual optical phenomena. Throughout there was the added beauty of a continually varying display of iridescence on the lower clouds.

S. E. Ashmore.

22, Soho Road, Handsworth, Birmingham, 21. *May 8th,* 1934.

Halo Phenomena, Whit Sunday

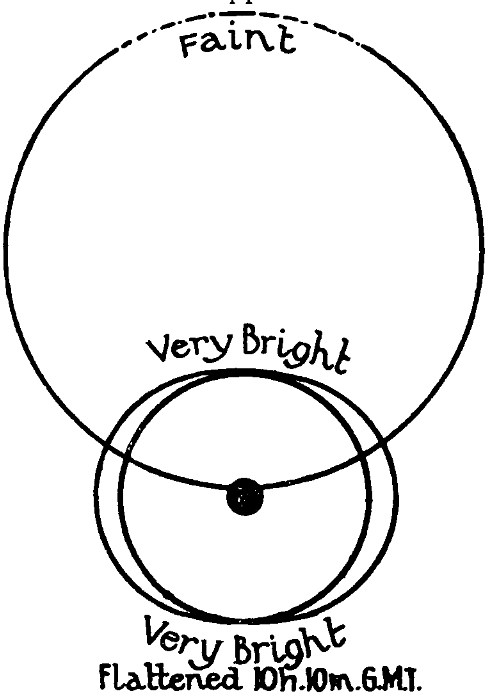
On May 19th at 14h. the 22° halo with upper contact arc was noted.

On May 20th, Whit Sunday, at 8h., the 22° halo with upper contact arc was seen again. There was a faint right parhelion. About 9h. 30m. the lower arc began to appear, and by 10h. the circumscribed halo was fully developed and bright especially at the points of contact with the 22° halo. In addition a large portion of the parhelic circle was to be seen. Lack of time prevented exact measurements, but the circle could be traced on both sides right up to the glare surrounding the sun, and also for some considerable distance outside the halo, especially on the right side. At 11h. 40m. the 22° halo was still visible but lower clouds intervened.

CICELY M. BOTLEY.

Guildables, 17, *Holmesdale Gardens*, *Hastings*. *May 20th*, 1934.

At 10h. 10m. G.M.T. on the morning of May 20th, the following phenomenon was observed here. It consisted of the ordinary halo with the upper and lower tangent arcs which formed an elliptical halo outside the ordinary circular one. The whole was very distinct, and the upper and lower junctions of the arcs with the halo were very brilliant and prismatic; the lower one was decidedly flattened where it joined the halo. In addition to this a more or less complete parhelic circle was visible at the same time; this was very faint, and was only discovered to be present with the aid of the black mirror, as the sun was shining rather brightly through a film of cirro-nebula. It was particularly noted that the parhelic circle passed inside the halos towards the sun, as indicated in the accompanying drawing. Indeed, this section of the parhelic circle was more readily discernible than that outside the halos. The phenomenon was visible until just before 10h. 55m. when cloud rapidly thickened and only an ordinary halo was visible. A solar halo was first observed as early at 7h. 40m.



At 14h. 40m., in a sheet of smooth altostratus, a very fine and brilliant solar corona was observed, consisting of two rings of colours, red being outermost. This corona extended for several degrees outwards from, and formed a complete circle round, the sun. It was quite distinct, however, from the extensive patches of colour occasionally seen on the edges of certain forms of cirrocumulus, or a high type of alto-cloud (usually observed

during the summer months), frequently referred to as iridescence.

A. E. MOON.

39, *Clive Avenue, Clive Vale, Hastings. May 26th*, 1934.

A very beautiful halo with mock suns and partial mock sun ring was witnessed at Lympne on Whit Sunday, May 20th, 1934. A partial faint ring was observed at 6h. 30m. G.M.T., which persisted until 13h. 15m. and increased in intensity as the sun rose, reaching maximum brilliance at 10h. 45m., when the halo was completed. Its radius was 22° of a great circle and the colours red, orange, and yellow were very clear and easily recognisable, with a dazzling white on the edge furthest from the sun. An unusual feature of the colours was the fact that they appeared only in the north-west quadrant of the halo, the remainder of the ring being a dazzling white.

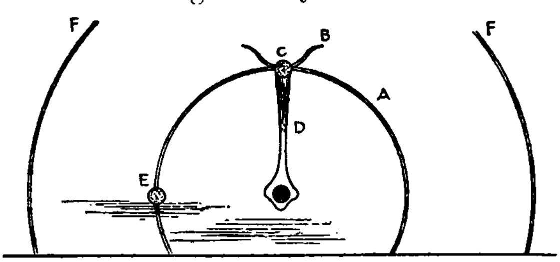
The mock sun ring also appeared only in the north-west quadrant, and was distinctly visible passing through the sun and forming a mock sun at the point of its intersection with the halo. This ring did not continue to pass beyond the sun's centre. A further mock sun, with less intensity, appeared for a short while on the opposite side of the sun but, strange to say, this one definitely appeared to be a good way " off " the mock sun ring. Was this due to an optical illusion or to the effect of cirrus cloud, of which the sky was nine-tenths covered?

D. F. BOWERING.

Lympne Airport, Hythe, Kent. May 31st, 1934.

Halo Complex in Holland, May 26th

A remarkable halo complex was visible near Nijmegen, Holland, on the evening of May 26th. About 7.45 p.m. B.S.T. a well-developed halo of 22° appeared; the left-hand side especially was brightly coloured and showed a mock sun at the point E of the sketch. At the same time there was a rudimentary cross of light about the sun, the vertical arm having a length of five or six degrees.



Towards 8 p.m. the left-hand mock sun faded, but the 22° halo remained well developed A with the upper tangent arc B and another mock sun at the point of contact C. At the same time the vertical arm of the solar cross extended upwards to this mock sun; it had a striking shape as shown by D in the figure. On each side of the 22° halo appeared a large arc of the 46° halo F also brilliantly developed.

The display was also watched by Dr. C. Braak of the Netherlands Meteorological Institute, who was with me on the train at the time. C. E. P. Brooks.

NOTES AND QUERIES

German Meteorological Service

According to the German Press, a Government Order, dated April 6th, 1934, organises the whole work of the meteorological service of Germany (excluding the educational and research work of colleges and schools) under the administration of the Air Minister. The Air Minister will be responsible for all "applied meteorology," including aviation, agriculture, marine, upper air and climatic services. The marine service was formerly maintained by the Deutsche Seewarte at Hamburg, while the agricultural and climatic services were maintained in various ways by the governments of the constituent states or even individual towns. The new decree establishes the basis for a uniform meteorological service for the whole of Germany.

Geophysical Observatory on the Pamir

We learn from a note by L. Breitfuss in *Petermann's Mitteilungen* that with a view to studying the water supply of the Amu Daria, which is supplied by the glaciers of the Pamir and is important for the cotton, fruit, and vine plantations of Turkestan, an observatory has been erected on the Fedtschenko Glacier, in Russian Turkestan, 38° 50′ N., 72° 20′ E., at a height of 4,700 m. The work was commenced in October, 1933, and in spite of the bitter cold the building was completed by the end of December. Observations have already begun.

Whirlwind at Ilford on May 26th

On the afternoon of Saturday, May 26th, a small whirlwind developed at Ilford. It first appeared in Valentines Park as a column of dust and pieces of paper about 100 feet high, travelling southwards. It passed through a group of children, whipping off the girls' hats and drawing them high into the air, while some of the children were blown over. The track then turned towards the south-west, and crossing the tennis courts, the whirl lifted boxes of tennis balls over the wire netting into the cricket ground, where a match was in progress. Here chairs were overturned and a fielder was thrown to the gound. The whirlwind then turned sharply to the left, regaining its original southerly direction. It caught a heavy wooden sight-screen, which requires two men to push it, and lifted it bodily, throwing it into an iron-rail fence, which was broken by the impact. The whirlwind then passed away across the car park and over the lake.

The *Daily Weather Report* for May 26th shows a well-developed anticyclone centred west of Ireland, where pressure exceeded 1032 mb. The winds over south-east England were between north and north-east, so that the track of the whirl followed the general drift of the air. Temperatures on the ground were moderate, and upper air temperatures showed no particularly abnormal conditions. At South Farnborough and Hamburg the lapse rate in the lowest 1,000 feet was rather steep, but this was not the case at Duxford.

Obituary

Heer Peter Helbert Gallé.—We regret to learn of the death on May 9th, 1934, of Heer P. H. Gallé, well known for his work on the climatology of the sea. Gallé was born in 1874 and after four years' training at the K. Instituut voor de Marine at The Helder, at the age of twenty he was appointed to the Royal Navy of Holland, serving with distinction both in Holland and the East Indies. In 1906 he was appointed Assistant-Director of the Koninklijk Nederlandsch Meteorologisch Institut at De Bilt, his duties being especially concerned with marine meteorology, and in this capacity he attended the conference on Safety of Life at Sea in London in 1913 and 1914. He published a number of monographs on temperatures, winds and currents in the Indian and Atlantic Oceans, based on the rich store of material accumulated at De Bilt, and his paper "On the relation between fluctuations in the strength of the trade winds in the North Atlantic in summer and departures from the normal of the winter temperature in Europe," published in 1916, caused some discussion. In 1919 Gallé was appointed Director of the Oceanographical Branch of the Meteorological Institute, which has its office at Amsterdam, where he brought out his book on the "Climatology of the Indian Ocean," published in seven sections between 1924 and 1930. He received many distinctions including the Gold de Ruyter medal. His relations with his colleagues were always pleasant and his loss will be deeply regretted.

Professor William Morris Davis.—We regret to learn of the death of Professor W. M. Davis at the age of nearly 84 at Pasadena, California, on February 6th. Professor Davis was a physical geographer who for about ten years, 1884 to 1894, devoted himself to the subject of meteorology. At first his chief interest was the study of winds and storms, particularly thunderstorms, and he wrote many papers on this subject, but later he turned to other aspects of meteorology. In 1894 his book of Elementary Meteorology, which is still used as a text book in United States colleges, was published. He was a stimulating teacher and was active as a founder and member of the New England Meteorological Society. In recognition of his services to meteorology and his help in the founding of the American Meteorological Society, Professor Davis was elected in 1928 an honorary life member of this society—the only man to hold this distinction.

News in Brief

Dr. G. C. Simpson, C.B., F.R.S., has been elected a Corresponding Member of the Academy of Science, Vienna.

The Royal Aeronautical Society has awarded the Simms Gold Medal to Sir Gilbert Walker for his paper on cloud formation.

The Birthday Honours List includes the name of Mr. G. W. E. Loder, J.P., M.A., who since 1915 has regularly forwarded observations from his climatological station at Ardingley, Sussex. Mr. Loder is raised to the peerage with the title of Baron.

We learn that Dr. J. Maurer has retired from the directorship of the Schweizerische Meteorologische Zentralstalt. He is succeeded as Director by Dr. P. L. Mercanton, Professor at the University of Lausaune.

Mr. T. Schumann has been appointed Chief Meteorologist, Dept. of Irrigation, Pretoria, S. Africa, as from November, 1933.

Mr. Alfred Westley, of Blisworth, Northamptonshire, has 27 copies of *British Rainfall*, 1894 to 1920, which he desires to sell. Anyone interested should communicate direct with Mr. Westley.

Errata

May, 1934, photograph facing p. 93. Title under the photograph *should read* " Refraction at sea on the way to Nain, Labrador " and *for* " facing p. 9 " *read* " facing p. 93."

The Weather of May, 1934

Pressure was below normal over western and southern United States, Alaska, eastern Canada, Greenland, Spitsbergen, Iceland, northern Europe and Madeira, the greatest deficits being 8·7 mb. at Point Barrow and 8·3 mb. at Reykjavik. Pressure was above normal in a small area in western Canada, Mexico, north-east United States, Newfoundland, and across the North Atlantic to western, central, southern and eastern Europe and northern Africa, the greatest excess being 4·6 mb. at Valentia. Temperature was above normal generally but below normal in south-west Europe. Rainfall was in excess in Spitsbergen and northern Norway and southern Sweden but deficient in central Europe and only about 20-40 per cent in Norrland, Sweden.

The weather of May over the British Isles was mainly dry in the south and unsettled in the north, the outstanding features being the high temperatures experienced on the 11th and in south and south-east England also on the 12th, and the absolute drought in places in eastern and south-eastern England and the Midlands from the 16th or 17th onwards. On the 1st rain fell in Scotland, but on the 2nd and 3rd mainly dry fine conditions prevailed, except locally in the south-east, over the whole country, though fog occurred at many places on the 1st and 2nd. At Spurn Head the temperature did not rise above 46°F. on the 1st owing to fog, while 70° was recorded at South Farnborough and Ross-on-Wye. Thunderstorms occurred on the 2nd and 4th. From the 4th to 9th depressions passing across the country gave unsettled weather but with bright intervals. On the 6th the southerly winds reached gale force in parts of Scotland, Ireland, and north England, a gust of 77 m.p.h. being recorded at Valentia. The rainfall was generally slight during this period, though heavy rain fell locally on the 4th and 6th, 2·11 in. at Watendlath, Cumberland, and 1·43 in. at Tairbull, Brecon, on the 6th. After the 8th the depressions passed further north and high pressure spread northwards over the country so that from the 10th to 13th fine dry warm weather prevailed over England, but cloudy mild conditions occurred in Scotland and Ireland becoming unsettled there on the 12th. Temperatures were high generally, 84°F. was recorded at Cambridge on the 11th, 82°F. at South Farnborough and 81°F. at Tottenham and Southampton on the 12th. A trough of low pressure brought cooler conditions locally early on the 12th in the north and later in the Midlands where it was accompanied by thunder. The sunniest day of this period was the 11th when 14·5 hrs. were recorded at Eastbourne and 14·4 hrs. at Torquay. From the 13th to 21st depressions passing across the country, first south-eastwards and then north-eastwards, caused cool unsettled weather with bright periods. Hardly any rain fell in the south, but heavy rain occurred locally in the north and west; 2·08 in. fell at Snowdon (Carnarvon) and 1·82 in. at Borrowdale (Cumberland) on the 15th. Snow and sleet occurred generally, and gales locally in Scotland, sleet and hail fell in the Midlands, while thunderstorms were reported on the 13th, 14th and 16th from south and east England. Ground frosts were experienced frequently. On the 21st the anticyclone over France moved northwards and from then to the 31st anticyclonic conditions prevailed with mainly fair weather though much cloud developed at times in the north and west with slight rain or drizzle. The 24th, 26th, 27th, 30th and 31st were all very sunny days, 15·0 hrs. bright sunshine were recorded at Weymouth on the 24th, at Valentia on the 26th, and at Falmouth and Cardiff on the 27th, 15·1 hrs. at Lowestoft on the 30th, and 15·0 hrs. at Dalwhinnie on the 31st. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	151	—30	Liverpool	153	—46
Aberdeen	188	+15	Ross-on-Wye	211	+18
Dublin	182	— 5	Falmouth	243	+28
Birr Castle	159	—15	Gorleston	207	—22
Valentia	154	—35	Kew	201	— 2

Miscellaneous notes on weather abroad culled from various sources.

A cloudburst accompanied by hail destroyed the vines and crops at Orjais near Covilhan, Portugal, on the 11th, and a storm of hail, rain, wind and thunder of unusual violence occurred at Rome on the 12th. A violent hailstorm wrought great havoc among the vineyards of Tokay and the surrounding district of the Hegyalja on the 17th, but the plentiful rain all over Hungary during the previous two days saved the grain harvest. Night frosts caused much damage to the vineyards in the side-valleys of the Moselle about the 20th. Crops have been lost in some of the southern regions of Russia owing to drought. (*The Times*, May 14th-29th.)

Severe gales were experienced at Karachi on the 9th. A cloudburst at noon on the 14th destroyed a portion of the old part of Tiberias on the Sea of Galilee. Two inches of rain fell in 45 minutes and 25 people were killed. Another cloudburst on a similar scale occurred at noon on the following day. The monsoon rain had not reached Burma by the 21st, which constitutes a record for nearly 50 years. Little rain fell in the Madras Presidency, and a heat-wave was experienced towards the end of the month. (*The Times*, May 12th-June 1st.)

Rainfall in South Australia this year was 4 in. short of the average towards the end of May. (*The Times*, May 29th.)

About the 9th and 10th duststorms occurred over Saskatchewan, where the previous week-end snow ploughs had had to be used to clear the roads and railways. These duststorms developed in intensity over western Canada and western United States and then spread eastwards. A heat-wave was experienced in Canada in the later part of the month accompanied by forest fires, but rain fell in north-west Quebec and north Ontario about the 28th and the heat-wave had broken by the 31st. Copious rain also fell on the 30th in north Alberta, but in the central regions drought still prevailed. In the United

(*Continued on p.* 132)

Rainfall: May, 1934: England and Wales.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond	Camden Square	·46	26	*Leics.*	Thornton Reservoir	·96	48
Sur	Reigate, Wray Pk. Rd.	·58	31	,,	Belvoir Castle	·72	34
Kent	Tenterden, Ashenden	·61	39	*Rut*	Ridlington	·71	35
,,	Folkestone, Boro. San.	1·09	...	*Lincs*	Boston, Skirbeck	·80	45
,,	Eden'bdg., Falconhurst	·76	41	,,	Cranwell Aerodrome	·50	28
,,	Sevenoaks, Speldhurst	·67	...	,,	Skegness, Marine Gdns	·93	55
Sus	Compton, Compton Ho.	·66	30	,,	Louth, Westgate	1·19	59
,,	Patching Farm	·44	24	,,	Brigg, Wrawby St.	·94	...
,,	Eastbourne, Wil. Sq.	·49	30	*Notts*	Worksop, Hodsock	1·02	51
,,	Heathfield, Barklye	·68	38	*Derby*	Derby, L. M. & S. Rly.	·77	40
Hants	Ventnor, Roy. Nat. Hos.	·78	46	,,	Buxton, Terr. Slopes	3·22	104
,,	Fordingbridge, Oaklnds	·93	45	*Ches*	Runcorn, Weston Pt.	1·82	79
,,	Ovington Rectory	1·24	57	*Lancs*	Manchester, Whit. Pk.	1·91	90
,,	Sherborne St. John	·82	42	,,	Stonyhurst College	4·28	150
Herts	Welwyn Garden City	·68	37	,,	Southport, Hesketh Pk	3·26	156
Bucks	Slough, Upton	·39	23	,,	Lancaster, Greg Obsy.	4·58	185
,,	H. Wycombe, Flackwell	·42	23	*Yorks*	Wath-upon-Dearne	·92	45
Oxf	Oxford, Mag. College	·69	39	,,	Wakefield, Clarence Pk.	·90	46
Nor	Pitsford, Sedgebrook	·77	40	,,	Oughtershaw Hall	6·24	...
,,	Oundle	·49	...	,,	Wetherby, Ribston H.	1·36	66
Beds	Woburn, Exptl. Farm	·48	25	,,	Hull, Pearson Park	·81	42
Cam	Cambridge, Bot. Gdns.	...	...	,,	Holme-on-Spalding	1·37	68
Essex	Chelmsford, County Lab	·51	35	,,	West Witton, Ivy Ho.	2·00	89
,,	Lexden Hill House	·99	...	,,	Felixkirk, Mt. St. John	·84	45
Suff	Haughley House	1·04	...	,,	York, Museum Gdns.	1·00	50
,,	Campsea Ashe	1·88	125	,,	Pickering, Hungate	1·18	60
,,	Lowestoft Sec. School	1·22	76	,,	Scarborough	1·10	58
,,	Bury St. Ed., Westley H.	·75	41	,,	Middlesbrough	·66	34
Norf	Wells, Holkham Hall	1·76	109	,,	Baldersdale, Hury Res.	...	...
Wilts	Calne, Castleway	·89	47	*Durh*	Ushaw College	1·96	91
,,	Porton, W.D. Exp'l. Stn	·78	45	*Nor*	Newcastle, Town Moor	1·08	53
Dor	Evershot, Melbury Ho.	1·20	59	,,	Bellingham, Highgreen	1·73	72
,,	Weymouth, Westham	·68	42	,,	Lilburn Tower Gdns	1·62	70
,,	Shaftesbury, Abbey Ho.	·76	36	*Cumb*	Carlisle, Scaleby Hall	2·80	117
Devon	Plymouth, The Hoe	2·27	110	,,	Borrowdale, Seathwaite	11·75	170
,,	Holne, Church Pk. Cott.	2·64	83	,,	Borrowdale, Moraine	9·21	166
,,	Teignmouth, Den Gdns.	·96	52	,,	Keswick, High Hill	5·18	162
,,	Cullompton	1·66	77	*West*	Appleby, Castle Bank	...	...
,,	Sidmouth, U.D.C.	·81	...	*Mon*	Abergavenny, Larchf'd	1·62	61
,,	Barnstaple, N. Dev. Ath	1·54	74	*Glam*	Ystalyfera, Wern Ho.	4·09	117
,,	Dartm'r, Cranmere Pool	4·20	...	,,	Cardiff, Ely P. Stn.	1·57	63
,,	Okehampton, Uplands	3·26	121	,,	Treherbert, Tynywaun	5·16	...
Corn	Redruth, Trewirgie	2·43	105	*Carm*	Carmarthen, Priory St.	...	...
,,	Penzance, Morrab Gdn.	1·65	75	*Pemb*	Haverfordwest, School	2·38	95
,,	St. Austell, Trevarna	1·74	72	*Card*	Aberystwyth	4·22	...
Soms	Chewton Mendip	1·52	55	*Rad*	Birm W.W. Tyrmynydd	3·09	90
,,	Long Ashton	1·46	69	*Mont*	Lake Vyrnwy	4·05	129
,,	Street, Millfield	·99	52	*Flint*	Sealand Aerodrome	1·43	76
Glos	Blockley	·74	...	*Mer*	Dolgelley, Bontddu	5·93	179
,,	Cirencester, Gwynfa	·98	48	*Carn*	Llandudno	3·17	178
Here	Ross, Birchlea	1·43	67	,,	Snowdon, L. Llydaw 9	12·35	...
Salop	Church Stretton	2·14	83	*Ang*	Holyhead, Salt Island	3·87	197
,,	Shifnal, Hatton Grange	·99	48	,,	Lligwy	4·39	...
Staffs	MarketDrayt'n, Old Sp.	1·04	47	*Isle of Man*			
Worc	Ombersley, Holt Lock	1·00	49		Douglas, Boro' Cem.	3·36	133
War	Alcester, Ragley Hall	·92	45	*Guernsey*			
,,	Birminghm, Edgbaston	·92	43		St. PeterP't. Grange Rd	1·42	83

Rainfall: May, 1934: Scotland and Ireland.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per cent. of Av.
Wig	Pt. William, Monreith	3·94	167	*Suth*	Melvich	2·75	134
,,	New Luce School	4·66	164	,,	Loch More, Achfary	7·13	162
Kirk	Dalry, Glendarroch	3·94	125	*Caith*	Wick	1·76	85
,,	Carsphairn, Shiel	6·23	148	*Ork*	Deerness	2·16	108
Dumf	Dumfries, Crichton, R.I	2·67	103	*Shet*	Lerwick	2·67	128
,,	Eskdalemuir Obs.	4·79	145	*Cork*	Caheragh Rectory	3·58	...
Roxb	Branxholm	3·03	135	,,	Dunmanway Rectory	4·06	119
Selk	Ettrick Manse	4·19	114	,,	Cork, University Coll.	1·98	88
Peeb	West Linton	2·84	...	,,	Ballinacurra	2·17	91
Berw	Marchmont House	1·83	74	,,	Mallow, Longueville	2·34	105
E.Lot	North Berwick Res.	1·43	72	*Kerry*	Valentia Obsy	2·26	71
Midl	Edinburgh, Roy. Obs.	1·24	61	,,	Gearhameen	4·40	84
Lan	Auchtyfardle	2·56	...	,,	Darrynane Abbey	2·15	72
Ayr	Kilmarnock, Kay Pk.	3·43	...	*Wat*	Waterford, Gortmore	2·83	123
,,	Girvan, Pinmore	4·95	166	*Tip*	Nenagh, Cas. Lough	2·40	97
Renf	Glasgow, Queen's Pk.	...	...	,,	Roscrea, Timoney Park	1·15	...
,,	Greenock, Prospect H.	3·82	111	,,	Cashel, Ballinamona	1·87	78
Bute	Rothesay, Ardencraig.	3·88	...	*Lim*	Foynes, Coolnanes	2·00	86
,,	Dougarie Lodge	3·85	...	,,	Castleconnel Rec.	2·23	...
Arg	Ardgour House	7·09	...	*Clare*	Inagh, Mount Callan	4·01	...
,,	Glen Etive	8·24	165	,,	Broadford, Hurdlest'n.	2·26	...
,,	Oban	3·62	...	*Wexf*	Gorey, Courtown Ho.	2·44	110
,,	Poltalloch	4·79	166	*Wick*	Rathnew, Clonmannon	2·33	...
,,	Inveraray Castle	6·48	165	*Carl*	Hacketstown Rectory	2·53	97
,,	Islay, Eallabus	3·47	131	*Leix*	Blandsfort House	1·78	73
,,	Mull, Benmore	14·50	194	,,	Mountmellick	1·62	...
,,	Tiree	2·85	114	*Offaly*	Birr Castle	2·00	90
Kinr	Loch Leven Sluice	2·17	89	*Dublin*	Dublin, FitzWm. Sq.	1·78	87
Perth	Loch Dhu	...	...	,,	Balbriggan, Ardgillan.	1·51	73
,,	Balquhidder, Stronvar	3·58	..	*Meath*	Beauparc, St. Cloud	1·68	...
,,	Crieff, Strathearn Hyd.	2·07	83	,,	Kells, Headfort	2·17	80
,,	Blair Castle Gardens	2·78	137	*W.M*	Moate, Coolatore	1·85	...
Angus	Kettins School	1·87	69	,,	Mullingar, Belvedere	2·11	86
,,	Pearsie House	2·62	...	*Long*	Castle Forbes Gdns.	2·69	104
,,	Montrose, Sunnyside	1·88	92	*Gal*	Galway, Grammar Sch.	3·50	...
Aber	Braemar, Bank	2·99	126	,,	Ballynahinch Castle	3·94	109
,,	Logie Coldstone Sch.	2·91	117	,,	Ahascragh, Clonbrock.	2·81	101
,,	Aberdeen, King's Coll.	3·45	148	*Mayo*	Blacksod Point	3·74	133
,,	Fyvie Castle	2·63	102	,,	Mallaranny	4·62	...
Moray	Gordon Castle	2·57	121	,,	Westport House	2·48	87
,,	Grantown-on-Spey	...	...	,,	Delphi Lodge	7·31	121
Nairn.	Nairn	1·98	110	*Sligo*	Markree Obsy	3·07	112
Inv's	Ben Alder Lodge	3·69	...	*Cavan.*	Crossdoney, Kevit Cas.	3·02	...
,,	Kingussie, The Birches	2·69	...	*Ferm*	Enniskillen, Portora	2·80	...
,,	Inverness, Culduthel R.	2·02	...	*Arm*	Armagh Obsy	2·80	118
,,	Loch Quoich, Loan	...	...	*Down*	Fofanny Reservoir	4·57	...
,,	Glenquoich	...	...	,,	Seaforde	3·25	124
,,	Arisaig, Faire-na-Sguir	...	...	,,	Donaghadee, C. Stn.	3·00	132
,,	Fort William, Glasdrum	5·80	...	,,	Banbridge, Milltown	2·22	99
,,	Skye, Dunvegan	3·81	...	*Antr*	Belfast, Cavehill Rd.	3·76	...
,,	Barra, Skallary	3·05	...	,,	Aldergrove Aerodrome	2·83	125
R&C	Alness, Ardross Castle	2·81	108	,,	Ballymena, Harryville	4·11	144
,,	Ullapool	2·41	94	*Lon*	Garvagh, Moneydig	2·96	...
,,	Achnashellach	7·07	158	,,	Londonderry, Creggan	3·22	123
,,	Stornoway	2·61	102	*Tyr*	Omagh, Edenfel	3·75	145
Suth	Lairg	2·42	95	*Don*	Malin Head	2·56	...
,,	Tongue	2·56	107	,,	Killybegs, Rockmount.	...	...

Climatological Table for the British Empire, December, 1933

STATIONS	PRESSURE		TEMPERATURE								Relative Humidity	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
	Mean of Day M.S.L.	Diff. from Normal	Absolute Max.	Absolute Min.	Mean Values Max.	Mean Values Min.	Mean Values ½ max. and min.	Mean Values Diff. from Normal	Mean Wet Bulb				Am'nt	Diff. from Normal	Days	Hours per day	Per-cent-age of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F	°F.		%	0—10	in.	in.			
London, Kew Obsy.	1021·8	+ 8·1	44	25	38·5	32·0	35·3	− 5·0	32·6		82	8·1	0·32	− 1·97	5	0·6	8
Gibraltar	1016·5	− 3·8	66	35	58·3	45·1	51·7	− 4·3	45·7		81	5·3	8·56	+ 3·14	16	..	..
Malta	1012·5	− 3·7	69	43	62·1	53·0	57·5	− 0·4	52·4		73	6·3	5·42	+ 1·71	15	5·8	60
St. Helena	1011·5	− 1·4	68	55	64·4	56·7	60·5	− 1·2	57·5		94	9·5	0·77	..	14	..	..
Freetown, Sierra Leone	1012·7	+ 1·3	89	64	85·6	67·6	76·6	− 4·8	72·4		73	2·0	1·23	− 0·19	6	..	..
Lagos, Nigeria	1009·5	− 0·5	90	70	87·1	75·0	81·1	− 0·7	74·4		83	4·8	0·97	+ 0·16	2	7·2	62
Kaduna, Nigeria	..	..	99	53	92·4	57·8	75·1	+ 1·8	59·2		53	1·6	0·00	0·00	0	9·3	81
Zomba, Nyasaland	1008·8	+ 0·5	83	52	77·9	63·9	70·9	− 2·2	66·1		78	8·0	11·04	+ 0·17	23	..	..
Salisbury, Rhodesia	1011·2	− 0·5	82	51	76·7	58·0	67·3	− 2·3	61·7		68	6·5	5·21	− 0·88	13	5·9	45
Cape Town	1013·4	− 0·9	96	57	82·3	62·4	72·3	+ 4·4	62·7		61	3·8	0·04	− 0·77	2	..	..
Johannesburg	1011·7	+ 0·7	87	43	74·6	53·9	64·3	− 1·2	56·9		68	5·8	5·94	+ 0·51	14	6·9	50
Mauritius	1013·4	− 0·6	90	64	85·3	70·2	77·7	− 0·6	72·3		65	6·6	2·00	− 2·73	17	8·5	64
Calcutta, Alipore Obsy.	1014·0	− 1.7	82	54	77·9	57·8	67·9	+ 1·4	58·9		87	1·3	0·00	− 0·24	0*	..	..
Bombay	1012·0	− 1·5	92	65	86·2	69·5	77·9	+ 0·5	67·5		73	2·1	0·93	+ 0·88	3*	..	..
Madras	1011·7	− 1·8	85	63	82·6	68·9	75·7	− 1·0	71·6		87	5·8	15·00	+ 9·65	6*	..	..
Colombo, Ceylon	1010·2	− 0·1	88	66	84·8	71·7	78·3	− 1·2	73·8		74	4·9	1·16	− 3·96	5	7·7	66
Singapore	1009·0	− 0·7	89	69	84·7	71·5	78·1	− 1·8	74·8		82	7·2	4·49	− 6·07	18	4·4	37
Hongkong	1017·3	− 2·4	77	55	70·4	61·4	65·9	+ 2·9	60·0		71	4·2	1·37	+ 0·34	5	6·7	62
Sandakan	1008·2	..	91	71	88·7	74·2	81·5	+ 1·3	76·8		84	7·9	9·25	− 9·39	22	..	..
Sydney, N.S.W.	1013·9	+ 2·0	90	55	75·4	62·4	68·9	− 1·2	64·2		69	6·2	3·33	+ 0·47	18	8·0	56
Melbourne	1014·3	+ 1·6	90	47	74·7	56·3	65·5	+ 0·7	59·4		64	6·8	4·74	+ 2·47	13	6·6	45
Adelaide	1014·9	+ 1·7	102	49	81·6	57·9	69·7	− 1·4	58·4		40	4·3	0·83	− 0·17	7	9·9	69
Perth, W. Australia	1013·6	+ 0·4	103	52	83·9	62·9	73·4	+ 2·6	63·1		52	3·9	0·04	− 0·52	1	10·2	72
Coolgardie	1012·0	+ 0·8	110	51	90·6	60·8	75·7	0·0	62·4		41	2·5	0·40	− 0·29	2	..	..
Brisbane	1012·4	+ 0·4	88	62	81·6	66·7	74·1	− 2·3	68·2		81	6·7	5·20	+ 0·31	19	7·4	54
Hobart, Tasmania	1013·2	+ 3·5	90	43	68·5	51·9	60·2	0·0	53·9		58	6·5	1·93	− 0·06	17	7·5	49
Wellington, N.Z.	1014·6	+ 2·4	74	43	66·3	53·6	59·9	− 0·3	56·1		70	7·3	0·89	− 2·33	9	8·1	54
Suva, Fiji	1010·0	+ 1·4	92	72	85·9	74·6	80·3	+ 1·3	76·2		80	6·5	18·95	+ 6·43	25	6·8	52
Apia, Samoa	1009·4	+ 1·1	86	71	83·0	73·8	78·4	− 0·9	75·7		82	8·0	15·63	+ 1·74	23	4·7	36
Kingston, Jamaica	1014·8	+ 0·8	88	63	85·2	68·0	76·6	− 1·1	67·8		89	6·0	0·90	− 0·69	6	6·9	62
Grenada, W.I.	..	..	..	..	..	..	..	..	..		..	..	..	..	..	..	..
Toronto	1019·6	+ 2·0	50	−22	31·5	16·9	24·2	− 2·9	20·0		52	7·2	1·09	− 1·38	11	2·4	27
Winnipeg	1021·9	+ 3·2	40	−42	5·6	−14·8	−4·6	−10·4	..		..	5·3	0·00	− 0·94	0	2·9	35
St. John, N.B.	1015·7	+ 1·7	43	−21	24·2	6·6	15·4	− 9·0	12·0		72	6·9	1·86	− 2·31	6	3·1	35
Victoria, B.C.	1009·0	− 7·7	56	30	45·2	38·4	41·8	+ 0·7	40·0		84	8·5	10·34	+ 4·60	25	1·2	14

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

Climatological Table for the British Empire, Year 1933.

STATIONS	PRESSURE: Mean of Day M.S.L. mb.	PRESSURE: Diff. from Normal mb.	TEMPERATURE Absolute: Max. °F.	TEMPERATURE Absolute: Min. °F.	TEMPERATURE Mean Values: Max. °F.	TEMPERATURE Mean Values: Min. °F.	TEMPERATURE Mean Values: ½ max. and min. °F.	TEMPERATURE Mean Values: Diff. from Normal °F.	TEMPERATURE Mean: Wet Bulb °F.	Relative Humidity. %	Mean Cloud Am'nt 0—10	PRECIPITATION: Am'nt in.	PRECIPITATION: Diff. from Normal in.	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
London, Kew Obsy.	1016·6	+ 1·2	89	23	58·3	44·5	51·4	+ 1·7	45·6	84	6·4	18·24	− 5·56	127	4·8	39
Gibraltar	1016·5	− 1·4	96	35	71·7	56·6	64·1	− 0·1	56·4	83	4·4	49·28	+ 14·01	92	..	..
Malta	1015·4	0·0	94	42	70·2	60·1	65·2	− 0·9	59·5	73	4·8	20·48	+ 0·62	90	8·3	68
St. Helena	1013·7	− 0·2	73	52	64·3	57·6	60·9	− 0·6	58·4	94	9·1	22·40	..	207	..	..
Freetown, Sierra Leone	1013·3	+ 1·9	93	62	85·9	71·3	78·6	− 2·1	75·6	85	5·6	145·13	− 12·10	188	..	..
Lagos, Nigeria	1011·4	+ 0·6	95	66	86·0	75·6	80·8	+ 0·1	75·8	86	7·4	75·85	+ 3·87	145	5·4	45
Kaduna, Nigeria	..	..	100	53	89·8	66·5	78·2	+ 1·8	67·9	69	5·5	43·94	− 9·89	111	7·3	60
Zomba, Nyasaland	1011·5	− 0·8	93	45	79·2	60·2	69·7	+ 0·3	62·5	65	5·5	41·29	− 13·25	107	..	..
Salisbury, Rhodesia	1014·4	− 0·5	91	34	76·9	52·9	64·8	− 0·5	56·8	59	3·5	33·71	+ 2·16	81	8·0	66
Cape Town	1017·0	0·0	105	36	71·8	54·3	63·0	+ 0·7	54·9	77	4·3	18·14	− 6·90	86	..	..
Johannesburg	1015·2	+ 0·1	91	25	71·7	49·7	60·7	+ 1·0	50·4	56	3·1	30·59	− 2·63	90	8·9	74
Mauritius	1016·0	− 0·1	93	53	80·3	67·2	73·8	− 0·2	69·5	70	6·2	34·38	− 15·28	224	7·7	64
Calcutta, Alipore Obsy.	1007·7	+ 0·1	101	48	87·3	71·3	79·3	+ 0·5	71·8	85	4·7	81·86	+ 17·54	103*	..	..
Bombay	1008·4	− 0·8	100	57	87·7	74·7	81·2	+ 0·6	73·5	77	4·1	62·37	− 9·82	74*	..	..
Madras	1008·5	− 0·3	102	63	89·8	75·2	82·5	− 0·6	75·4	78	6·4	40·18	− 9·38	43*	..	..
Colombo, Ceylon	1010·0	+ 0·3	91	66	85·0	74·5	79·8	− 1·2	76·1	79	6·6	89·49	+ 9·36	200	6·3	52
Singapore	1009·1	− 0·4	93	68	87·2	73·7	80·4	− 0·5	76·7	81	6·2	82·52	− 12·60	200	5·6	46
Hongkong	1012·7	+ 0·2	93	41	78·0	69·0	73·5	+ 1·2	67·8	75	6·9	62·32	− 23·41	139	5·8	48
Sandakan	1009·3	..	93	71	87·7	75·1	81·4	+ 0·1	77·1	82	7·1	114·69	− 10·10	189	..	..
Sydney, N.S.W.	1016·0	+ 0·1	101	37	69·7	55·9	62·8	− 0·1	57·7	72	5·9	42·71	− 4·77	153	6·5	54
Melbourne	1016·6	+ 0·3	99	32	67·7	49·1	58·4	0·0	52·5	69	6·1	22·28	− 3·19	136	5·6	46
Adelaide	1017·3	+ 0·3	108	37	72·0	52·4	62·2	− 0·8	53·9	54	5·9	22·12	+ 0·94	130	6·8	56
Perth, W. Australia	1016·7	+ 0·3	112	38	74·7	56·4	65·5	+ 1·3	57·4	61	4·5	32·47	− 1·90	115	8·1	66
Coolgardie	1016·1	+ 0·2	113	34	77·3	52·1	64·7	+ 0·2	54·3	52	3·3	9·21	− 1·06	53	..	..
Brisbane	1015·7	− 0·2	98	38	77·2	60·2	68·7	− 0·2	62·3	68	5·4	49·70	+ 4·41	118	7·5	62
Hobart, Tasmania	1013·7	+ 1·2	90	33	61·1	46·3	53·7	− 0·7	48·3	66	6·4	23·18	− 0·61	173	5·8	48
Wellington, N.Z.	1015·2	+ 0·5	82	34	60·0	48·6	54·3	− 1·1	51·3	75	7·0	38·62	− 9·42	150	5·8	48
Suva, Fiji	1011·9	+ 0·6	96	62	83·4	72·4	77·9	+ 0·9	73·4	80	6·9	151·40	+ 34·26	259	5·2	43
Apia, Samoa	1010·5	+ 0·2	89	68	85·0	73·9	79·4	+ 0·9	76·3	78	6·0	136·16	+ 26·45	230	6·8	56
Kingston, Jamaica	1012·9	+ 0·8	92	63	86·4	71·0	78·7	− 0·6	70·3	83	4·9	73·53	+ 39·94	105	..	..
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1015·2	− 1·4	98	−22	55·6	39·4	47·5	+ 2·3	42·0	71	5·6	19·12	− 12·70	115	5.8	48
Winnipeg	1015·1	− 1·1	97	−42	45·3	24·5	34·9	+ 0·3	..	..	6·2	14·58	− 5·60	55	..	..
St. John, N.B.	1013·6	− 1·0	80	−21	49·6	34·1	41·8	+ 0·6	37·9	78	6·6	47·40	− 0·68	151	5·1	42
Victoria, B.C.	1015·9	− 0·8	91	17	54·5	43·5	49·0	− 0·4	44·6	76	6·4	36·18	+ 5·87	182	5·9	48

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(*Continued from p.* 127)
States temperature was considerably above normal in the western part, while in the eastern part it was above normal at first becoming about or below normal later. Rainfall was generally below normal, and drought conditions were experienced in the north-west and middle western States. Twenty people lost their lives in floods caused by four days' torrential rain at Andacollo, Coquimbo, Chile, about the 22nd. Much damage was done to property by a cyclone at Concepcion, Chile, on the 27th. (*The Times*, May 11th-June 1st, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, May, 1934

* Date	Pressure, M.S.L. 13h	Wind, Dir., Force 13h	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain	Sun	REMARKS (see p. 1)
	mb.		°F	°F	%	in.	hrs.	
1	1012·9	NNW.2	43	67	73	—	6·1	
2	1012·7	W.2	47	63	60	0·01	1·5	f early pr$_0$14h. 16h.
3	1013·6	NNE.3	50	64	50	—	3·5	
4	1007·6	W.2	43	63	46	—	0·7	
5	1008·6	SW.3	46	59	66	0·04	4·7	r$_0$r6h.-9h.pr$_0$12h.30m.
6	1013·8	S.6	42	62	55	0.15	0.1	r$_0$9h.r$_0$r 21h.-24h..
7	1023·2	W.3	42	61	58	0·10	7·2	r$_0$r 0h.-2h.
8	1029·6	SW.2	47	59	56	0·03	0·0	r$_0$ 15h. r$_0$r 17h. 24h.
9	1029·4	NNW.2	50	59	71	0·03	0·5	r$_0$ 0h.-4h. f 15h.-17h.
10	1030·6	ENE.3	49	64	54	—	10·5	m early
11	1028·9	E.3	47	74	54	—	13·3	
12	1022·2	NE.2	49	79	50	—	9·3	tl 20h.
13	1018·3	N.W.3	52	63	42	—	11.9	
14	1015·3	NW.4	47	56	36	0·01	9·2	pr$_0$ 18h.-9h.
15	1013·4	SW.3	39	59	37	—	8·0	
16	996·5	WNW.3	48	56	60	0·07	6·0	r$_0$r 3h.-8h. pr$_0$ 12h.
17	1008·9	SW.4	37	55	44	trace	10·9	pr$_0$12h.pr$_0$h$_0$15h.30m.
18	1013·4	S.4	43	62	40	—	10·7	Solar halo 9h.
19	1014·6	SW.5	44	65	41	trace	5·3	pr$_0$ 15h. 30m.
20	1021·4	SW.4	45	60	49	—	1·2	
21	1022·5	SW.3	52	68	68	—	2·1	
22	1026·7	W.3	58	70	67	—	5·2	
23	1026·8	SW.2	54	69	64	—	0·4	
24	1025·3	NNW.2	48	65	40	—	14·0	
25	1018·6	W.1	43	66	45	trace	5·3	pr$_0$ 14h. 30m., 16h.
26	1027·6	N.3	44	58	35	—	13·1	
27	1026·2	N.W2	44	65	44	—	12·8	
28	1024·4	WNW.3	46	62	62	—	7·2	
29	1022·7	S.2	49	69	53	—	3·5	
30	1020·3	E.4	51	65	45	—	13·0	
31	1016·5	E.3	50	70	58	—	3·8	

* The dates of Sundays are in heavy type.

General Rainfall for May, 1934

England and Wales ...	71	per cent of the average 1881-1915.
Scotland	120	
Ireland	103	
British Isles	89	

M.O. 371.

The Meteorological Magazine

Vol. 69

July 1934

No. 822

Air Ministry: Meteorological Office

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

The Drought of 1933–4

In various parts of Europe and North America a period of deficient rainfall began late in 1932 or early in 1933 and has continued with little intermission through the remainder of 1933 and the early months of 1934, resulting in a serious shortage of water in many districts. In England and Wales the drought may be said to have made its first appearance in November, 1932, and it seemed best to begin this investigation with that month. The progress of the drought is shown graphically in fig. 1, which represents the cumulative excesses or deficiencies of rainfall in each month since November 1st, 1932, as percentages of the normal annual total. The zero of each curve is the line drawn through the left hand extremity. A rising curve in any month shows that the rainfall in that month was above normal, a falling curve shows that it was below normal. An accumulated excess of rain is indicated by a position of the curve above the zero line, an accumulated deficiency by a position of the curve below the zero line. Each pair of horizontal lines is separated by a distance equal to 10 per cent of the annual normal; thus the topmost curve for England and Wales shows that the accumulated deficiency had reached 10 per cent by the end of January, 1933. The heavy rains of February and March eased the situation, and the deficiency did not again reach 10 per cent until August. In December it amounted to 20 per cent, and in February, 1934, it reached 30 per cent, since then it has fluctuated about the latter figure. The figure at the right hand end of each curve shows the accumulated deficiency at the end of May, 1934.

Since in Europe there is no reason to suppose that over a long period of years there is a net accumulation or loss of water, we may suppose that under normal conditions the incomings in the form of rainfall balance the outgoings in the form of evaporation from the ground, water surfaces or vegetation, run-off in rivers, and loss of water in various ways through human action. The balance is maintained by means of a reserve of water in the soil and underlying rocks, which supplies springs and wells through a dry period. In long periods of heavy rainfall this reserve grows, though it is unfortunately true that the water from isolated heavy storms is liable to run quickly to the sea so that a large part of it is lost. In times of drought the reserve decreases, for not only is the rainfall less, but generally speaking a smaller proportion of the amount which actually reaches the ground percolates through the soil. Thus the curves of the figure may be regarded as analogous to a balance sheet between income and expenditure; a rising curve shows that the water wealth of the country has increased, a falling curve shows that it has diminished.

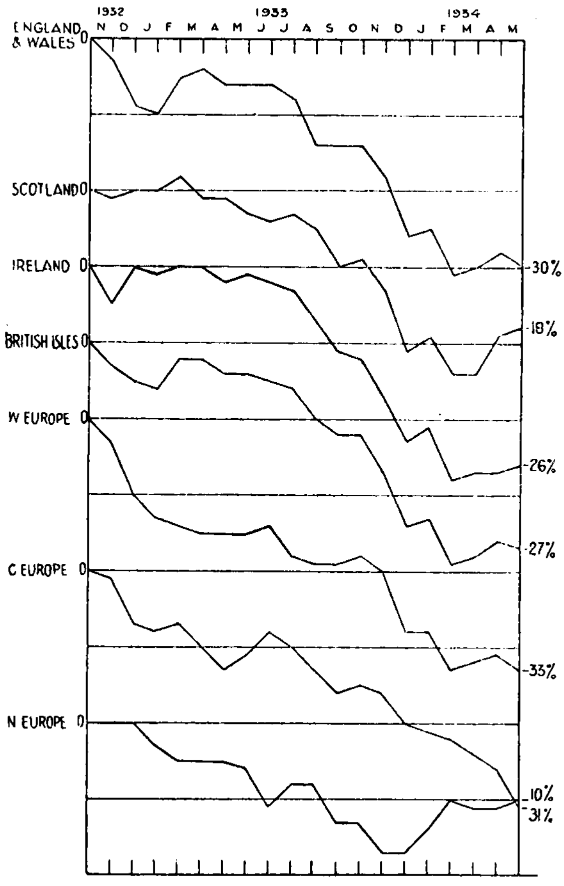


FIG. 1

The figures have been expressed in percentages of the annual rainfall rather than in actual amounts in inches because percentages give a better picture of the situation than do actual amounts. A deficiency of 4 in. in a district with an average annual rainfall of 20 in. is fully as serious as a deficiency of 8 in. in a rainfall of 40 in. The former region is on the threshold of drought even in years when the rainfall is almost up to normal, while the rainier region has a much greater margin of safety.

The percentage deficiencies can be readily converted into inches of rain by means of the following table, which shows the average annual rainfall of each of the regions for which curves are given in the figure :—

	in.		in.
England and Wales ...	35	Europe—	
Scotland	50	west	33
Ireland	43	central	33
British Isles	41	north	30

For the British Isles the accumulated deficiency by the end of May, 1934, was 27 per cent. This does not sound very alarming, but even if the weather turns wet in July, several months of abnormally heavy rain will be required to restore the balance. In the past sixty years the rainiest period of six successive months has been May to October, 1903, when the total exceeded the normal for those months by 9·1 in. or 22 per cent of the annual normal. It is true that autumn and early winter usually include the months of heaviest rainfall and least evaporation, when the reserves of water in the soil are replenished after the losses of summer even in a moderately dry season, but this year the accumulated deficiency is so great that even if the next six months are as wet as the wettest period of six months in the past sixty years, it seems doubtful if they will succeed in entirely making good our depleted reserves.

This is especially true of England and Wales, where in spite of the marked break in the drought during February and March, 1933, the accumulated deficiency at the end of May, 1934, was as much as 30 per cent. The heavy rainfall of February and March, 1933, was very fortunate for England for as a result the dry summer which followed passed without serious difficulties. In Scotland and Ireland the drought did not begin until April or May, 1933, and in these countries, especially Scotland, the accumulated deficiency is less than in England ; moreover, in these relatively rainier countries the margin of safety is much greater than in England, and little has been heard of the shortage of water there.

The drought has been most severe in the Thames valley, and at Richmond the accumulated deficiency at the end of May, 1934, was as much as 48 per cent of the annual total. This abnormally dry region includes those parts of England which normally have the least rainfall of the British Isles, and the rural parts of Essex with no elaborate organisation for water supply have suffered severely.

In western and central Europe the progress of the drought has been very similar to the British Isles, but owing largely to the absence of a wet period in the spring of 1933 the deficiency became noticeable early, especially in western Europe. In central Europe it was to some extent relieved by good summer rains, but thereafter it grew rapidly and by the end of May, 1934, amounted to a third of the normal annual rainfall. At this time the rivers, especially the Rhine, had fallen to a very low level. In northern Europe the deficiency never reached 20 per cent and at the end of May, 1934, amounted to only 10 per cent, while in southern and eastern Europe (which are not shown in fig. 1) the total rainfall from November, 1932, to May, 1934, was about normal. Eastern Europe in fact, had a slight excess, but here the normal rainfall is small, and in spite of a rainy summer in 1933, the persistent failure of the winter rains in 1933–4 is already causing difficulties.

Detailed figures for each month are not readily available for the United States, but it is clear that the drought has been even more severe than in western Europe. This is clearly shown by the map, fig. 2, which shows the rainfall of the 17 months, January, 1933, to

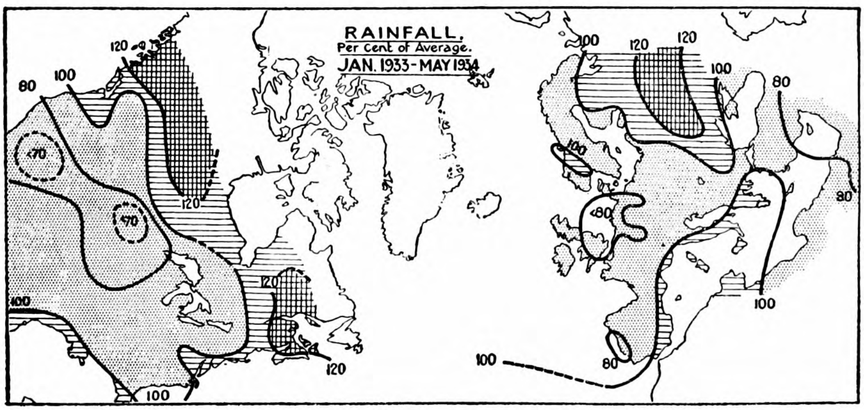


FIG. 2

May, 1934, as a percentage of the normal for those months. Areas with a rainfall below normal are stippled, while those with an excess are shaded. Areas for which no observations are yet available are left blank. The stippled areas, which are those with deficient rainfall, are seen to include the greater part of western and central Europe and practically the whole of the United States. The deficiency can only be regarded as serious however in the regions enclosed within the lines of 80 per cent; these include most of England and the neighbouring part of north-west Europe, a small part of Portugal, and a very large area in the central and western United States. In two regions, including the states of Nevada in the Far West and North and South Dakota in the Middle West, the amount is actually below 70 per cent, and as these states have a small average rainfall (Nevada 8·9 in., North Dakota 17·4 in., South Dakota 20·3 in.) the effect is far more disastrous than in Europe. In the western United States the total rainfall of January to May, 1933, was about normal, and the drought did not begin until June. By the end of February, 1934, the accumulated deficiency in the Dakotas was 30 per cent, and by April this had risen to more than 40 per cent.

The month of May was exceedingly dry, with only 14 per cent of normal in North Dakota and 20 per cent in South Dakota, and the accumulated deficiency rose to 48 per cent, or nearly half the rainfall of a normal year. The ground became so dry that the wind swept up great clouds of dust, which spread eastwards over the greater part of the country and reached New York as the phenomenal "black blizzard" of May 11th. In the British Isles the effects of the drought have been to some extent mitigated by the full reserves available from the rainfall of preceding years, which had been up to normal, but in the western and northern parts of the United States the preceding five years had been generally dry and the country had not recovered from the severe drought of 1930.

Finally, it may be of interest to compare the drought of 1933–4 with the well known droughts of 1887 and 1921. In the British Isles the driest period set in about the beginning of July, 1933, and was to some extent broken by the rains of March and April, 1934, so that we may regard its duration (leaving on one side the question of what may happen in the future) as the eight months July, 1933, to February, 1934. These eight months may be compared with the similar periods of February to September, 1921, and February to September, 1887, with the following results :—

	Percentage of normal.		
	1933–4	1921	1887
England and Wales	66	60	68
Scotland	73	87	78
Ireland	64	81	67
British Isles	67	74	71

Thus it appears that in England and Wales the drought of July, 1933, to February, 1934, was more severe than that of 1887, but less so than that of 1921. This bare comparison does not fully represent the situation however, for in 1933–4 the drought included the rainy months of winter, whereas the other two droughts merely accentuated the usual relative dryness of spring and summer. Moreover the drought of 1931 followed on a long period which had been wetter than usual, while the winter of 1932–3, as we may have seen, was on the whole rather dry. Taking into account these two considerations we may regard the drought from July, 1933 to February, 1934, as of about the same severity as the eight months drought of 1921 in England. In Scotland, Ireland and the British Isles as a whole, the eight months of drought of 1933–4 was undoubtedly the most severe in the past 60 years.

Water Supply from Roofs

In view of the attention which has been given recently to the question of utilising roofs as collectors of rainfall for the purpose of domestic water supply, the following calculations may be of interest. Their object is to ascertain the most favourable relationship between "effective" roof area and storage capacity, the average daily consumption and the average rainfall of the place being given.

The term "effective roof area" is used to represent the horizontal area on the ground to which the roof is equivalent as a collector of rainfall. The relation between the effective roof area and the actual roof area depends upon such factors as the material of which the roof is made, its pitch, its height above ground, etc. In the absence of published data on the subject, it would be necessary to ascertain the effective area by comparing the run-off from the roof with the readings of a rain-gauge over a period of months. For the purpose of the present calculation, it is necessary to assume that the ratio of run-off to rainfall is constant. This assumption is probably correct for practical purposes in the case of a roof covered with impervious material, but may not be quite correct in the case of a roof covered with porous tiles, which probably absorb and subsequently evaporate a larger percentage of summer rains than of winter rains. The conclusions arrived at are therefore to be regarded as provisional and subject to correction in the light of actual run-off data.

The problem to be discussed is "what must be the effective roof area and what must be the capacity of the storage tank if a roof-supply is to provide for a stated average daily consumption, even during the worst periods of drought?"

Consider first the simple case in which the roof area is so related to the mean annual rainfall that the yield is just sufficient to meet normal requirements. To fix ideas let us take 1,000 sq. ft. as the roof area and 24 in. as the mean annual rainfall. An inch of rain on a square foot is equivalent to half a gallon of water very nearly. Consequently the annual yield would be 12,000 gallons or about 33 gallons per day, which might prove adequate for a small family. 24 in. happens to be the mean annual rainfall at Huntingdon. From data published in the "Book of Normals, Section V," we obtain the figures in the second column of Table I, showing how the yield of 12,000 gallons is distributed through a normal year at that particular place. The difference between yield and consumption (taken as 1,000 gallons per calendar month) is shown in the third column. The last column shows the aggregate difference between yield and consumption, reckoned from the beginning of the year to the end of each calendar month. It will be seen that the stock available on January 1st would be depleted to the extent of 920 gallons by the end of May, this deficiency being gradually reduced to zero by the end of the year. In this particular example, therefore, we see that a storage capacity of the order of 1,000 gallons is required merely to meet the fluctuations occasioned by the normal seasonal variation of rainfall.

Coming now to drought conditions, we find on examining published statistics that during a dry sequence of years, the aggregate rainfall in 10 years may be of the order of 10 per cent below the long period average. In other words, starting from a fixed epoch, we must face the possibility of coping with an aggregate deficiency amounting to a year's rainfall or more. In the example chosen, therefore, storage of at least 12,000 gallons would be necessary to meet such an emergency.

TABLE I

Month.	*Yield of Roof.*	*Difference (Yield-Consumption).*	*Progressive Total.*
	gallons	gallons	gallons
January	820	− 180	− 180
February	690	− 310	− 490
March	840	− 160	− 650
April	770	− 230	− 880
May	960	− 40	− 920
June	1,090	+ 90	− 830
July	1,280	+ 280	− 550
August	1,210	+ 210	− 340
September	910	− 90	− 430
October	1,340	+ 340	− 90
November	1,040	+ 40	− 50
December	1,050	+ 50	0
	12,000		

It is clear that a more reasonable figure for the storage could be arrived at by reducing the consumption or by increasing the roof area. For a quantitative treatment of the problem we need to know the maximum deficiency of rainfall in the worst droughts of specified duration, and this information is provided by a formula due to J. Glasspoole*, viz. :—

$$R_D = 8{\cdot}33\,M - 11\sqrt{M}$$

where R_D is the rainfall, expressed as a percentage of the annual normal, in the driest recorded period of M months. This formula applies with fair accuracy to any place in the British Isles, for values of M greater than 2.

To simplify calculations it is better to express R_D as a percentage of the average monthly rainfall, when the formula becomes

$$R_D = 100\,M - 132\sqrt{M} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

We assume that this formula tells us the minimum run-off from the

* "The Reliability of Rainfall over the British Isles." *London, Trans. Inst. Water Engin.* **35,** 1930, p. 174.

roof, expressed as a percentage of the long-period average monthly run-off.

Let us suppose that the monthly consumption is constant and equal to A per cent. of the average monthly run-off. The consumption in M months, expressed in the units adopted in (1) is therefore AM and the deficiency D after M months of worst shortage is given by

$$D = AM - R_D$$

$$\text{or } D = (A - 100)\, M + 132\sqrt{M} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

D being also expressed as a percentage of the average monthly run-off. By differentiating D with respect to M and equating the result to 0 we obtain the value of M for which the deficiency is a maximum. The differentiation gives

$$A - 100 + \frac{66}{\sqrt{M}} = 0$$

$$\text{whence } \sqrt{M} = \frac{66}{100 - A}$$

and the value of the maximum deficiency is obtained by substituting this value of M in (2). Putting $A = 90$, we obtain $\sqrt{M} = 6{\cdot}6$, $M = 43{\cdot}6$ and $D = 435$. That is to say, if the average consumption is equal to 90 per cent of the average run-off, the maximum depletion of reserve stocks will occur after 43·6 months of drought and will be equivalent to 435 per cent of the average monthly run-off measured over a long period. This depletion is equivalent to $\frac{435}{90}$ or 4·8 months' consumption. Similarly we find that by making $A = 80$ the maximum depletion comes to the equivalent of 2·7 months' consumption, while $A = 70$ gives a maximum deficiency equivalent to 2·1 months' consumption. These figures, combined with a knowledge of the rainfall of the district, make it possible to calculate the size of the storage reservoir to be provided if the effective roof area and the average daily consumption are known. Alternatively, they provide the means of calculating the roof area required when a decision has been made as to the maximum amount of storage that can be economically provided. It has to be remembered that the calculations only give the maximum depletion to be expected during the most intense conditions of drought and it cannot safely be assumed that the storage tank would be full at the beginning of the period of maximum rainfall deficiency. With this consideration in mind it would appear unwise to provide less than 3 months' storage, in a case where the roof area is such that the run-off exceeds normal consumption by 25 per cent.

If R is the mean annual rainfall in inches and B the effective roof area in square feet, the annual run-off is $\frac{R.B}{12}$ cubic feet or $\frac{R.B \times 6{\cdot}25}{12}$ gallons. The average daily yield, is, therefore,

$\frac{R.B \times 6 \cdot 25}{12 \times 365}$ gallons. If W is the mean daily consumption in gallons, and storage equivalent to 3 months' consumption can be provided, the above considerations suggest that W should not exceed 80 per cent of the average daily yield. This gives

$$W = \frac{80}{100} \times \frac{R.B. \times 6 \cdot 25}{12 \times 365}$$

which reduces to $W = \cdot 00114\ R.B.$ .... (3)

$$\text{or } B = 876\ \frac{W}{R} \quad \text{.......................................(4)}$$

From (4) it is found that a daily consumption of 40 gallons would require a roof area of 1,400 sq. ft. in a region with an annual rainfall of 25 in. The capacity of the storage reservoir would need to be 91 × 40 or 3,640 gallons, or, say, 4,000 gallons to be on the safe side. The figures both for roof area and storage capacity are rather high, which suggests that it may not often be practicable to use a roof as the sole source of domestic water supply in the drier regions of the British Isles. The owner of such an installation would have the satisfaction of knowing, however, that his supply was capable of withstanding the worst recorded droughts, and also that every rain which wetted his roof would replenish his reserves—a comfort denied to the user of a failing well during a summer drought. This consideration should, at least, stimulate residents in drought-stricken areas to make adequate provision for storing the run-off from existing roofs. In round figures, 50 gallons will result from an inch of rain per 100 sq. ft. of roof area and storage on this scale must be provided if the run-off from that relatively small amount of rain is not to be wasted.

E. G. Bilham.

Abercromby in Modern Dress*

Abercromby's " Weather " written nearly fifty years ago was called " a popular exposition of the nature of weather changes from day to day." It was a skin full of good wine. There are not many wine skins 50 years old which will stand filling with new wine. The experiment in this case has been successful, owing largely to the skill of the new author, who has given us a book containing an excellent, and eminently readable, description of the present-day knowledge of weather. Although, in accordance with modern sentiment, the words " popular exposition " have been omitted from the title, I think they do, nevertheless, correctly describe the work.

---

* *Weather. The nature of weather changes from day to day.* By Ralph Abercromby. New edition, revised and largely rewritten by A. H. R. Goldie, M.A., F.R.S.E. Size 8½ × 5½ in. pp. xii + 274. *Illus.* London, Kegan Paul, Trench, Trubner & Co., Ltd., 1934, 10s. 6d.

Of the original work two chapters, number II on Synoptic Charts and number XIII on Types and Spells of Weather, have been reproduced with little change. The other fourteen chapters and the introduction are either wholly or substantially new. The book is a little shorter than the original, but not so much shorter as the number of pages would suggest (472 pages in the old and 274 pages in the new), because the size of the pages in the new book is larger than in the old. The old book was divided into two sections, Elementary and Advanced. In the new book that division has been abandoned.

The two chapters mentioned (II and XIII) are the longest in the book, and between them make up about a quarter of it. The other chapters, which are relatively short, deal concisely with cloud—the structure of cyclones—autographic records—wind—temperature—diurnal, local, seasonal, and secular, variation of weather—the general circulation of the atmosphere—line squalls and thunderstorms—tornadoes and revolving storms; and then there are three new chapters on the upper air—visibility and fog—and practical applications. There are also about seventy illustrations. While the two chapters on synoptic charts and on types and spells of weather are historically of great interest, I do not think they are as good as the other parts of the book. Not infrequently the statements in them contain enough truth not to be entirely wrong, but they do not convey a right impression of present-day knowledge. I may illustrate by one or two examples.

> On p. 17 we find it stated that "if you give a meteorologist a chart of the world with the isobars only marked on it . . . . he could write down very nearly the kind of weather which would be experienced everywhere." It is certain that he could not: he would be profoundly wrong if he tried to do it. And yet there is an element of truth in the idea.
>
> On p. 20: "The character of the weather and the direction of the wind depend entirely on the shape of the isobars." Replace "entirely" by "largely" and the statement is broadly true, but as it stands it is contrary to daily experience.
>
> On p. 24: "Suppose the cyclone stood still for a week, then the observer would see a watery sky for a week without any rain falling." Again this is not correct. If a cyclone is stationary there are still changes of weather at an individual place, because the air moving in a system plays its part and the weather does not depend only on the motion of the system itself.

I think, for the benefit of those—and I hope they will be many—who imbibe their knowledge of the weather from this book, it would be well, either by footnotes or by a cautionary preliminary note to Chapter II, to indicate where statements in the chapter should be taken *cum grano salis*, or in conjunction with modifying information elsewhere. When I was reading Chapter II, I thought it was a fine effort on the part of the author to add the dotted line in the diagram of the weather of a cyclone (Fig. 3). Additions to an old picture usually detract from its value, but this addition does the contrary and definitely improves the picture.

The chapter on the upper air is excellent. It gives a good general account of the fascinating results of modern investigations by balloons, by the spectroscope and by "sound-ranging." The chapter on clouds, too, is a great improvement on the old work, and the inclusion of the well-reproduced plates of cloud types adds pleasure to the profit. I miss "altocumulus castellatus," a type with some, as yet unexplained, prognostic significance, when a period of fine weather is going to break up in thunderstorms. Clouds really need a book to themselves—they cannot be adequately treated in a book on weather in general. Chapter V, on the structure of cyclones, is regarded as supplementary to Chapter II. It describes well the general principles of the modern development based on the idea of fronts or surfaces of separation between air of different qualities. This chapter should prove most useful in enabling the general reader to understand synoptic charts and to prepare for the day when general inferences will normally include a description of fronts and air-masses and their probable development. In the chapter on spells and types of weather, the reproduction of a chart of weather in the northern hemisphere for July 12th, 1933, illustrates very vividly the advances which have been made since the other charts in the chapter (which were taken from the original work) were drawn.

The question to which the reader of a review naturally wants an answer is this : Is the book worth buying for anyone ? Is it worth buying for me ? Well this book is worth buying if you know some physics and a little meteorology, or much meteorology and a little physics, or if you are a beginner keen on knowing something about present-day meteorology. If you are already an expert, it will interest you to see your subject described clearly and in some places provokingly : e.g. "the data required for the construction of synoptic charts are the readings of any instrument," or again, "when the veil of cirro-status reaches the horizon in one direction but leaves a segment of sky clear in the other direction it may be regarded as indicating the northern edge of a disturbance."

There is a slip and an elided comma on page 2 ; the elided comma makes it appear that the unit of pressure is the dyne instead of the dyne per cm^2. The slip makes it appear that the pressure due to the weight of a gramme per unit area is one unit of pressure whereas it is really about 981 units of pressure. In this connexion, a useful approximate relationship to remember is that the pressure of the atmosphere—about 1000 mb.—is also, approximately, the same as the pressure of a layer of water 10 metres thick or, more vividly, about the same as the pressure on one's back (area 500 cm.^{2}) in a motor car accelerating in one second of time from rest to a speed of 200 m.p.h.

E. GOLD.

Official Publication

The following publication has recently been issued :—

PROFESSIONAL NOTES.

No. 65. *The winds of Berbera : discussion of observations made under the supervision of R. S. Taylor, M.B., Ch.B., Principal Medical Officer.* By C. E. P. Brooks, D.Sc., and C. S. Durst, B.A. (M.O. 336*e*.)

Berbera lies on the southern shore of the deep narrow trough occupied by the Gulf of Aden ; it experiences a NE. monsoon from October to May and a SW. monsoon from June to September. The structure of these two wind currents is studied in detail, using the records of a pressure-tube anemograph from May, 1931 to April, 1933, and a series of pilot-balloon soundings made almost daily (sometimes both morning and evening) from April 24th, 1931 to the end of July, 1932. Typical anemograms are illustrated and discussed and the measurements of the whole series are expressed as monthly and hourly resultants, while the diurnal and seasonal variation of upper winds is represented by wind roses at various levels. Finally the structure of the monsoons, and of the diurnal variations superposed on them, is discussed in the light of the temperature variations over the Gulf of Aden and the adjacent land, and of the character of the gustiness shown by the anemograms.

Royal Meteorological Society

The last monthly meeting of the present session was held on Wednesday, June 20th, at 49, Cromwell Road, South Kensington, Lt.-Col. E. Gold, D.S.O., F.R.S., President, in the Chair.

At the beginning of the meeting Mr. H. W. L. Absalom gave an account of a small whirlwind which visited the village of Dunton, about 12 miles east of Ilford and a mile north-west of the Laindon Hills, on the evening of June 6th, damaging timber bungalows, fences and telegraph poles and uprooting trees.

Mr. S. K. Banerji then gave a brief account of recent meteorological work in India.

The following papers were read :—

Sir Napier Shaw, F.R.S.—The Natural History of Weather.

The paper describes an arrangement of the meteorological data for a station with special reference to the encouragement of the study of nature.

I. S. Astapowitsch.—Air waves caused by the fall of the meteorite on June 30th, 1908 in central Siberia.

The writer gives a short review of the investigation of the fall of the meteorite in central Siberia on June 30th, 1908, and gives the results of the barograph records obtained by him at the time of his research expeditions of 1930 and 1932. The time of fall of the meteorite and the force of the explosion were determined by examination of various independent sources. The air wave was recorded by microbarograms in Japan, China, India and perhaps America.

F. J. W. Whipple, Sc.D.—On phenomena related to the great Siberian meteor.

This paper is supplementary to one published by the author in 1930.* Additional evidence with regard to the illumination of the sky during the nights following the arrival of the meteor is summarised. In view of the fact that recorded observations of this phenomenon are confined to the north of Europe it is suggested that the meteor had a tail which was captured by the earth's atmosphere. The airwaves produced by the meteor were recorded at Batavia and at Washington as well as at several places in Europe.

S. E. Ashmore, B.Sc.—The splashing of rain.

The connexion between the rate of rainfall and the splashing produced by it from a horizontal surface has been studied experimentally for a large number of surfaces which may be used as the surroundings for rain-gauges. The splashing from ice and water has also been investigated. The results may be utilised :—

(1) In forming an estimate of the number of occasions on which the rainfall recorded by a standard gauge is too large on account of insplashing.

(2) In deciding on the best material on which to set up a rain-gauge or sink an evaporation tank. Suggestions are given on how to eliminate the effects of outsplashing from evaporimeters.

W. R. Baldwin-Wiseman, M.Sc.—The cartographic study of drought.

This paper presents a method of setting out rainfall statistics for drought periods. In order to illustrate this method the famous drought in Queensland during 1902 has been investigated. Maps are given defining the progress of this drought, the rainfall being expressed as deficiencies from the average for groups of consecutive months.

Correspondence

To the Editor, *Meteorological Magazine*

Whirlwind at Shooter's Hill.

I believe you like to hear of anything happening out of the ordinary with regard to the weather. On Sunday, June 17th, at 12.15 p.m.,

* *London, Q.J.R. Meteor. Soc.* 56, 1930, p. 287.

I was on my allotment which is situated within a half-mile of the top of Shooter's Hill on the north-east side.

I was talking to a friend when we were startled by the violent banging of a door. A man was standing outside his shed when the door crashed up against him, hitting him on the forehead and nearly putting him out. The cause of the disturbance was a whirlwind which had struck the door and when we looked it was picking up pieces of stick, leaves, etc., and hurling them in the air; the force of the wind I should say was operating at an angle of 45°.

My friend and I could see the whirlwind approaching us, he moved one way and I the other and it passed in between us; all the while throwing things in the air, it passed over a bed of iris and some of the flowers were thrown in the air about 20 ft. It also shifted two sheets of corrugated iron but did not lift them. It then picked up a sheet of brown paper and carried it up to a height of between 150 to 200 ft.

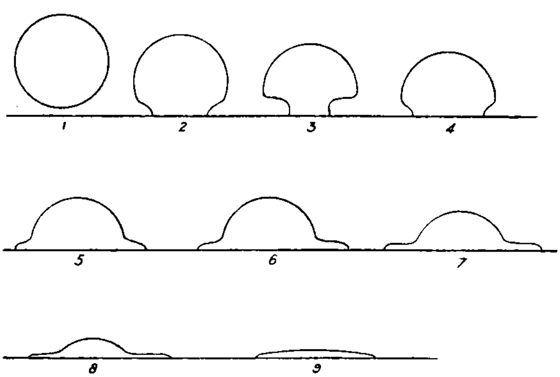
We watched its progress for about a quarter of a mile, when it passed over a school and we saw clouds of dust rise above the school.

S. THEOBALD.

*9, Isla Road, Plumstead, S.E.*18, *June* 21*st*, 1934.

An Unusual Sunset

The following observations of the sunset made on the evening of June 3rd, 1934, from The Great Orme, Llandudno, North Wales, may be of interest :—



The apparent shape of the Sun went through the changes shown in the sketches over a period of about 15 minutes before sunset. The visibility was such that the Irish Coast was very faintly visible.

I cannot recollect the exact details of the change from the "mushroom" shape of figs. 2–4, to the "Bowler Hat" shape of the later phases.

W. A. OWEN.

*Research Department, Woolwich, S.E.*18. *June* 8*th*, 1934.

A Phenomenon accompanying Lightning

Referring to the letter of Mr. J. E. Belasco in the *Meteorological Magazine* for May, I called attention to the "sound of lightning" in *Nature* a few years ago, and many others wrote to say they too had heard the sound. I heard of it first as a very small boy from a nurse who told me that if lightning came very close it made a swishing sound. In riper years I quite disbelieved this until three employees who were working in a field, one at one end, the others two hundred yards away, all described the phenomena as having occurred when a very vivid flash of lightning struck a farm about a quarter of a mile away. A letter to *Nature* describing the phenomenon elicited a number of letters from others who had heard the sound. The noise has been compared to a red-hot poker being plunged into water, the tearing of canvas, the sudden arc of an electric short circuit. It is only heard when lightning is very close and the sequence seems to be lightning, swish, thunder. But one observer who heard the sound a number of times during a thunderstorm in the Indian Ocean describes the swish as coming before the lightning. It has been suggested that perhaps the swish always occurs before the lightning but that the faint sound is heard more slowly than the bright light is seen. If this is really the case the swish may be caused by a brush discharge from points round the observer, similar in nature to the small spitting brush discharge that may be seen to occur on a Wimshurst machine immediately before a large spark. On the other hand, photographs of lightning show that a flash often ramifies near the ground into one large flash and it may be a great number of small ones. It seems to me that the swish may be caused by one or more quite small branches which have reached the earth at points nearer the observer than the main flash.

I have heard the sound myself, subsequently to the above-mentioned correspondence in *Nature*; the sequence in my mind was lightning, swish, thunder, but they all came so close together that a small fraction of a second must have separated the lightning from the thunder, and I suspect that the lightning conductor on my house was struck. The swishing noise was heard by at least two other people in the house and by two people in two cottages about fifty yards from the house.

C. J. P. CAVE.

Stoner Hill, Petersfield, Hants. May 22nd, 1934.

Thunderstorms of June 25th.

After a period of 20 months (October 21st, 1932, to June 24th, 1934) in which no day yielded as much as 0·75 in. of rain, this district caught the full force of one of the severe thunderstorms that were drifting in the stagnant region between shallow depressions over Cornwall and the Netherlands on June 25th last. Light showers from a canopy of low stratiform cloud before 11h. (G.M.T.) were followed by sunshine setting up strong convection until about 12¼h., when a large cumulonimbus cloud of particularly lurid aspect began to overspread the sky from south-west and south. The storm developed quickly as it approached, and at 12h. 44m. it broke overhead. From then until soon after 13h. rain was torrential and lightning almost incessant: several of the flashes (which were of a brilliant blue colour) came to earth in the immediate vicinity of the climatological station, while one, at 13h. 2m., accompanied by a shattering crash of thunder like the report of a large gun close at hand, definitely shook the ground for a fraction of a second. Two houses near-by were struck, and the local telephone service was put out of action.

Measurements made with the special "Storm" gauge, described and pictured in the August, 1932, issue of this magazine (Vol. 67, p. 160), gave the rainfall as 0·50 in. for the seven minutes 12h. 44m. to 12h. 51m., and 1·23 in. for the 22 minutes 12h. 44m. to 13h. 6m., when the downpour ceased quite suddenly. During the latter interval the standard gauge, 30 yards distant, also logged 1·23 in. There was no hail. The road running along the bottom of the valley was flooded—nine or ten inches deep in places—but only for a short time. So rapid was the infiltration of the water through the surface layers of the soil (sand and gravel over chalk), parched as they were by the long spell of droughty weather, that by 15h. there was no trace of "sponginess" about the lawn. At 9h. next morning the entry "dry ground" was unhesitatingly made in the register for the 47th day in succession.

During the storm the thermograph showed a precipitate fall of temperature: as nearly as can be judged from the chart, there was a decrease of 13°F., from 68°F. to 55°F., within five minutes.

E. L. HAWKE.

Caenwood, Rickmansworth, Herts. June 30th, 1934.

While observing the thunderstorm which developed here on the evening of the 25th, I noticed that there were two distinct layers of cloud. The upper layer was apparently moving from south-west and the lower, which appeared as an even sheet of dark cloud, came from the north-west, and apart from occasional breaks, soon covered the whole sky. The surface wind was NNE. but on the approach of the lower cloud, backed to WNW.

Thunder was first heard at 17h. 23m. G.M.T. but since no lightning was then visible, I assume that the discharge was between the two cloud sheets.

Finally both layers of cloud appeared to slowly move away to east-north-east, and on reaching the zenith, heavy rain fell which lasted 67 minutes. After the storm clouds had passed, the wind veered again in feeble gusts to north-east and a brilliant rainbow appeared in the south-east. The weather map for 18h. on the 25th, published in the *Daily Telegraph* on the 26th, shows a shallow depression over southern England, covering London; and another off the coast of Norfolk.

I do not know if the former depression had a well marked warm sector, but it seems probable that the lower cloud and surface wind originated to the north of the depression off Norfolk and were undercutting the warmer currents from the south-west in the depression over London, and the higher clouds were produced by this warm air being forced up over the northerly current from the North Sea.

The thunderstorm itself apparently developed at the warm front of the depression over London.

DONALD L. CHAMPION.

187, *High Street, Waltham Cross. June 28th,* 1934.

Thunderstorm of June 28th in the Isle of Wight

A severe thunderstorm passed over the centre and south-east of the Isle of Wight, last Thursday afternoon week, June 28th. My brother at Carisbrooke (I.W.), reports that two storms came up from the north-east and north-west simultaneously and broke over Newport, eventually passing south-east over Sandown, Shanklin and Ventnor. Flooding occurred over a wide area, and many houses were struck by lightning including my Father's at Shanklin. The storm lasted from about 3–4 p.m. (B.S.T.) and produced ½ in. of rain in 20 minutes at Newport, the rainfall for the day there being 0·63 in. and 0·36 in. at Shanklin 9 miles away to the south-east. Sandown had only 0·11 in., but Ventnor 0·31 in. The feature of the storm was the extraordinary hailstorm that accompanied it. My brother tells me that he was in his car during the storm and when every flash came, the engine cut out and the car stopped. The hail stones were as big as marbles and just as hard—for over an hour after the storm, they were still on the ground ! He ends up his letter to me by saying " To give you some idea of the force of the hail, I found a partridge sitting on her nest dead—the hail had killed her ! The Isle of Wight is usually free of such visitations. This storm is the third severe one we have had in Shanklin since last spring, which is most unusual ! May 29th and September 26th last year gave thunderstorms right over the town, but last Thursday week's (June 28th) beat the two previous storms for its severity !

J. E. COWPER.

22, *Broad Street, Birmingham. July 6th,* 1934.

NOTES AND QUERIES

New Ascents to the Stratosphere

According to the *National Geographic Magazine* for April, the National Geographic Society, Washington, D.C., is co-operating with the U.S. Army Air Corps and other donors in a new ascent to the stratosphere. The balloon will be manned by Major W. E. Kepner and Capt. A. W. Stevens, who hope to carry out a programme of scientific work including the collection of samples of the air in the stratosphere, determination of electric gradient, observations of cosmic rays and of ozone content and photography at great height. According to *The Times*, Dr. Max Cosyns, who accompanied Professor Picard on his second ascent to the stratosphere, has completed his preparations for a new ascent.

Review

High lapse-rates of temperature and their diurnal variation in the surface layers of the atmosphere over northern India. By Barkat Ali. Reprinted from Gerlands Beiträge zur Geophysik, Vol. 39, p. 121, 1933.

This paper discusses the results of nine sounding balloon ascents made on three days at Agra up to a height of about 400 metres. The temperature recording was made more than usually sensitive, so that fairly reliable records of temperature could be obtained for height intervals of 10 m., although unfortunately the probable instrumental errors were not precisely determined. The variation of temperature with height, which is shown in graphs and tables for the various ascents, does not contain any surprises ; possibly none could be expected without the use of much more delicate apparatus. From the results the co-efficient of eddy diffusion (k) is calculated for one of the days of ascent from Brunt's equation $\frac{d\theta}{dt} = k\frac{d^2\theta}{dh^2}$. It is found that k increases from the surface where it is of the order of 10^4 c.g.s. units, up to a maximum of $3\cdot6 \times 10^4$ at 50 m. for the ascent at 8h. 55m., and to a maximum of $10\cdot8 \times 10^4$ at 170 m. for the ascent at 12h. 5m., the temperature gradient in both cases being super-adiabatic in the lowest layers. The height at which k attains its greatest value would appear to the reviewer to indicate a maximum vertical extent of the convectional eddies of about 50m. in the early morning and 170 m. at midday.

A. F. CROSSLEY.

NEWS IN BRIEF

Mr. D. M. Little has been appointed Chief of the Aerological Division of the Central Office, Washington, D.C., in succession to Mr. W. R. Gregg now Chief of the Weather Bureau.

The Howard Prize of the Royal Meteorological Society has been awarded for 1934 to Cadet Eric Kingsley Ballard, of H.M.S. *Conway* for the best essay on " Cloud Forms ".

The Weather of June, 1934

Pressure was below normal over North America, except over the North-West Territory of Canada and western Mexico, over the North Atlantic, southern Europe and Russia, and above normal over the rest of Europe, north Africa, Iceland and Spitsbergen. The greatest excesses were 6·7 mb. at Barrow and 5·3 mb. at Isafjord and the greatest deficits 4·2 mb. at 40°N., 90°W. and 4·5 mb. at 40°N., 40°W. In Sweden temperature was generally about normal and the rainfall variable, being more than 200 per cent of the normal at Gotland, but below normal in the north.

The chief features of the weather of June over the British Isles were the general deficiency of rainfall, the warm spell from the 16th to 18th and the excess of sunshine in Ireland and north Scotland. On the 1st the high pressure to the west of the British Isles spread eastwards over the country and became more intense. Thunderstorms were experienced in south-east England on that day with heavy rain in the Channel Isles but generally the weather was fair to fine. Fine sunny weather continued in the north and west until the 7th but in the south and east conditions occasionally became cloudy with slight rain owing to shallow continental depressions. Sunshine records were good generally except in the south-east, over 15hrs. bright sunshine being recorded at several places in Scotland Ireland and north England on the 2nd–5th, with 16·0hrs. at Tiree on the 5th. On the 6th and 7th the continental depression spread across the southern British Isles giving cloudy to dull weather with local thunderstorms on the 7th and 8th and a little mist or fog. By the 9th, however, pressure was again high and from the 9th–13th fair or fine weather with local mist or fog was generally experienced, cool in the north but warm in the south. Sunshine records were especially good on the 10th–12th with 16·0hrs. at Tiree on the 11th and at Stornoway on the 12th. By the 14th, however, the north and west came under the influence of the large depression over the North Atlantic which was moving north-east and weather there became unsettled with rain, heavy at times, but bright intervals, while in the south conditions remained mainly fair or fine until the 19th. Several places in Dorset, Somerset, Worcester and Gloucester reported an absolute drought from the 1st to 17th and a few places in Wiltshire one from the 1st–20th. Temperature rose above 80°F. in parts of the south on the 16th–18th and 91°F. was reported at Greenwich on the 17th. From the 18th to 28th the depressions followed a more southerly course and the unsettled cooler weather spread from the north and west over the whole country. On the 22nd westerly winds reached gale force in parts of north England. Thunderstorms occurred in many parts of England on the 23rd, 25th and 28th and also in Scotland on the 27th and 28th, and heavy rain was experienced locally, among the heaviest falls being 1·45 in. at Borrowdale (Cumberland) on the 18th, 1·57 in. at Marchmont (Berwick) on the 21st, 1·25 in. at Falconhurst (Kent), 1·27 in. at Malmesbury (Wiltshire) on the 24th and 1·50 in. at Brushford (Somerset) on the 25th. Flooding occurred in a few places for a short time. During this period sunshine records were variable but Lerwick (Shetland Isles) had 17·3hrs. on the 23rd and 17·4hrs. on the 24th, and

Kirkwall (Orkneys) 16·5hrs. on the 24th. On the 28th an anticyclone over the Atlantic extended also over the British Isles giving mainly fair or fine conditions with a rise of temperature on the 30th, 80°F. being exceeded in parts of the south on that day. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	228	+60	Liverpool ...	214	+10
Aberdeen ...	204	+23	Ross-on-Wye ...	198	−12
Dublin	203	+17	Falmouth ...	240	+18
Birr Castle ...	183	+22	Gorleston ...	203	− 5
Valentia... ...	189	+13	Kew	205	+ 6

Miscellaneous notes on weather abroad culled from various sources.

Storms occurred in many parts of France on the 2nd and 3rd, a hailstorm near Tarbes devastating acres of crops and orchards. By the 5th, the drought was broken in Russia and heavy rain had been falling for 2 or 3 days. In western Germany, the heavy thunderstorms which interrupted the drought on the 3rd and flooded villages in the Mosel Valley, did little to improve the condition of the crops. Dry, hot weather was experienced in Germany about the 18th, the temperature rose to 92°F. at Würzburg on the 18th and forest fires occurred in the Heimburg district in the Harz Mountains. Much damage was done to crops by a hailstorm on the 19th in the Stedinger district near the mouth of the Weser (north-west Germany). The drought and heat in France proved detrimental to the crops (except the vines) over a large area. Torrential rain fell in Switzerland on the 28th–29th causing the rivers to rise rapidly.—(*The Times*, June 4th–30th).

Showers of rain occurred in Bombay city about the 8th after two days of great heat. In northern India exceptional heat was experienced during the first part of June after a comparatively cool May. Heavy rains in Assam had caused much damage by the 20th and heavy rains in the Himalayas caused disastrous floods in parts of Assam, east Bengal, Cooch Bihar and Bihar later in the month, many villages being submerged and the crops destroyed, 50 people were drowned in Nowgong (Assam).—(*The Times*, June 9th–28th).

A great sandstorm swept over the Khartoum district on the 7th and was followed by heavy rain.—(*The Times*, June 8th).

By the 3rd generous rains had broken the drought in the western and prairie districts of Canada ; these spread across the Dominion and by the 18th good rains had fallen nearly everywhere and the crops generally had benefited greatly. Serious forest fires occurred in the east up to about the 8th. The first rains to break the drought in the Middle States fell on the 3rd and 4th and heavy rain fell in Minnesota and the Dakotas on the 8th. The rainfall, however, continued below normal except locally and along the Atlantic coast. Temperature was generally above normal and a heat wave passed over the Upper Mississippi–Missouri Valley early in the month. A hurricane, accompanied by torrential rains which caused floods and many landslides occurred in San Salvador at the beginning of the month—more than 500 people were drowned. A hurricane coming in from the Gulf of Mexico on the 16th did damage to buildings and crops in Louisiana and Mississippi and caused the death of 7 people.—*The Times*, June 1st–23rd, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*

Daily Readings at Kew Observatory, June, 1934

* Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
	mb.		°F	°F	%	in.	hrs.	
1	1018·3	NNE.3	50	73	61	—	8·5	distant t 19h. 35m.
2	1021·0	NNE.4	52	76	43	—	13·5	
3	1024·3	NE.5	48	64	42	—	14·1	
4	1019·4	NE.3	47	60	74	—	1·4	
5	1016·5	N.3	50	61	49	—	5·7	
6	1014·0	N.4	48	56	61	0·02	3·2	$ir_0$10h.-12h.&16h.-20h.
7	1016·0	NW.1	48	62	41	trace	4·4	pr_0 13h. 45m.
8	1020·0	S.3	46	71	52	trace	7·1	w early. pr_0 17h. 40m.
9	1023·5	S.2	52	73	53	—	7·1	
10	1019·8	E.3	52	76	47	—	9·0	
11	1016·8	NE.3	54	75	45	—	8·5	
12	1020·1	ESE.2	49	70	50	—	8·8	
13	1016·7	WNW.1	46	76	47	—	9·8	[23h. 20m.
14	1019·4	WNW.2	55	74	56	trace	3·7	r_0 17h.50m., 19h.20m.,
15	1024·2	E.3	60	72	59	—	2·6	
16	1022·2	SE.2	55	81	48	—	8·9	
17	1019·4	SW.3	54	84	38	—	12·9	
18	1018·1	SW.4	62	84	45	—	12·7	
19	1006·5	SW.5	58	70	77	trace	1·9	r_0 10h.25m., 16h., 23h.
20	1010·1	NW.3	56	67	65	0·08	8·2	pr_2 11h.25m.–11h.40m.
21	1011·6	SW.3	50	65	76	0·18	0·1	rr_0 10h.–24h.
22	1009·7	W.5	57	69	39	—	13·0	
23	1016·6	E.4	55	69	51	0·09	4·9	tlr 23h.–24h.
24	1012·2	E.2	54	69	79	0·08	0·4	rr_0 0h.–3h., $pr_0$16h.
25	1011·5	E.3	58	74	67	0·15	3·6	f 7h., tlr 20h. 30m.
26	1018·0	SW.2	56	69	59	trace	1·4	f early ; pr_0 13h.
27	1016·7	SW.4	60	68	74	0.22	0·5	r 4h.–8h., 14h.–17h.
28	1014·7	SW.3	50	66	69	0·19	6·6	$tlrr_2$ 17h.–19h.
29	1023·8	N.3	51	67	57	—	7·8	
30	1024·5	NE.4	52	76	49	—	14·7	

* The dates of Sundays are in heavy type.

General Rainfall for June, 1934

England and Wales ...	71	per cent of the average 1881–1915.
Scotland	79	
Ireland	72	
British Isles	74	

Rainfall : June, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	1·13	56	*Leics* .	Thornton Reservoir	·96	44
Sur .	Reigate, Wray Pk. Rd.	·82	39	,, .	Belvoir Castle	·72	38
Kent .	Tenterden, Ashenden	2·10	110	*Rut* .	Ridlington	·97	51
,, .	Folkestone, Boro. San.	·94	...	*Lincs* .	Boston, Skirbeck	·58	32
,, .	Eden'bdg., Falconhurst	2·11	96	,, .	Cranwell Aerodrome	·63	38
,, .	Sevenoaks, Speldhurst.	1·74	...	,, .	Skegness, Marine Gdns.	1·89	115
Sus .	Compton, Compton Ho.	1·92	77	,, .	Louth, Westgate	1·83	85
,, .	Patching Farm	1·47	73	,, .	Brigg, Wrawby St.	1·76	...
,, .	Eastbourne, Wil. Sq.	1·45	79	*Notts* .	Worksop, Hodsock	1·20	61
,, .	Heathfield, Barklye	1·48	70	*Derby* .	Derby, L. M. & S. Rly.	·48	21
Hants .	Ventnor, Roy.Nat.Hos.	1·25	68	,, .	Buxton, Terr. Slopes	1·68	52
,, .	Fordingbridge, Oaklnds	1·01	55	*Ches* .	Runcorn, Weston Pt.	2·11	82
,, .	Ovington Rectory	1·41	61	*Lancs* .	Manchester, Whit. Pk.	2·04	77
,, .	Sherborne St. John	1·52	71	,, .	Stonyhurst College	2·64	86
Herts .	Welwyn Garden City	1·92	92	,, .	Southport, Hesketh Pk.	1·96	90
Bucks .	Slough, Upton	1·12	54	,, .	Lancaster, Greg Obsy.	2·65	103
,, .	H. Wycombe, Flackwell	1·03	51	*Yorks* .	Wath-upon-Dearne	1·92	86
Oxf .	Oxford, Mag. College	1·48	69	,, .	Wakefield, Clarence Pk.	1·48	69
Nor .	Pitsford, Sedgebrook	...	...	,, .	Oughtershaw Hall	3·68	...
,, .	Oundle	1·06	...	,, .	Wetherby, Ribston H.	1·89	90
Beds .	Woburn, Exptl. Farm	1·28	65	,, .	Hull, Pearson Park	1·22	59
Cam .	Cambridge, Bot. Gdns.	...	...	,, .	Holme-on-Spalding	1·40	64
Essex .	Chelmsford, County Lab	1·35	71	,, .	West Witton, Ivy Ho.	1·54	75
,, .	Lexden Hill House	1·03	...	,, .	Felixkirk, Mt. St. John.	1·49	68
Suff .	Haughley House	1·18	...	,, .	York, Museum Gdns.	2·11	102
,, .	Campsea Ashe	·88	46	,, .	Pickering, Hungate	1·25	59
,, .	Lowestoft Sec. School	1·56	86	,, .	Scarborough	1·18	64
,, .	Bury St. Ed., WestleyH.	1·60	76	,, .	Middlesbrough	2·34	124
Norf. .	Wells, Holkham Hall	·84	43	,, .	Baldersdale, Hury Res.	2·18	92
Wilts .	Calne, Castleway	1·14	50	*Durh* .	Ushaw College	2·38	110
,, .	Porton, W.D. Exp'l. Stn	1·28	66	*Nor* .	Newcastle, Town Moor.	2·00	92
Dor .	Evershot, Melbury Ho.	1·47	64	,, .	Bellingham, Highgreen	2·46	107
,, .	Weymouth, Westham.	1·16	65	,, .	Lilburn Tower Gdns.	2·56	124
,, .	Shaftesbury, Abbey Ho.	·89	38	*Cumb* .	Carlisle, Scaleby Hall	3·67	146
Devon .	Plymouth, The Hoe	1·67	77	,, .	Borrowdale, Seathwaite	6·00	98
,, .	Holne, Church Pk. Cott.	2·48	86	,, .	Borrowdale, Moraine	5·76	118
,, .	Teignmouth, Den Gdns.	1·26	64	,, .	Keswick, High Hill	2·55	87
,, .	Cullompton	1·90	90	*West* .	Appleby, Castle Bank	1·77	77
,, .	Sidmouth, U.D.C.	1·36	...	*Mon* .	Abergavenny, Larchf'd	1·18	48
,, .	Barnstaple, N. Dev.Ath	1·55	69	*Glam* .	Ystalyfera, Wern Ho.	3·31	88
,, .	Dartm'r, Cranmere Pool	3·40	...	,, .	Cardiff, Ely P. Stn.	1·56	63
,, .	Okehampton, Uplands.	2·78	100	,, .	Treherbert, Tynywaun.	3·25	...
Corn .	Redruth, Trewirgie	1·98	79	*Carm* .	Carmarthen, Priory St.	2·06	72
,, .	Penzance, Morrab Gdn.	1·80	81	*Pemb* .	Haverfordwest, School.	...	...
,, .	St. Austell, Trevarna	1·89	73	*Card* .	Aberystwyth	2·06	...
Soms .	Chewton Mendip	2·18	74	*Rad* .	BirmW.W.Tyrmynydd	2·12	65
,, .	Long Ashton	1·56	62	*Mont* .	Lake Vyrnwy	3·09	98
,, .	Street, Millfield	·82	38	*Flint* .	Sealand Aerodrome	·86	40
Glos .	Blockley	1·64	...	*Mer* .	Dolgelley, Bontddu	2·35	68
,, .	Cirencester, Gwynfa	1·84	77	*Carn* .	Llandudno	1·30	68
Here .	Ross, Birchlea	·89	41	,, .	Snowdon, L. Llydaw 9.	7·73	...
Salop .	Church Stretton	1·75	72	*Ang* .	Holyhead, Salt Island	1·55	72
,, .	Shifnal, Hatton Grange	1·43	64	,, .	Lligwy	1·89	...
Staffs .	Market Drayt'n, Old Sp.	·73	30	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	·89	39		Douglas, Boro' Cem.	2·94	119
War .	Alcester, Ragley Hall	1·04	46	*Guernsey*			
,, .	Birminghm, Edgbaston	1·02	44		St. PeterP't.Grange Rd.	170	92

Rainfall: June, 1934: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	1·78	76	*Suth* .	Melvich	1·86	96
,, .	New Luce School	2·16	75	,, .	Loch More, Achfary	2·16	58
Kirk .	Dalry, Glendarroch	2·22	80	*Caith* .	Wick	1·06	59
,, .	Carsphairn, Shiel	4·32	108	*Ork* .	Deerness	1·10	60
Dumf.	Dumfries, Crichton, R.I.	1·95	82	*Shet* .	Lerwick	1·09	61
,, .	Eskdalemuir Obs	2·59	82	*Cork* .	Caheragh Rectory	...	...
Roxb .	Branxholm	2·27	101	,, .	Dunmanway Rectory	2·75	79
Selk .	Ettrick Manse	2·38	66	,, .	Cork, University Coll.	1·63	64
Peeb .	West Linton	2·38	...	,, .	Ballinacurra	1·58	61
Berw .	Marchmont House	2·87	124	,, .	Mallow, Longueville	1·71	77
E.Lot .	North Berwick Res.	1·91	115	*Kerry*.	Valentia Obsy	2·45	77
Midl .	Edinburgh, Roy. Obs.	2·47	123	,, .	Gearhameen	2·80	56
Lan .	Auchtyfardle	2·12	...	,, .	Darrynane Abbey	3·00	95
Ayr .	Kilmarnock, Kay Pk.	2·03	...	*Wat* .	Waterford, Gortmore	1·42	54
,, .	Girvan, Pinmore	2·15	74	*Tip* .	Nenagh, Cas. Lough	2·06	84
Renf .	Glasgow, Queen's Pk.	1·96	85	,, .	Roscrea, Timoney Park	1·67	...
,, .	Greenock, Prospect H.	2·82	85	,, .	Cashel, Ballinamona	1·46	63
Bute .	Rothesay, Ardencraig	3·36	...	*Lim* .	Foynes, Coolnanes	1·69	65
,, .	Dougarie Lodge	2·96	...	,, .	Castleconnel Rec.	1·64	...
Arg .	Ardgour House	3·08	...	*Clare* .	Inagh, Mount Callan	3·10	...
,, .	Glen Etive	2·74	58	,, .	Broadford, Hurdlest'n.	2·59	...
,, .	Oban	2·65	...	*Wexf* .	Gorey, Courtown Ho.	2·03	83
,, .	Poltalloch	2·89	97	*Wick* .	Rathnew, Clonmannon.	2·22	...
,, .	Inveraray Castle	3·41	86	*Carl* .	Hacketstown Rectory	...	...
,, .	Islay, Eallabus	2·43	93	*Leix* .	Blandsfort House	1·57	61
,, .	Mull, Benmore	3·20	41	,, .	Mountmellick	1·59	...
,, .	Tiree	3·49	137	*Offaly*.	Birr Castle	1·93	83
Kinr .	Loch Leven Sluice	2·45	112	*Dublin*	Dublin, FitzWm. Sq.	1·37	70
Perth .	Loch Dhu	...	...	,, .	Balbriggan, Ardgillan	1·50	74
,, .	Balquhidder, Stronvar.	2·42	...	*Meath*.	Beauparc, St. Cloud	1·96	...
,, .	Crieff, Strathearn Hyd.	1·52	58	,, .	Kells, Headfort	1·57	59
,, .	Blair Castle Gardens	1·00	51	*W.M* .	Moate, Coolatore	1·94	...
Angus.	Kettins School	1·03	50	,, .	Mullingar, Belvedere	2·07	80
,, .	Pearsie House	·93	...	*Long* .	Castle Forbes Gdns	2·06	80
,, .	Montrose, Sunnyside	·71	43	*Gal* .	Galway, Grammar Sch.	2·53	...
Aber .	Braemar, Bank	1·39	71	,, .	Ballynahinch Castle	3·48	98
,, .	Logie Coldstone Sch.	1·42	73	,, .	Ahascragh, Clonbrock.	2·50	89
,, .	Aberdeen, King's Coll.	1·20	70	*Mayo*.	Blacksod Point	1·78	64
,, .	Fyvie Castle	1·51	72	,, .	Mallaranny	3·44	...
Moray	Gordon Castle	2·21	108	,, .	Westport House	1·59	59
,, .	Grantown-on-Spey	...	...	,, .	Delphi Lodge	4·33	75
Nairn.	Nairn	1·23	70	*Sligo* .	Markree Obsy	1·91	65
Inv's .	Ben Alder Lodge	1·75	...	*Cavan*.	Crossdoney, Kevit Cas.	1·90	...
,, .	Kingussie, The Birches.	1·03	...	*Ferm* .	Enniskillen, Portora	1·83	...
,, .	Inverness, Culduthel R.	1·49	...	*Arm* .	Armagh Obsy	1·40	56
,, .	Loch Quoich, Loan	...	...	*Down*.	Fofanny Reservoir	1·41	...
,, .	Glenquoich	3·66	74	,, .	Seaforde	1·18	43
,, .	Arisaig, Faire-na-Sguir.	3·88	...	,, .	Donaghadee, C. Stn.	1·42	61
,, .	Fort William, Glasdrum	2·71	...	,, .	Banbridge, Milltown	1·49	58
,, .	Skye, Dunvegan	3·12	...	*Antr* .	Belfast, Cavehill Rd.	2·58	...
,, .	Barra, Skallary	2·67	...	,, .	Aldergrove Aerodrome.	2·79	116
R&C .	Alness, Ardross Castle.	2·43	108	,, .	Ballymena, Harryville.	2·43	83
,, .	Ullapool	1·55	66	*Lon* .	Garvagh, Moneydig	2·02	...
,, .	Achnashellach	3·65	92	,, .	Londonderry, Creggan.	2·58	91
,, .	Stornoway	1·89	82	*Tyr* .	Omagh, Edenfel	1·80	64
Suth .	Lairg	1·52	73	*Don* .	Malin Head	4·13	...
,, .	Tongue	1·78	87	,, .	Killybegs, Rockmount.	2·43	...

Climatological Table for the British Empire, January, 1934

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1020·8	+ 3·2	56	22	44·4	34·7	39·5	+ 0·6	36·7	90	7·8	1·20	− 0·56	18	1·44	17
Gibraltar	1026·7	+ 5·2	69	40	61·6	45·4	53·5	− 1·4	46·1	80	4·4	0·12	− 4·52	2	...	...
Malta	1020·0	+ 3·0	61	41	56·8	48·1	52·5	− 2·8	48·0	75	6·6	5·31	+ 2·10	20	4·49	45
St. Helena	1011·1	− 0·6	73	59	68·0	60·7	64·3	+ 0·3	61·8	96	9·2	3·29	...	22	...	...
Freetown, Sierra Leone	1012·3	+ 1·5	92	62	86·2	67·5	76·9	− 4·4	72·7	78	3·2	0·00	− 0·41	0	...	...
Lagos, Nigeria	1009·8	+ 0·2	90	67	87·4	73·4	80·4	− 0·5	73·0	88	2·1	0·20	− 0·84	2	6·4	55
Kaduna, Nigeria	1008·5	...	96	53	88·8	55·7	72·3	− 1·1	52·1	35	0·8	0·00	0·00	0	9·1	79
Zomba, Nyasaland	1006·4	− 1·5	87	60	81·4	64·6	73·0	+ 0·2	68·3	74	6·1	5·47	− 5·63	18	...	...
Salisbury, Rhodesia	1009·1	− 0·9	87	55	80·0	59·7	69·9	+ 0·2	63·4	69	6·1	7·19	− 0·13	18	8·3	63
Cape Town	1013·0	− 0·4	103	52	82·8	61·2	72·0	+ 2·1	61·9	65	2·7	0·54	− 0·14	3	...	...
Johannesburg	1011·1	+ 0·6	82	50	73·9	56·1	65·0	− 1·7	59·6	81	6·5	12·03	+ 5·86	18	6·3	46
Mauritius	1010·1	− 1·8	90	69	84·9	73·4	79·2	− 0·1	73·8	69	7·1	6·96	− 0·80	22	7·8	59
Calcutta, Alipore Obsy.	1014·1	− 1·1	86	45	77·6	55·5	66·5	− 0·1	56·2	84	2·7	0·00	− 0·42	0*	...	...
Bombay	1012·0	− 1·6	92	53	81·9	64·1	73·0	− 2·5	60·3	63	3·1	0·00	− 0·10	0*	...	...
Madras	1011·8	− 2·3	84	65	82·4	70·3	76·3	+ 0·1	71·9	85	6·2	2·05	+ 0·91	3*	...	...
Colombo, Ceylon	1009·6	− 1·2	89	69	84·0	72·1	78·1	− 1·4	73·5	78	6·2	12·22	+ 8·97	17	4·9	42
Singapore	1009·2	− 1·2	87	67	82·6	70·9	76·7	− 3·0	73·6	84	8·5	18·94	+ 9·05	18	3·8	32
Hongkong	1021·2	+ 1·5	69	43	61·1	52·3	56·7	− 3·5	50·0	65	6·8	0·47	− 0·85	5	4·7	43
Sandakan	1008·4	...	88	70	85·2	73·7	79·5	− 0·3	76·1	89	8·0	33·96	+ 14·56	28	...	...
Sydney, N.S.W.	1013·3	+ 0·9	103	57	78·7	65·1	71·9	+ 0·3	66·2	65	5·8	2·35	− 1·32	12	8·2	58
Melbourne	1013·6	+ 0·7	103	49	78·7	57·7	68·2	+ 0·8	60·7	59	6·0	3·59	+ 1·70	10	7·2	50
Adelaide	1013·2	+ 0·2	110	53	89·8	65·1	77·5	+ 3·6	60·8	29	4·4	0·46	− 0·26	3	10·2	72
Perth, W. Australia	1010·7	− 1·8	110	59	87·8	66·3	77·1	+ 3·3	66·2	55	4·2	0·27	− 0·07	3	10·1	73
Coolgardie	1008·6	− 2·9	111	56	97·5	66·1	81·8	+ 4·4	65·5	43	3·8	0·99	+ 0·53	4	...	...
Brisbane	1013·7	+ 2·4	92	62	82·3	67·4	74·9	− 2·3	68·4	63	7·0	3·26	− 3·19	9	8·2	60
Hobart, Tasmania	1013·1	+ 2·8	91	47	69·9	53·4	61·7	− 0·3	55·2	58	7·2	1·00	− 0·83	10	6·8	46
Wellington, N.Z.	1011·6	− 1·7	77	39	67·3	53·0	60·1	− 2·4	56·0	69	6·7	2·03	− 1·30	13	7·1	48
Suva, Fiji	1009·0	+ 1·5	95	72	88·4	75·9	82·1	+ 2·2	76·8	78	6·0	9·18	− 2·25	22	7·1	54
Apia, Samoa	1008·9	+ 1·0	88	72	85·4	75·0	80·2	+ 1·2	76·5	81	6·9	15·25	− 1·80	27	7·2	56
Kingston, Jamaica	1015·1	0·0	87	65	84·3	66·9	75·6	− 1·2	65·9	89	2·5	0·68	− 0·28	5	6·9	62
Grenada, W.I.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toronto	1018·5	+ 0·6	43	− 9	32·6	19·0	25·8	+ 3·6	23·2	75	8·7	1·12	− 1·67	8	1·5	16
Winnipeg	1017·9	− 3·0	39	−39	17·6	−5·9	5·9	+ 9·8	...	...	5·5	0·01	− 0·90	1	2·7	31
St. John, N.B.	1016·4	+ 0·9	41	−16	25·5	6·5	16·0	− 3·2	12·7	75	6·4	2·29	− 2·51	8	3·4	37
Victoria, B.C.	1019·4	+ 3·4	52	34	46·5	40·4	43·5	+ 4·5	41·7	91	8·2	7·27	+ 2·73	24	2·0	23

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(21764) Wt. 25/32 1,000 7/34 Hw. G.377/6

M.O. 371.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 69

August 1934

No. 823

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

A fifth of an inch in a Minute

By F. J. W. Whipple, Sc.D.

The autographic rain-gauges which are in general use are well designed for recording rainfall hour by hour or even five minutes by five minutes. The records fail, however, to provide the answer to the questions how much rain fell in a minute and what was the instantaneous intensity of the rainfall. The gauge, which is generally known at Kew Observatory as the storm gauge, but which is better described as the minute by minute gauge, was designed to record as accurately as possible the amount of rain falling in each minute.

The chart used in this gauge is mounted on a drum to which a float is attached so that as the float chamber is filled with rain-water the drum rotates. A pen writing on the chart is displaced at each minute by the action of an electromagnet. The distance between the minute marks is a measure of the rainfall. The electric current which actuates the electromagnet is controlled by a relay in the same circuit as the time-markers of the seismographs. There are a few other details which may be mentioned. An 8-inch gauge is used. The orifice of the funnel has been enlarged, however, to 3·8 cm., so as to allow hail stones to fall through at once. The funnel does not communicate with the float chamber but with a side tube. This provision also is made to deal with hail. The hail stones float on the water in the side tube and affect the common level in side tube and float chamber as much as the equivalent amount of water. The side tube and float chamber have diameters 3·8 cm. and 10·2 cm.,

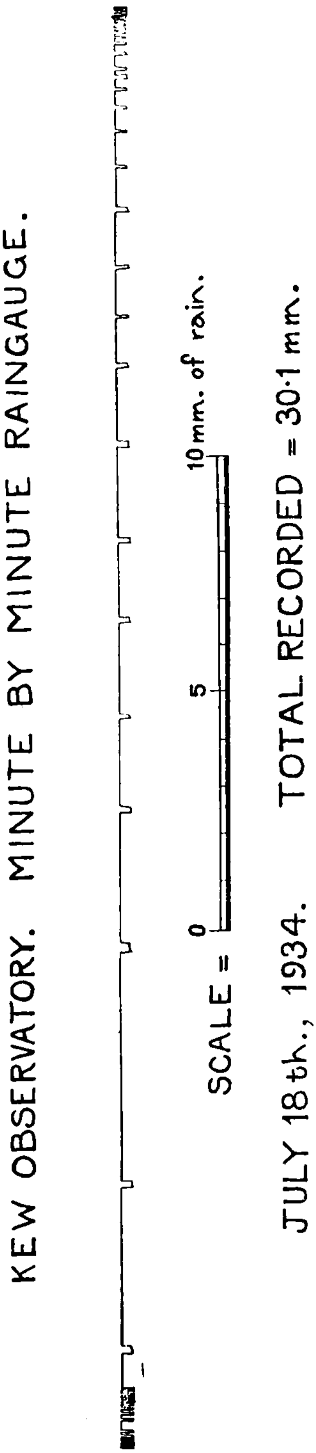


Fig. 1.

respectively. The scale of the record is about nine times the normal scale for rainfall. The circumference of the drum being about 40 cm. one revolution corresponds with 45 mm. of rain and to allow for the possibility of as much as 200 mm. in a day the traces of the pen have to be kept separate. To this end the axle carrying drum, float and counterpiece has a screw thread and rides on skew wheels. Until recently ink was used on the pen, but a metallic pen writing on metallic paper has now been adopted. This has got over the difficulty that a pen repeating the same mark over and over again is sure to make blots.

The minute by minute gauge has been in use since 1928, but the wide opening for the reception of hail stones was not made until May, 1931, after a storm in which it appeared that the equivalent of 1 cm. of rain had reached the float chamber in the course of a minute. There was no way to decide whether the water reaching the chamber had remained for some minutes as hail melting in the funnel and therefore the reading was not accepted.

The storm of July 18th, 1934, has provided measurements which are not affected by the mixture of hail with the rain, that is to say the water equivalent of the hail is included with the rain.

Fig. 1 is a reproduction of the original record of this storm and the amounts falling minute by minute are graphed in Fig. 2. It will be seen that in the second, third and fourth minutes after the commencement of the heavy rain the amounts were 3·4, 5·0 and 2·9 mm. The highest rainfalls in stated times from one to sixteen minutes are given in Table 1. The highest fall in one minute was 5·0 mm., *i.e.*, 0·2 in. More than a centimetre of rain fell in three minutes and more than an inch (25·4 mm.) in thirteen minutes. The last two readings would just fail to qualify for inclusion as

" very rare falls " in the British Rainfall classification. There is no entry for less than 1½ minutes in the British Rainfall List of known " Rainfalls of Very Rare Intensity lasting for one Hour or Less. " The measurements* by Symons of 0·10 in. in ½ minute and 0·17 in. in 1 minute at Camden Square on June 23rd, 1878, might have been quoted there. The Kew Observatory observation of 0·20 in. in one minute may be included in future.

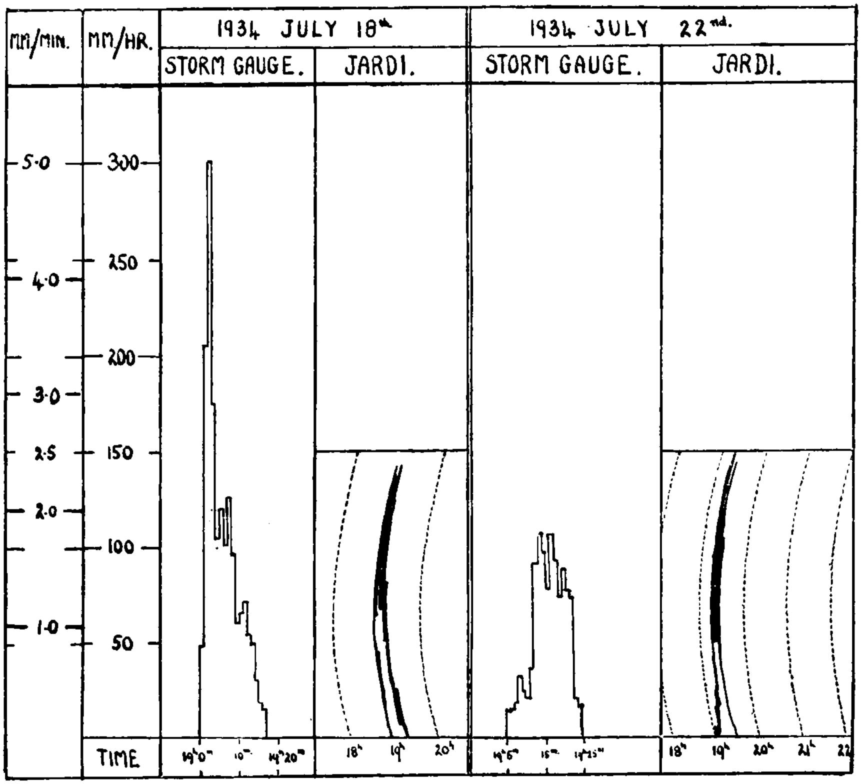


FIG. 2.—RAINFALL INTENSITY, KEW OBSERVATORY, JULY 18TH AND 22ND, 1934

The Jardi records are reproduced by tracing. The storm gauge records are graphs of minute by minute readings.

According to the minute by minute gauge the rainstorm on Sunday, July 22nd, was not so severe at Kew Observatory as that of July 18th. The records for the second day are illustrated in Fig. 2. It is hardly necessary to add that both these storms were very local in their effects. It appears that on the second occasion the rainfall was much heavier about a mile from the Observatory.

The aim of the Jardi rain-gauge is to provide a continuous record of the rate of the rainfall. The instrument, which has been described in *British Rainfall*, 1930, p. 284, is constructed with a small float

* cf. *Meteorological Magazine* **59,** 1924, p. 151.

chamber containing a float carrying a tapered spike. This spike passes through an aperture in the bottom of the chamber. When the rainfall is heavy the chamber is filled and the spike is withdrawn, leaving an annulus through which the water runs away. The tapering is so contrived that the lift of the float may be proportional to the rate of rainfall. Records of the Jardi gauge are reproduced in Fig. 2. It will be seen that on July 18th, when the minute by minute gauge indicated a maximum rate of fall of 300 mm./hr. the pens of the Jardi instrument did not reach the top of its range 150 mm./hr. The most likely explanation of the discrepancy is that half of the precipitation in the other gauge was hail. The second day the Jardi recorded 150 mm./hr. though the highest of the

TABLE I.—THE HIGHEST RAINFALL IN STATED TIMES. KEW OBSERVATORY, JULY 18TH, 1934

Time.	Rainfall		Hourly rate.		Time.	Rainfall.		Hourly rate.	
Min.	mm.	in.	mm.	in.	Min.	mm.	in.	mm.	in.
1	5·0	0·20	300	12	9	21·7	0·85	145	5·7
2	8·5	0·33	255	10·0	10	22·7	0·89	136	5·3
3	11·3	0·44	226	8·8	11	23·9	0·94	131	5·1
4	13·3	0·52	200	7·8	12	24·9	0·98	125	4·9
5	15·3	0·60	184	7·2	13	25·7	1·01	119	4·7
6	16·9	0·66	169	6·6	14	26·5	1·04	114	4·5
7	19·1	0·75	164	6·4	15	26·9	1·06	108	4·3
8	20·7	0·81	155	6·1	16	27·3	1·07	104	4·0

minute by minute readings was only equivalent to 106 mm./hr. It may be that this difference is genuine, and that the instantaneous rate was 40 per cent. greater than the average rate for a minute, or again that the rain fell heavier at the one spot than the other 100 yards away. We need not stress the difference; it is satisfactory that two instruments of such varied construction are not more inconsistent. It may be added that the two gauges would serve the needs of different classes of the community. For the engineer who wants to know how much rain has fallen or can fall in a short period the minute by minute gauge should be useful. On the other hand, the Jardi gives a record which is readily compared with a pressure tube anemogram, and is therefore the record for the student of dynamical meteorology.

Thunderstorms in July, 1934

A fair amount of thunderstorm activity occurred during July, thunder being heard in London, Calshot and Lympne on six days, at Cranwell and Ross-on-Wye on four days, and at places so widely scattered as Shoeburyness, Gorleston, Birmingham, Inchkeith (Firth of Forth) and Dublin on three days.

At the beginning of the month the weather was generally very fine. On the morning of July 11th a thunderstorm was reported from a ship in the Bay of Biscay, where a trough of low pressure was moving north-east towards the British Isles. Thunderstorms occurred in the southern part of England and Ireland on the 11th and 12th. The amounts of rainfall were, however, generally quite insignificant. On the 13th, 14th, 17th, 18th, 19th, 21st, night of 22–23rd, 24th and from 29th to 31st thunderstorms were again prevalent, especially so on 12th, 13th, 18th and 24th. There were heavy falls of rain locally on 12th, 13th, 17th, 18th, 22nd, 24th, 25th, but so far as information is available falls within the London district were heavy only on 13th, 18th, night of 22–23rd, and 24th.

During the periods of thunderstorms up to July 24th the British Isles were covered alternately by shallow " lows " which moved over the country either from the south or from the north-west, and by unstable currents from the north-west which followed the passage of the " lows " eastward. Thus :—

On the 12th—Shallow " lows " moved in from the Atlantic.

On the 13th and 14th—Unstable north-west current in rear of " lows " which had moved east.

On the 17th and 18th—Shallow " low " developed over England out of trough from Atlantic.

On the 19th—" Low " moved east and unstable north-west currents set in.

On the 22nd—Shallow " low " spread north from south-south-west.

On the 23rd–24th—" Low " moved east and pressure remained irregular with unstable NW. winds.

The thunderstorm period of 29th to 31st was associated with the approach of a depression from the Atlantic, the warm and cold fronts of which crossed most of the British Isles.

It has been known for a long time that the synoptic situations described above are, at any rate in summer and apart from extreme north-west districts, favourable for the development of thunderstorms. That is mainly a result of experience, and intelligent consideration of the question is only possible when observations for the upper air are also taken into account. It is known that thunderstorms are the results of violent convection in the atmosphere, brought about either (1) by forced ascent of warm damp air at a front or (2) by inherent instability in an air column, produced usually by rapid heating of damp surface layers after a period of sunny hours, often combined with advection of abnormally cold air at a height of 15,000 or more feet. In such a case partially saturated air at the surface would rise along the dry adiabatic under the influence of the heating effects from the ground, until it reached the temperature of saturation. The saturated air would then move rapidly upwards in an unstable manner along the saturated adiabatic, unless in doing so it met potentially warmer air. If there were no such potentially warmer air, or if the amount of such air were small, the chances of the formation of a thunderstorm would be respectively more or less considerable. This statement of the case is not a complete one, for a thunderstorm probably draws air from layers two or three thousand feet above the ground as well as from layers near the ground.

If now we turn to the results of aeroplane ascents at Duxford (Cambridge), as plotted on tephigrams, and use as far as possible ascents made in the afternoon* we find that the air over Duxford was unstable on July 13th, 14th, 18th (very pronounced), 21st (doubtful) and 24th. The ascents showed that violent convection in the air at Duxford was practically impossible or very unlikely on July 11th, 12th, 17th, 19th, 20th, 23rd. There was no ascent on Sunday, July 22nd. On most of these last-named days pronounced inversions of temperature occurred at moderate heights which effectively prevented convection, while on some of them the humidity in layers near the ground was so low that the lower layers of air did not possess sufficient potential temperature or entropy to cause convection.

In using tephigrams it has to be remembered that any result derived from them is applicable only to an area near the place of ascent which is (i) in the same kind of air, and (2) is likely to undergo changes of temperature and humidity similar to those at the place of observation. It would, for example, be incorrect to attempt to apply the results to a place beyond a warm or cold front. It is for reasons of this kind that the ascents at Duxford do not and cannot be expected to explain the occurrence of all the thunderstorms which occurred in other parts of the country.

R. CORLESS.

The following reports and extracts from letters received show the intensity of some of the heavier falls experienced between July 12th and 22nd.

On the 12th the observer at Bettws-y-Coed, Denbighshire, reports that 3·18 in. fell in under 2 hours but that "within a mile each way very little rain fell." On the same day the observer at Trowbridge, Wiltshire, recorded 1·88 in. of which 1·15 in. fell in 1 hour from 16h.–17h. (G.M.T.); at Kimbolton, near Leominster, 1·57 in. was recorded from 14h. 15m. to 15h. (G.M.T.); and at Frinton (Suffolk), 2·70 in. were recorded during the day.

On the 13th a fall of 2·07 in. in a thunderstorm of 2 hours' duration was recorded at Sway, in Hampshire, and 3·32 in. occurred at Gorleston.

---

* If morning ascents are used, an estimate of maximum temperature in the afternoon is made, and it is assumed that vapour content will not appreciably change between the times of the two ascents.

On the 17th 2·20 in. fell at Fleetwood (Lancashire).

Mr. M. W. Binns reports that he recorded 1·05 in. on the 18th at Lutterworth (Leicester). "It was a wild storm. Most of the precipitation occurred in 20¼ minutes, the total duration being 30½ minutes. Large transparent hailstones, $\frac{7}{10}$ in. in diameter, swept before a strong out-blowing wind (force 6–7) from S. by W., and these were driven northward where, two miles away, some still lay next morning. It is almost certain some of the catch was lost owing to the hail being so heavy."

On the 18th, also 2·15 in. were recorded between 17h. 30m. and 18h. 30m. (G.M.T.) in a thunderstorm accompanied by hail at Castleton (Yorks.).

Mr. D. A. Worthington, of Woodland Way, West Wickham (Kent), reports that 4·55 in. of rain and hail fell there in 1 hr. 40 mins. from 18h. 40m. to 20h. 30m. (G.M.T.) on July 22nd. "At 18h. 50m. I was outside the house and noted the intense stagnation of the air. . . a few heavy drops fell, but it was not until 18h. 55m. that it became very heavy. Thunder and lightning then rapidly approached from the north and rain increased to a heavy torrent. About 19h. 5m. this suddenly changed to a sheet of hail driven by a fierce squall from the north, but within five minutes the hail turned to rain, which fell with an even greater intensity. This continued till 20h. 15m. when it lessened and at 20h. 30m. it was only normal heavy rain. Thunder and lightning were almost directly overhead and the lightning appeared to average some 10 flashes a minute. I was unable to make a close study of the storm as our house soon became nearly full of drenched folk sheltering from the storm. Although on top of the hill water poured over the lawns and ran round the house in torrents."

Mr. Derek Schove, of Beckenham Road, West Wickham (Kent), says: "In the storm of July 22nd, I recorded 3·75 in. with a standard gauge. The heavy rain apparently did not occur anywhere in the locality until 7.45 p.m. (B.S.T.) when it began here to last for about 80 minutes. However, the centre of the rain seemed to be to the south or south-east of us, clear sky being observed to the south-west, and often to the north-east, north and north-west. Lightning centres began to the west or north-west with a few sharp "blue" flashes and moved slowly to the south and east of the village, increasing in frequency, but apparently changing to a reddish colour (haze ?) and passing from cloud to cloud. The intensity of the flashes would be remarkable in any case, but more so in view of the fact that until 9.15 scarcely any flashes were observed more than ½ mile distant from my house. The damage done was not large however, and rumours of fireballs proved difficult to analyse. At one such place, however, among more serious damage, a smoky trace was observable along the frieze and, where the bend in the wall occurred the lightning had sparked across and left a deep "rifle-shot" hole about $\frac{1}{10}$ in. diameter. Peculiar red-brown marks appeared in an unaffected room and soot and brick were blown out from the downstair grates to strike the opposite wall. The barometer trace rose only ·02 in. at the onset of the heavy rain but continued rising until 8.50 p.m. when it had risen ·06 in."

At Bromley (Kent) rain commenced on the 22nd at 19h. 10m. and in the period from then until 20h. 30m., 1·40 in. was recorded. The Engineer to the West Kent Main Sewerage Board states that "the storm of July 22nd did not affect Bexley, Crayford or Dartford."

Mr. J. H. J. Burtt reports that at Tooting Common his hyetograph chart indicates "that during the thunderstorm of the evening of July 22nd, 1934, an inch fell in the first 16 minutes and that within half an hour one inch and a half fell. It left off at about 9.10, and I then had to syphon, as the container was full. I did not consider the lightning very severe and only two flashes synchronised with the clap."

At Barcombe, near Lewes, 1.11 in. fell in 45 minutes during the late afternoon on the same day.

Correspondence

To the Editor, *Meteorological Magazine*

The Halo Complex in Holland, May 26th

The halo complex witnessed by Messrs. C. E. P. Brooks and C. Braak* near Nijmogen was part of a remarkable phenomenon of great brilliancy and long duration observed in a great part of the Netherlands.

In the morning of May 26th six different forms were seen; the halos of 22° and 46°, the tangent arcs, the parhelia, the parhelic ring and an infra-lateral arc. At about 10h. (Amsterdam Summer Time) the phenomenon was obscured by low clouds. In the afternoon, about 18h., again six forms were present: the halo of 22° and its upper tangent arc, the parhelia and the parhelic ring, the pillar and the circumzenithal arc. It must be remarked that the observer at Abcoude (south-east of Amsterdam) drew the pillar in quite the same manner as Dr. Brooks.

The halo remained visible until sunset and appeared again around the rising moon at 22h. The same particulars were seen, moreover the great halo and the circumzenithal arc were present simultaneously. All seven forms were observed at Amsterdam.

In the morning of May 27th, between 0h. and 1h., the halo complex disappeared behind cumulus.

S. W. VISSER.

Leersum, Holland, July 14th, 1934.

* See *Meteorological Magazine*, **69**, 1934, p. 122, and De Halo van 26 Mei, 1934, by Dr. S. W. Visser, *Hemel en Dampkring* **32**, 1934, pp. 261–5.

Strange Sunset Effect

The notice in the June *Meteorological Magazine* of a "Strange Sunset Effect" observed in Hampshire by Mr. W. L. Baxter, on October 11th, 1933, leads me to report a similar effect observed by me at Angra do Heroismo, Terceira Isl., Azores, a few days before that date, on October 4th, 1933.

Similar shafts of pale-rose light were observed for a few minutes beginning at 17h. 30m., Azores Time, on the eastern horizon, radiating from a point diametrically opposite the sun just set. The point of radiation (possibly an anthelium) I could not see, as it was hidden by a big cumulus behind a line of mountains. I also observed that the shafts were moving slowly to the right around the supposed anthelium.

I was informed a few days later by the superintendent of our observatory at Ponta Delgada, Mr. Miranda, that a similar phenomenon was observed there at sunset on the same date, by himself and Dr. Lugeon, who was then on his way back to Lisbon and Warsaw.

It is also worthy to report that on April 2nd last we experienced the lowest temperature this year in the Azores. A minimum of 3·2°C. was registered at the Flores station, which is exceptional for the year and much more exceptional for the month of April in the Azores. I was coming back from a tour of inspection to our observatories in Flores and Faial and, while crossing from Graciosa to Terceira, at 9h. I had the opportunity—very rare indeed—of seeing the tops of the mountains in Saint Georges, Pico and Terceira Islands covered with snow above an altitude of 2,000 ft. I took some pictures of the mountain of Santa Barbara, in Terceira, covered with snow as it was never seen before. It is interesting to note that an anticyclone was extending from Iceland by the eastern coasts of Greenland to the Azores, which is also a quite exceptional situation.

J. Agostinho.

Angra do Heroismo, Terceira, Azores. June 30th, 1934.

With reference to Mr. W. L. Baxter's letter in the June issue of the *Meteorological Magazine*, the effect he observed was witnessed here in the evening of Friday, July 6th, 1934. Seen from the north-west corner of Croydon aerodrome the rays were practically white. The same effect was observed here three or four years ago, but then the rays were decidedly pink. In each case the sky was cloudless and the sunset light very brilliant. I have not yet found any explanation for the phenomenon.

W. Hayes.

Wallington, Surrey, July 10th, 1934.

Weekly Weather Reports

The library at Kew Observatory contains an almost complete set of the climatological publications of the Meteorological Office. Until recently there were many years for which the *Weekly Weather Report* had been left unbound, but now from Vol. III, 1880 onwards all the reports are bound. We have the weekly issues for 1878 with one exception, No. 22, but all the 1879 issues are missing. Unfortunately the Meteorological Office does not possess spare copies of the reports in question. It may be that broken sets of the *Weekly Weather Report* have been preserved at some climatological station and that the numbers required in the Kew Observatory library could be spared. To facilitate a search it should be noted that for these first two years the *Weekly Weather Report* was printed on pages 10 in. by 6 in.; the pages of volume III are larger, $12\frac{1}{2}$ in. by $8\frac{3}{4}$ in.

If anyone can help me to make up the Observatory set I shall be very grateful.

F. J. W. WHIPPLE.

Kew Observatory, Richmond, Surrey, May 30th, 1934.

The Height of the Tropopause at Calgary, Alberta, and Goderich, Ontario, during the Second International Polar Year, 1932–3

During the International Polar Year sounding balloons were sent up from Calgary, Alberta, latitude 51° 2′, longitude 114° 2′ W., and Goderich, Ontario, latitude 43° 45′, longitude 81° 37′ W., on the second Wednesday and Thursday of each month during the year. The instrument used was a modified Dines meteorograph in that the temperature element in the Dines instrument was replaced by an element made of thermostat metal. The ascents were all made in the evening so that radiation did not affect the instruments. The recovery of the balloons was remarkably good, one or both being found at each of the stations in practically every month.

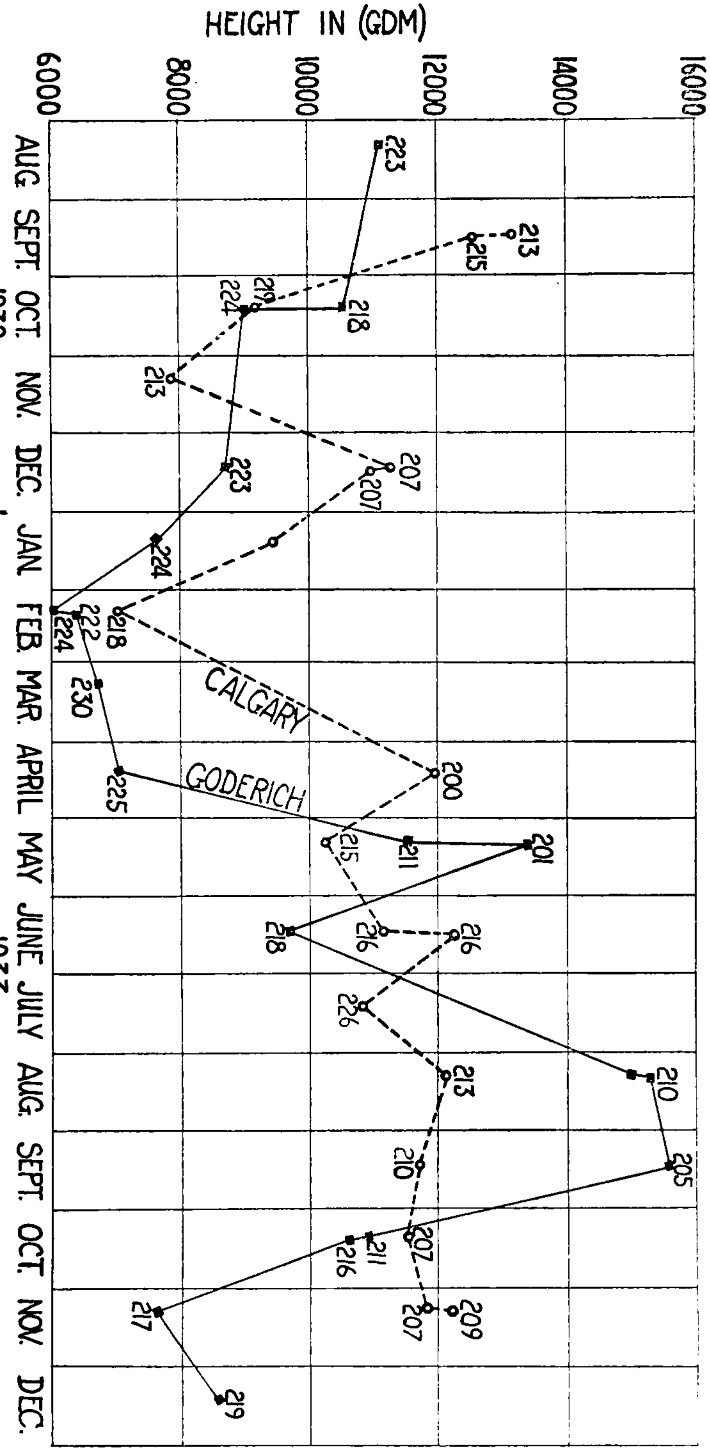
The chart gives the height in geodynamic metres of the tropopause for each of the ascents, and the figures give the absolute temperature of the tropopause. One set of curves is for Goderich and the other for Calgary.

It is interesting to note that in February the height of the tropopause was about 6,000 gdm. at Goderich on both days and 7,000 at Calgary. On this occasion the heights obtained by the U.S. Weather Bureau at Omaha, Nebraska, and Elmvale, North Dakota, were about 6,000 metres, showing that at this period the tropopause was very low over the whole of the southern part of Canada and the northern part of the United States.

The curves indicate that the tropopause is lowest in the winter months and highest in the summer. This is in agreement with results obtained from ascents at Woodstock, made during the years 1911–4.

J. PATTERSON.

The Meteorological Office, Toronto, Canada, May 30th, 1934.



HEIGHT AND TEMPERATURE OF TROPOPAUSE AT CALGARY AND GODERICH

Unusual Anemometer Record

The copy of the anemometer record from Amman for March 4th, 1934 shown on the opposite page, is probably of a most unusual type and will be of general interest.

A very deep depression was situated over the eastern Mediterranean on the 4th. The strong south-easterly winds in front caused severe sandstorms; the visibility at M/Y. "Imperia," Mirabello Crete, 250 miles from the African coast being reduced to 100-200 yards owing to dust. At all stations the change in wind speed and direction was normal, *i.e.*, SE'ly. 40-50 m.p.h., becoming SW'ly. 30-40 m.p.h., and finally W.-WNW. 20 m.p.h. At Amman the strength of the SE'ly. wind, 20 m.p.h., was considerably less than at other stations, but as will be observed just before 14h. G.M.T. a gust of 67 m.p.h. occurred suddenly which lasted for a few minutes; the wind then decreased and oscillated between SE. and SW. before commencing to blow from its original direction and with its original speed. The change to SW. may be seen occurring about 17h. G.M.T. A considerable fall of temperature occurred just after the squall.

J. DURWARD.

R.A.F. Heliopolis, Egypt, April 14th, 1934.

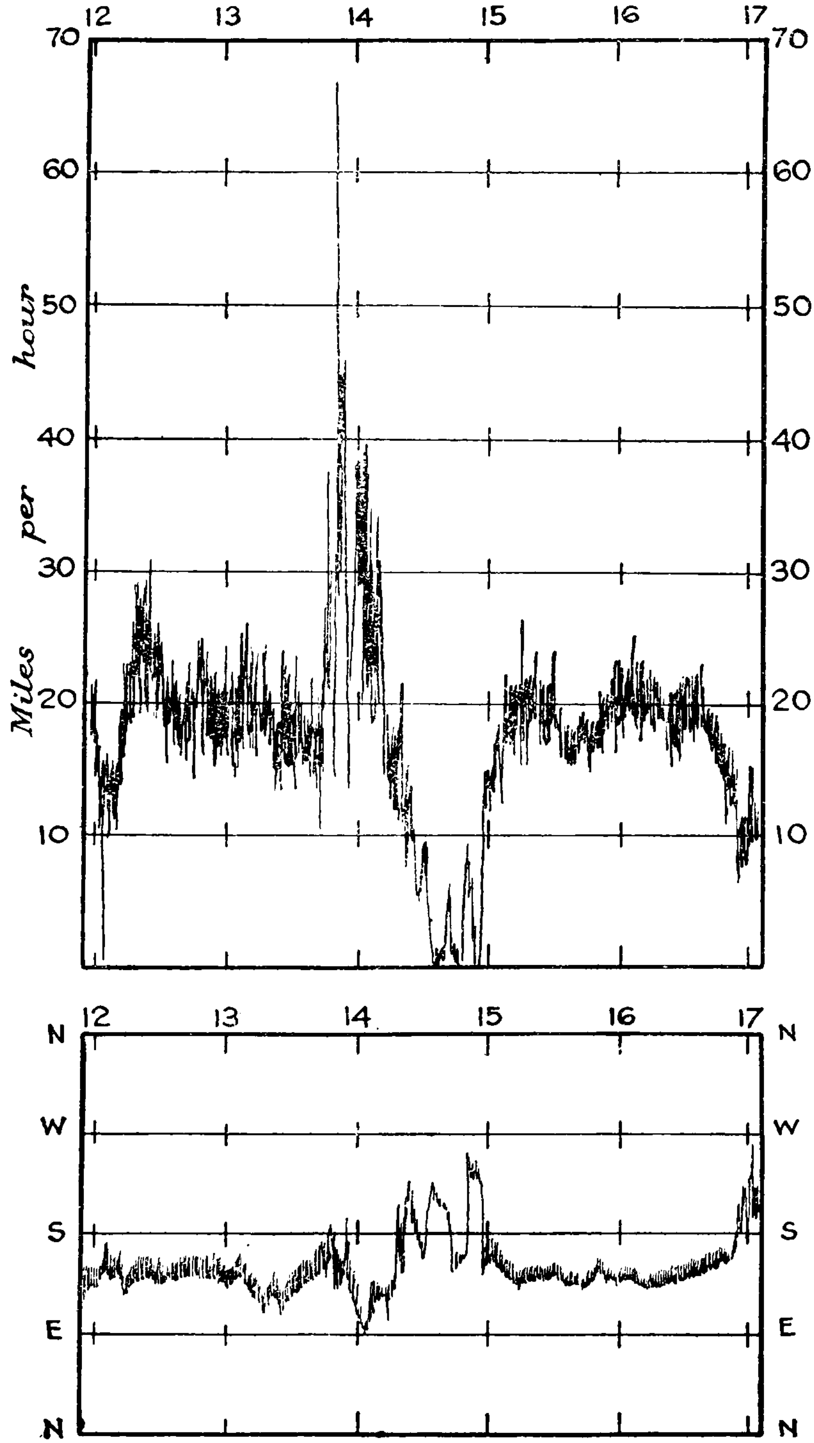
Summer Rainfall in Iraq

There are only two months in the year, namely July and August, in which rainfall never occurs in central Iraq, but a fall of rain in June is sufficiently remarkable to warrant mention. During the 12 years for which Air Ministry meteorological records exist, rain was recorded at Hinaidi on June 2nd, 1923 (0·4 mm.), and June 1st, 1926 (0·9 mm.), whilst from previous scanty records which exist for Baghdad it appears that during the period 1888 to 1914 rain was recorded in June during three years only.

It is interesting to record, therefore, that on June 10th this year a thunderstorm occurred at Hinaidi, which yielded a measurement of 0·4 mm. As the maximum temperature that day was 111°F. and during the fall of rain the temperature was 102°F., it is probable that the rain-gauge was too hot to allow of all the fall being collected without evaporation.

The rainfall was the result of a distinct line squall which moved from west to east across the country, and was accompanied also by thunder, lightning and thick dust. The squall passed Hinaidi at 16h. G.M.T. (19h. L.T.), giving a sudden rise of wind from almost calm to 41 m.p.h., and a drop in visibility to 50 yards owing to dust. The temperature and humidity traces showed very little variation, but the barograph gave a rise of pressure of 3mb. in about half an hour.

It will be seen that the date this year, June 10th, is the latest in



ANEMOMETER RECORD, AMMAN, MARCH 4TH, 1934.

the summer on which rain has fallen since the British took observations here. It gave rise to the not unexpected comment in the local press that the climate of Iraq was changing !

R. H. MATTHEWS.

R.A.F., Hinaidi, Iraq, June 12th, 1934.

NOTES AND QUERIES

The Basis of the Expression $\frac{1}{4}$(7+13+2×21h.) for mean temperature

The combination $\frac{1}{4}(7 + 13 + 2 \times 21h.)$, the analysis of which forms part of the subject of a paper by L. Besson discussed at the Meteorological Office on January 15th, is so widely and successfully used as an expression for the 24-hour or " true " mean temperature that it is of interest to search for the physical basis underlying it.

In general, the diurnal variation of temperature can be expressed with sufficient accuracy by the equation :—

$$T = a_0 + a_1 \sin (t + A_1) + a_2 \sin (2t + A_2)$$

This equation has five unknown quantities, a_0, a_1, a_2, A_1 and A_2, and so cannot be solved directly from observations at three hours only. It happens, however, that the second order term is small in comparison with the first order term, and its phase, A_2, is fairly constant. This term may therefore be replaced by known quantities without great inaccuracy. The amplitude a_2 is in general rather more than one quarter of a_1, roughly $0 \cdot 3a_1$, and the phase A_2 is such that the minima occur at about 7h. and 19h., the maxima about 13h. and 1h. The second order term in fact represents the retardation of the minimum temperature from 1h. to 6h. or 7h., the accentuation of the maximum at 13h. (which makes the mean of daily maxima and minima higher than the 24-hour mean) and the relatively rapid fall of temperature in the late afternoon.

In practice we may substitute for a_2 $0 \cdot 15$ times the difference between the 13h. and 7h. mean temperatures. If we write I, II and III for the temperatures at 7h., 13h. and 21h. and put $t = 0$ at 7h., we then have three equations :—

$$I + \cdot 15(II - I) = a_0 + a_1 \sin A_1$$
$$II - \cdot 15(II - I) = a_0 + a_1 \cos A_1$$
$$III + \cdot 075(II - I) = a_0 - \cdot 87 a_1 \sin A_1 - \cdot 5 a_1 \cos A_1$$

The solution of these equations gives us :—

$$a_0 = \cdot 31 \times I + \cdot 27 \times II + \cdot 42 \times III \qquad (1)$$

This is not far from the usual formula :—

$$a_0 = \cdot 25 \times I + \cdot 25 \times II + \cdot 5 \times III \qquad (2)$$

The best-fitting expression can also be determined from the hourly data for a number of stations by the method of least squares. I have done this for two groups of stations,* one in France and the

*True mean temperature, *Washington, D.C., Mon. Weather Rev.*, 1921, p. 226.

other in the tropics. The French group gave an approximation of formula (2), but the tropical group gave as the best-fitting expression :—

$$a_0 = \cdot 33 \times \text{I} + \cdot 30 \times \text{II} + \cdot 37 \times \text{III} \qquad (3)$$

The mean of (2) and (3) is :—

$$a_0 = \cdot 29 \times \text{I} + \cdot 27 \times \text{II} + \cdot 44 \times \text{III}$$

which comes very near the theoretical form calculated in (1). On the mean of 97 stations in the tropics for which hourly figures are given by Hann, expression (3) is accurate to 0·0° C., while (1) and (2) give values of a_0 0·1° C. too low.

C. E. P. BROOKS.

The Second Volume of World Weather Records*

In 1927 the Smithsonian Institute, with the aid of a generous grant from Mr. John A. Roebling, published a volume under the title "World Weather Records", which included monthly tables of pressure, temperature and precipitation for 385 land stations in all latitudes from Upernivik in 72° 47′ N. to Laurie Island in 60° 44′ S. With a few exceptions, the data for each station covered a continuous period of at least 20 years from 1901 or earlier to the end of 1920. The volume was reviewed, with a brief account of the needs and efforts which resulted in the international collaboration necessary to prepare it, in the *Meteorological Magazine* for November, 1927. This review ended with the words : "in another few years the investigator will find himself faced by the labour of extracting the data for the years 1921 to 1930, to add to those in the present volume, before he is able to begin his calculations. But the international effort so worthily begun cannot be allowed to lapse, and means must be found to issue a supplementary volume every ten years, as envisaged in Professor Exner's original proposal."

Thanks again to the generosity of Mr. Roebling, the means have been found for the first of these supplementary volumes. The general plan follows that of the original collection ; the first 80 pages are devoted to a series of notes on the stations giving the authority, the site, hours of observation, the corrections applied and details of any changes of site or other interruptions to the continuity of the observations. For most stations these details are very complete and add greatly to the utility of the figures. Then follow tables giving the monthly data for the years 1921 to 1930 for the majority of the stations included in the first series, together with the ten-year means.

**Smithsonian Miscellaneous Collections, Vol.* 90. World Weather Records continued from Vol. 79. 1921–1930, collected from official sources by Dr. G. C. Simpson, Sir Gilbert Walker, Robert C. Mossman and Frances L. Clayton, assembled and arranged for publication by H. Helm Clayton. Published under grant from John A. Roebling (Publication 3218). City of Washington, 1934, pp. vi + 616.

We should have liked to see also the means for the whole period covered by each station from the beginning to 1930, but it must be admitted that the additional computation involved would have been very great, and where so much is given, it would be unfair to ask for more.

Part II of the volume, from pp. 437 to 497, constitutes a new feature of great interest. It is entitled "Ocean and sea-level pressures. Atmospheric pressures over the northern oceans and sea-level pressures at selected land stations, 1921–1930." This section was included in response to a need for reliable meteorological data over the oceans, which in the first volume were represented only by a few island stations. The monthly means were not obtained directly from ships' observations, as are the marine observations for five-degree "squares" included in the Réseau Mondial, but indirectly by estimating values at fixed points from daily isobaric charts over the oceans, mainly the Japanese charts for the North Pacific and the British *Daily Weather Report* which includes the North Atlantic. Experiments showed that the monthly means so obtained could be regarded as accurate to 0·5 mm., and they are accordingly published to the nearest millimetre. It is stated that this unit was chosen because it is used for most of the land stations, and so less conversion was required to obtain uniformity in this section of the tables, but the millibar is now generally recognised as the unit for international studies in meteorology, such as those in connexion with the Polar Year, and conversion to millibars throughout would have well repaid the additional labour involved.

Part III, pp. 495 to 573, gives tables of pressure, temperature and precipitation for a number of stations over long periods, which were received too late for inclusion in the first series of World Weather Records. In Part IV are given a list of errata to the earlier volume, supplementary to the list of errata issued in 1929. Finally, the table of sun-spot relative numbers is carried on to 1930, and there is also a table of mean monthly values of solar radiation for the years 1921 to 1930. There is a double index on the same lines as that to volume 79, giving first an alphabetical list of stations and countries, and secondly a list of stations arranged from west to east in ten-degree zones of latitude, as adopted in the Réseau Mondial. Frequent reference to the first volume has shown that this double index is of great value and fully worth the additional space involved.

One of the most important uses of data of this kind is to plot them on charts. To facilitate the use of the "World Weather Records" for this purpose, the Smithsonian Institution has prepared two maps of the world, one on an elliptical projection and the other hemispherical, showing the positions of all the stations. A slip inserted in the volume states that copies of these charts can be purchased from the Smithsonian Institution at a price of 5 cents per sheet or four dollars per 100. There is no doubt that many scientists — geographers, botanists, etc., as well as meteorologists, will make extensive use of the great mine of information contained in "World Weather Records", and will wish to avail themselves of these maps so thoughtfully provided by the Institution.

We understand that copies of the second series of "World Weather Records", but not of the maps, will be stocked in this country by Messrs. Wheldon and Wesley, Ltd., 2, Arthur Street, W.C.2, and will be on sale at 15*s.* per copy.

REVIEW.

India Meteorological Department, Memoirs, Vol. XXVI, Part II—The Indian south-west monsoon and the structure of depressions associated with it. By K. R. Ramanathan, M.A., D.Sc., and K. P. Ramakrishnan, B.A.; Vol. XXVI, Part III.—*On the physical characteristics of fronts during the Indian south-west monsoon.* By N. K. Sur.

These two papers make a contribution to frontal analysis in India during the south-west monsoon, and cover much the same ground. The first discusses the mean upper air winds and temperatures in each of the months May, June, July, and then proceeds to a detailed description of the life-history of two monsoonal depressions which originated in the Bay of Bengal. The second paper discusses four cases of monsoonal depressions. The authors of both papers recognise three chief types of air-mass over India during the monsoon, viz., the fresh monsoon air from west or south-west, the old returning monsoon air from east and north-east and the north-westerly continental air. The last often intervenes between the fresh monsoon current over central and southern India and the easterly current in the north-east of India. This old monsoon air acts as "warm" air, and in ascending over one or both of the other two currents is a principal cause of rain. The investigations do not support the idea of a stationary cyclone derived by Wagner* from the consideration of mean values. The papers are plentifully supplied with maps, but some of these could have been more legible with advantage.

A. F. Crossley.

BOOKS RECEIVED.

Totland Bay, Isle of Wight. Meteorological Observations for the year 1932 *with extremes and averages for preceding years.* By J. Dover, M.A. Newport, Isle of Wight, 1933.

Some meteorological data for 1930 *and* 1931. By Dr. E. Kidson. Wellington, N.Z. Meteorological Office Note No. 11, 1932.

Meteorological Observations for 1931 *Prepared in the Meteorological Office, Wellington.* E. Kidson, D.Sc., Director, New Zealand Dept. of Scientific and Industrial Research. Wellington, N.Z., 1933.

* A. Wagner, Zur Aerologie des Indischen Monsuns. *Beitr. Geoph., Leipzig,* Bd. 30, 1931, p. 196.

OBITUARY.

Alfred John Rigby.—We regret to learn of the death of Mr. Rigby, which took place on June 2nd after 21 years of retirement from the Meteorological Office. Mr. Rigby was born in 1847, and at the age of 15 entered the service of Kew Observatory, where he was engaged for 12 years. In 1874 he was appointed to a temporary clerkship in the Observatories Branch of the Office and transferred later to the Telegraphic Section. He afterwards became a senior officer of the Statistical Branch, in which he remained until his retirement in March, 1913. Mr. Rigby enjoyed a robust and vigorous personality. From 1884 onward his time was mainly devoted to the preparation of the *Monthly Weather Report,* which has remained one of the standard publications of the Meteorological Office.

A. T. Bench.

NEWS IN BRIEF.

We learn that General Delcambre retired from the directorship of l'Office National Météorologique, Paris on July 1st. He is succeeded as Director by M. Ph. Wehrlé.

Rev. G. W. Stewart, of St. Philips, Scalby, Scarborough, informs us that he has for disposal a number of bound volumes of scientific publications, formerly the property of the Rev. W. E. Stewart, whose death was referred to in the April, 1934, number of this magazine. The books include *British Rainfall,* 1886–1921, 1929–32, and a number of volumes of the *Quarterly Journal of the Royal Meteorological Society, Monthly Notices Royal Astronomical Society, British Astronomical Journal, The Observatory* and *Knowledge.* Any persons interested should write direct to the Rev. G. W. Stewart.

The Weather of July, 1934.

Pressure was above normal over north and east Russia, Spitsbergen, most of Scandinavia, the British Isles, the Azores, most of Spain, north central Canada and Mexico, the greatest excess being 6·4 mb. at Waigatsch. Pressure was below normal elsewhere in Europe, over the Mediterranean, Madeira, Portugal, the United States, and west, south central, and east Canada, the greatest deficits being 4·1 mb. at 40° N., 40° E. and 3·0 mb. at 40° N., 110° W. Temperature was above normal in Spitsbergen and Scandinavia (over 5° F. in northern Norrland), about normal in Switzerland and below normal in south-west Europe, while rainfall was deficient in western Europe and Spitsbergen and in excess in Scandinavia as a whole.

The main features of the weather of July over the British Isles were marked excess of sunshine in all areas, high temperatures in most parts, deficiency of rain in many districts, and frequent thunderstorms between the 11th and 22nd. Sunshine values at Holyhead and Ross-on-Wye were the highest reported at these stations for July since records began in 1914 and 1915 respectively. The rainfall at Holyhead was the lowest value for July measured at that station since records began in 1871. At Southport, July 1934 was the warmest month of any name in the 63 years' history of the Fernley Observatory, the mean temperature (64·5° F.) being 4·7° F. above the July average—the previous warmest month there was August, 1911. From the 1st to 11th mainly anticyclonic conditions prevailed, and the weather continued fine, sunny and warm though slight rain fell in north Scotland and north Ireland at times. Thunder was heard locally in north England on the 6th and 7th, and a thunderstorm was reported from Auchincruive (Ayr) on the 6th. Temperature rose gradually at the beginning of this period and exceeded 85° F. in many places from the 6th to 11th ; 90° F. was recorded at Collumpton (Devon) on the 10th, 89° F. at Sealand on the 11th, and 88° F. at Southport, Chester and Bath on the 10th, and at Rhyl on the 9th and 11th and Cheltenham on the 8th. Good sunshine records were obtained from all parts throughout the period, and especially on the 3rd, 5th and 8th to 11th ; 16·5 hrs. were recorded at Stornoway on the 9th and 16·0 hrs. at Dalwhinnie on the 9th and at Tiree on the 8th. Kew recorded 131·9 hrs. bright sunshine in the first 10 days, which constitutes a record since observations began there in 1880. Some mist or fog, however, occurred locally. From the 11th to 22nd shallow disturbances crossed the country giving cooler thundery weather, getting warmer again about the 17th, with light to moderate winds, freshening locally occasionally. Thunderstorms, severe in some places, occurred over a wide area on the 11th, 12th, 13th, 14th, 17th, 18th, 19th, 21st and 22nd.* These caused some structural damage and temporary flooding as the rain was heavy locally ; 4·55 in. fell at West Wickham (Kent) on the 22nd.† Sunshine values were variable, but considerable sunny periods were enjoyed at most places over the whole country. Some mist or fog occurred at times. From the 23rd to 29th, pressure was low to the north and high to the south-west, giving moderate W. winds strengthening to high winds or gales locally from the 26th to 28th. Beaufort force 9 was reported from Spurn Head at 13 h. on the 26th, and a gust of 61 m.p.h. from Liverpool on the 28th. The weather was generally warm and unsettled with occasional rain or drizzle and cooler periods in most areas, but also considerable warm sunny intervals, particularly in the south. Thunderstorms occurred in the south on the 24th. On the 30th and 31st the northerly depression became centred more to the west of the British Isles and more general rain was experienced in the west and north and thunderstorms in east and south-east England. The distribution of bright

---

* See p. 160. † For other heavy falls, see p. 162.

sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	167	+19	Liverpool ...	244	+61
Aberdeen ...	186	+35	Ross-on-Wye ...	271	+83
Dublin	217	+45	Falmouth ...	276	+55
Birr Castle ...	195	+47	Gorleston ...	274	+68
Valentia... ...	182	+24	Kew	281	+86

Miscellaneous notes on weather abroad culled from various sources.

A cloudburst occurred near Nikopol, in the Danube Valley, at the beginning of the month causing floods, and 18 people were killed. No rain fell in Switzerland during the first 10 days of the month and the temperature was unusually high. Drought was also experienced during this period in Germany, where numerous forest and heath fires occurred. Violent thunderstorms accompanied by hail, which did much damage to crops, occurred in parts of southern and eastern France on the 14th and 15th. Rainfall of tropical intensity fell in Galicia between the 16th and 18th, and floods of unprecedented severity were experienced there from the 17th to 22nd. By the 19th the Dunajec, San, Raba and Sola rivers had begun to subside, but the Vistula, north of Cracow, continued to rise. Heavy rain fell throughout Poland on the 22nd–25th, but the level of the Vistula at Warsaw fell as the dams in the Sandomierz district gave way on the 22nd. By the 26th, however, conditions had improved and sunny weather was reported after violent thunderstorms during the preceding night. A spell of intensely hot weather in northern Italy was broken on the 21st by violent thunderstorms accompanied by hail—the most serious damage was done in Piedmont and in the Novara region. Thunderstorms and hail also did much damage over a wide area south of Lugano on the 21st and in southern France on the 22nd. (*The Times*, July 4th–27th.)

The floods in Assam and east Bengal had begun to subside by the beginning of the month. Ninety people were killed and over 1,000 head of cattle perished in floods in three villages in northern Afghanistan. A heavy fall of rain which began on the 10th caused serious floods in the prefectures of Toyama, Ishikawa and Niigata, in Japan. Widespread floods were also reported about the same time in the basins of the Sungari and Nonni rivers in Manchuria, and by the 24th over 100,000 people had been affected by floods in southern Korea. Drought and high temperatures prevailed generally in the Lower Yangtze region throughout the month, but a typhoon swept across east central China on the 22nd. The monsoon in India was generally weak during the middle of the month, but resumed normal activity near the end except over the plains of north-west India. (*The Times*, July 3rd–30th.)

A severe blizzard swept through the Otago Province of New Zealand on the 1st and 2nd.. (*The Times*, July 2nd.)

Hot dry weather was experienced in west Canada during the week ending the 19th, but a severe storm passed across southern and western Ontario on the 6th, and a considerable fall of rain improved the conditions there during the first fortnight. A tornado swept over four Illinois counties on the 11th. Temperature was above normal generally in the United States except about the middle of the month in parts of the Atlantic and Gulf States and towards the end of the month along the Pacific coast, while precipitation was mainly below normal. (*The Times*, July 9th–20th and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, July, 1934

* Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp.		Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
			Min.	Max.				
	mb.		°F	°F	%	in.	hrs.	
1	1025·3	NNE.3	57	78	51	—	13·7	
2	1025·2	NNW.2	60	78	48	—	11·0	
3	1026·2	CALM	57	77	47	—	8·9	
4	1023·9	W.1	54	80	50	—	12·1	w early.
5	1020·1	ENE.3	53	77	40	—	14·8	
6	1021·8	E.4	56	79	40	—	13·9	w early.
7	1024·3	E.3	58	82	37	—	14·1	w early.
8	1024·8	E.3	57	83	27	—	15·2	w early.
9	1023·1	E.4	58	80	38	—	12·3	
10	1019·0	E.4	57	81	16	—	14·9	
11	1014·6	E.5	57	83	29	—	14·0	w early.
12	1010·2	SW.1	61	71	82	0·04	0·2	rr$_0$ 11h.–13h.
13	1008·5	SW.1	61	74	88	0·55	0·7	rRtl 12h.–14h. & 20h.
14	1012·3	N.2	59	71	51	—	3·9	
15	1019·8	W.3	53	74	44	—	10·2	
16	1022·7	W.3	62	74	58	—	1·9	
17	1018·9	S.2	54	83	45	—	13·7	w early.
18	1010·1	NNE.4	64	79	41	1·28	9·2	RHtl 18h. 20m.–
19	1014·7	WSW.3	56	76	42	—	11·1	[19h.30m.
20	1008·8	SSE.2	54	80	46	—	11·1	
21	1006·5	E.3	62	75	53	0·17	3·4	ir$_0$ 2h.–8h. t 16h.
22	1009·4	NNW.2	58	77	58	0·78	6·3	tlrR 18h. 10m –
23	1014·4	NNW.3	60	73	42	—	7·6	[20h. 40m.
24	1015·9	NNE.3	56	67	93	0·35	4·2	irr$_0$ 9h.–21h. ; tlR 11h.
25	1019·0	W.3	55	74	57	—	4·7	f till after 7h. [–13h.
26	1016·3	WSW.4	58	79	60	—	10·7	
27	1017·7	W.4	57	70	47	—	9·0	
28	1011·1	WSW.5	56	75	48	—	6·6	
29	1011·3	WSW.4	59	74	73	0·01	3·1	pr 13h., t 18h. 30m.
30	1011·0	SSW.3	62	80	59	—	12·0	
31	1006·1	SW.4	63	77	58	0·01	6·8	pr 11h. 20m.

* The dates of Sundays are in heavy type.

General Rainfall for July, 1934

England and Wales ...	56	per cent of the average 1881–1915.
Scotland	108	
Ireland	68	
British Isles	70	

Rainfall : July, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.........	·94	39	*Leics* .	Thornton Reservoir ...	1·28	52
Sur .	Reigate, Wray Pk. Rd..	2·20	98	,, .	Belvoir Castle...........	2·76	114
Kent .	Tenterden, Ashenden...	1·30	62	*Rut* .	Ridlington	·85	34
,, .	Folkestone, Boro. San.	2·22	...	*Lincs* .	Boston, Skirbeck.........	1·29	59
,, .	Eden'bdg., Falconhurst	1·88	82	,, .	Cranwell Aerodrome...	2·94	126
,, .	Sevenoaks, Speldhurst.	1·46	...	,, .	Skegness, Marine Gdns.	·87	40
Sus .	Compton, Compton Ho.	1·49	53	,, .	Louth, Westgate.........	1·62	65
,, .	Patching Farm..........	1·31	55	,, .	Brigg, Wrawby St.......	1·00	...
,, .	Eastbourne, Wil. Sq....	1·04	47	*Notts* .	Worksop, Hodsock......	1·85	81
,, .	Heathfield, Barklye....	2·53	101	*Derby*.	Derby, L. M. & S. Rly.	·97	41
Hants.	Ventnor, Roy.Nat.Hos.	·35	17	,, .	Buxton, Terr. Slopes...	2·72	69
,, .	Fordingbridge, Oaklnds	1·32	66	*Ches* .	Runcorn, Weston Pt....	1·57	57
,, .	Ovington Rectory.......	2·36	91	*Lancs*.	Manchester, Whit. Pk.	2·14	65
,, .	Sherborne St. John......	2·45	110	,, .	Stonyhurst College......	2·17	56
Herts .	Welwyn Garden City ...	1·48	64	,, .	Southport, Bedford Pk.	1·29	45
Bucks.	Slough, Upton............	1·51	79	,, .	Lancaster, Greg Obsy.	2·27	65
,, .	H. Wycombe, Flackwell	·87	43	*Yorks*.	Wath-upon-Dearne......	1·42	57
Oxf .	Oxford, Mag. College...	1·08	48	,, .	Wakefield,Clarence Pk.	1·74	69
Nor .	Pitsford, Sedgebrook...	·92	39	,, .	Oughtershaw Hall.......	3·00	...
,, .	Oundle	2·61	...	,, .	Wetherby, Ribston H..	1·80	72
Beds .	Woburn, Exptl. Farm...	1·29	68	,, .	Hull, Pearson Park......	1·17	50
Cam .	Cambridge, Bot. Gdns.	1·26	58	,, .	Holme-on-Spalding......	1·91	74
Essex .	Chelmsford, County Lab	1·85	87	,, .	West Witton, Ivy Ho.	1·26	48
,, .	Lexden Hill House......	1·14	...	,, .	Felixkirk, Mt. St. John.	3·46	127
Suff .	Haughley House.........	1·37	...	,, .	York, Museum Gdns....	1·52	60
,, .	Campsea Ashe...........	1·71	74	,, .	Pickering, Hungate......	1·82	68
,, .	Lowestoft Sec. School...	...	...	,, .	Scarborough..............	1·79	74
,, .	Bury St. Ed., WestleyH.	1·05	42	,, .	Middlesbrough...........	1·56	61
Norf. .	Wells, Holkham Hall...	1·02	44	,, .	Baldersdale, Hury Res.	2·93	91
Wilts .	Calne, Castleway.........	1·39	57	*Durh* .	Ushaw College...........	2·07	74
,, .	Porton, W.D. Exp'l. Stn	1·38	70	*Nor* .	Newcastle, Town Moor.	2·25	85
Dor .	Evershot, Melbury Ho.	·70	27	,, .	Bellingham, Highgreen	3·54	107
,, .	Weymouth, Westham.	·12	7	,, .	Lilburn Tower Gdns....	1·52	62
,, .	Shaftesbury,Abbey Ho.	·97	38	*Cumb*.	Carlisle, Scaleby Hall...	2·67	82
Devon.	Plymouth, The Hoe....	·41	15	,, .	Borrowdale, Seathwaite	4·00	51
,, .	Holne, Church Pk. Cott.	·68	19	,, .	Borrowdale, Moraine...	2·88	45
,, .	Teignmouth, Den Gdns.	·41	17	,, .	Keswick, High Hill......	1·53	40
,, .	Cullompton	1·96	73	*West* .	Appleby, Castle Bank...	1·69	53
,, .	Sidmouth, U.D.C........	·36	...	*Mon* .	Abergavenny, Larchf'd	2·16	87
,, .	Barnstaple, N. Dev.Ath	·39	14	*Glam* .	Ystalyfera, Wern Ho....	1·24	27
,, .	Dartm'r,Cranmere Pool	2·00	...	,, .	Cardiff, Ely P. Stn.......	1·13	36
,, .	Okehampton, Uplands.	1·40	43	,, .	Treherbert, Tynywaun.	2·68	...
Corn .	Redruth, Trewirgie......	·85	28	*Carm* .	Carmarthen, Priory St..	·34	10
,, .	Penzance, Morrab Gdn.	·58	21	*Pemb* .	Haverfordwest, School.	...	...
,, .	St. Austell, Trevarna...	·63	19	*Card* .	Aberystwyth	1·75	...
Soms .	Chewton Mendip.........	1·25	36	*Rad* .	BirmW.W.Tyrmynydd	2·55	62
,, .	Long Ashton............	1·70	60	*Mont* .	Lake Vyrnwy	1·21	35
,, .	Street, Millfield..........	·94	38	*Flint* .	Sealand Aerodrome......	·69	29
Glos .	Blockley	1·19	...	*Mer* .	Dolgelley, Bontddu......	2·02	90
,, .	Cirencester, Gwynfa....	2·24	87	*Carn* .	Llandudno	·88	39
Here .	Ross, Birchlea...........	·71	31	,, .	Snowdon, L. Llydaw 9..	3·7[illegible]	...
Salop .	Church Stretton.........	1·65	67	*Ang* .	Holyhead, Salt Island...	·42	16
,, .	Shifnal, Hatton Grange	1·66	74	,, .	Lligwy	·34	...
Staffs .	Market Drayt'n, Old Sp.	1·25	46	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	·79	37		Douglas, Boro' Cem....	·46	15
War .	Alcester, Ragley Hall...	1·09	46	*Guernsey*			
,, .	Birminghm, Edgbaston	1·00	43		St. PeterP't.Grange Rd.	·08	4

Rainfall: July, 1934: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig	Pt. William, Monreith	2·58	92	*Suth*	Melvich	4·91	175
,,	New Luce School	2·57	76	,,	Loch More, Achfary	7·83	146
Kirk	Dalry, Glendarroch	2·92	81	*Caith*	Wick	2·30	87
,,	Carsphairn, Shiel	3·39	65	*Ork*	Deerness	...	...
Dumf.	Dumfries, Crichton, R.I.	2·11	69	*Shet*	Lerwick	1·80	79
,,	Eskdalemuir Obs	2·53	62	*Cork*	Caheragh Rectory	3·13	...
Roxb	Branxholm	2·69	89	,,	Dunmanway Rectory	3·75	96
Selk	Ettrick Manse	2·26	51	,,	Cork, University Coll	2·20	81
Peeb	West Linton	3·38	...	,,	Ballinacurra	1·79	64
Berw	Marchmont House	1·92	63	,,	Mallow, Longueville	1·95	78
E.Lot	North Berwick Res	2·68	104	*Kerry*	Valentia Obsy	2·73	72
Midl	Edinburgh, Roy. Obs.	2·83	100	,,	Gearhameen	4·80	83
Lan	Auchtyfardle	2·77	...	,,	Darrynane Abbey	2·94	77
Ayr	Kilmarnock, Kay Pk	3·08	...	*Wat*	Waterford, Gortmore	·73	23
,,	Girvan, Pinmore	2·47	93	*Tip*	Nenagh, Cas. Lough	2·13	68
Renf	Glasgow, Queen's Pk	2·22	76	,,	Roscrea, Timoney Park	3·06	...
,,	Greenock, Prospect H.	2·85	73	,,	Cashel, Ballinamona	1·78	61
Bute	Rothesay, Ardencraig	3·35	...	*Lim*	Foynes, Coolnanes	2·08	67
,,	Dougarie Lodge	2·23	...	,,	Castleconnel Rec	1·83	...
Arg	Ardgour House	7·80	...	*Clare*	Inagh, Mount Callan	5·26	...
,,	Glen Etive	7·27	125	,,	Broadford, Hurdlest'n.	2·62	...
,,	Oban	3·46	...	*Wexf*	Gorey, Courtown Ho	1·70	58
,,	Poltalloch	3·84	94	*Wick*	Rathnew, Clonmannon	·65	...
,,	Inveraray Castle	4·40	88	*Carl*	Hacketstown Rectory	1·42	41
,,	Islay, Eallabus	3·05	90	*Leix*	Blandsfort House	·74	24
,,	Mull, Benmore	13·50	129	,,	Mountmellick	1·13	...
,,	Tiree	3·32	92	*Offaly*	Birr Castle	1·80	61
Kinr	Loch Leven Sluice	3·66	127	*Dublin*	Dublin, FitzWm. Sq	1·26	49
Perth	Loch Dhu	...	...	,,	Balbriggan, Ardgillan	·59	22
,,	Balquhidder, Stronvar.	3·40	...	*Meath*	Beauparc, St. Cloud	·98	...
,,	Crieff, Strathearn Hyd.	2·69	91	,,	Kells, Headfort	·78	25
,,	Blair Castle Gardens	3·41	133	*W.M*	Moate, Coolatore	1·81	...
Angus	Kettins School	3·55	137	,,	Mullingar, Belvedere	2·09	66
,,	Pearsie House	4·11	...	*Long*	Castle Forbes Gdns	1·53	49
,,	Montrose, Sunnyside	2·43	92	*Gal*	Galway, Grammar Sch.	...	...
Aber	Braemar, Bank	4·11	160	,,	Ballynahinch Castle	5·15	124
,,	Logie Coldstone Sch	3·34	113	,,	Ahascragh, Clonbrock	1·58	45
,,	Aberdeen, King's Coll.	1·72	61	*Mayo*	Blacksod Point	4·16	132
,,	Fyvie Castle	3·01	93	,,	Mallaranny	5·02	...
Moray	Gordon Castle	3·03	95	,,	Westport House	3·27	105
,,	Grantown-on-Spey	4·47	146	,,	Delphi Lodge	8·66	131
Nairn	Nairn	4·06	152	*Sligo*	Markree Obsy	2·42	70
Inv's	Ben Alder Lodge	2·67	...	*Cavan*	Crossdoney, Kevit Cas.	2·20	...
,,	Kingussie, The Birches	5·09	...	*Ferm*	Enniskillen, Portora	...	...
,,	Inverness, Culduthel R.	4·67	...	*Arm*	Armagh Obsy	2·52	87
,,	Loch Quoich, Loan	...	...	*Down*	Fofanny Reservoir	2·60	...
,,	Glenquoich	...	...	,,	Seaforde	2·05	64
,,	Arisaig, Faire-na-Sguir	...	...	,,	Donaghadee, C. Stn.	1·56	56
,,	Fort William, Glasdrum	...	...	,,	Banbridge, Milltown	1·98	61
,,	Skye, Dunvegan	5·47	...	*Antr*	Belfast, Cavehill Rd	3·12	...
,,	Barra, Skallary	4·73	...	,,	Aldergrove Aerodrome	3·13	112
R&C	Alness, Ardross Castle	7·14	235	,,	Ballymena, Harryville	2·35	69
,,	Ullapool	4·94	156	*Lon*	Garvagh, Moneydig	3·10	...
,,	Achnashellach	5·92	115	,,	Londonderry, Creggan	3·40	93
,,	Stornoway	5·21	169	*Tyr*	Omagh, Edenfel	2·26	67
Suth	Lairg	4·59	147	*Don*	Malin Head	2·84	...
,,	Tongue	4·65	152	,,	Killybegs, Rockmount	...	...

Climatological Table for the British Empire, February, 1934

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and ½ Min.	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1030·7	+14·7	53	24	44·1	31·8	37·9	−2·2	33·6	87	7·3	0·22	−1·32	4	2·74	28
Gibraltar	1021·5	+1·5	65	36	59·8	46·9	53·3	−2·5	46·4	79	6·1	1·46	−3·05	6	...	...
Malta	1019·2	+3·1	67	41	58·2	48·5	53·3	−2·0	47·5	69	5·8	1·19	−1·01	7	7·09	66
St. Helena	1011·1	−0·4	72	59	68·8	62·0	65·4	−0·5	62·8	95	8·8	4·71	...	24	...	...
Freetown, Sierra Leone	1012·7	+1·9	91	65	86·8	67·9	77·3	−5·0	74·5	81	1·8	0·07	−0·23	1	...	...
Lagos, Nigeria	1009·7	0·0	91	70	89·0	76·4	82·7	+0·2	75·0	82	3·4	0·00	−1·90	0	6·02	51
Kaduna, Nigeria	1009·4	...	99	54	91·6	57·7	74·7	−2·2	53·6	36	1·0	0·00	−0·02	0	9·2	78
Zomba, Nyasaland	1006·5	−1·4	86	62	81·3	64·1	72·7	+0·7	68·6	77	7·4	10·03	−0·57	22	...	...
Salisbury, Rhodesia	1008·7	−1·4	85	51	79·1	59·7	69·4	+0·6	62·7	72	6·2	7·73	+0·91	11	7·2	57
Cape Town	1013·1	−0·3	100	57	83·9	62·9	73·4	+3·1	62·8	68	3·2	0·46	−0·12	6	...	...
Johannesburg	1010·9	−0·3	80	45	75·0	54·8	64·9	−0·7	57·8	70	4·7	1·09	−4·13	9	8·6	66
Mauritius	1012·2	+1·2	88	70	84·7	72·5	78·6	−0·7	74·3	73	6·1	1·20	−7·20	19	9·7	76
Calcutta, Alipore Obsy.	1011·6	−1·7	96	49	83·1	61·6	72·3	+1·1	61·9	85	3·5	0·08	−0·91	0*	...	...
Bombay	1011·6	−1·1	95	59	85·6	68·0	76·8	+1·1	67·2	75	1·9	0·00	−0·03	0*	...	...
Madras	1012·1	−0·8	91	59	85·2	66·5	75·9	−1·8	71·3	89	2·5	0·00	−0·30	0*	...	...
Colombo, Ceylon	1010·7	−0·1	90	63	85·9	71·0	78·5	−1·9	73·2	74	4·1	2·81	+0·87	10	8·9	75
Singapore	1009·8	−0·4	89	69	84·7	70·8	77·7	−2·5	74·2	82	7·8	6·07	−0·55	15	5·6	47
Hongkong	1018·9	+0·3	76	47	66·2	56·0	61·1	+2·0	54·7	67	4·8	1·51	−0·32	5	6·5	57
Sandakan	1010·3	...	88	70	84·3	72·7	78·5	−1·7	75·3	90	8·4	25·56	+14·59	24	...	...
Sydney, N.S.W.	1014·0	+0·1	90	58	76·5	64·7	70·6	−0·7	66·9	73	6·0	8·60	+4·40	13	6·5	48
Melbourne	1015·2	+0·7	102	50	78·0	57·9	67·9	+0·3	61·4	64	6·4	1·10	−0·61	8	6·9	51
Adelaide	1014·9	+0·7	109	51	86·9	62·4	74·7	+0·7	60·6	37	4·0	0·14	−0·58	3	10·0	75
Perth, W. Australia	1011·6	−1·4	109	54	88·5	67·4	77·9	+3·8	64·5	49	5·5	0·16	−0·29	4	8·6	65
Coolgardie	1010·6	−1·9	109	55	96·8	71·6	84·2	+8·0	64·2	41	4·2	0·00	−0·85	0	...	...
Brisbane	1013·9	+1·4	93	62	83·2	67·0	75·1	−1·4	69·5	68	5·9	16·16	+9·82	10	8·2	63
Hobart, Tasmania	1014·2	+1·0	99	47	72·2	53·4	62·8	+0·5	55·2	60	7·2	1·27	−0·21	7	6·9	50
Wellington, N.Z.	1017·5	+1·7	77	47	68·0	55·3	61·7	−0·9	57·4	74	6·5	3·51	+0·37	11	7·5	55
Suva, Fiji	1009·6	+1·8	94	72	86·7	74·1	80·4	+0·1	75·9	84	6·7	19·95	+9·23	24	5·9	46
Apia, Samoa	1010·1	+1·7	89	70	85·0	74·6	79·8	+0·8	76·4	82	7·5	11·54	−3·75	18	...	...
Kingston, Jamaica	1015·9	+0·6	86	65	83·7	67·1	75·4	−1·1	66·3	89	3·0	3·77	+3·17	9	6·8	59
Grenada, W.I.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toronto	1024·0	+6·0	34	−21	18·6	1·8	10·2	−10·9	6·1	63	5·4	0·00	−2·38	0	4·8	46
Winnipeg	1023·7	+1·9	41	−36	15·4	−6·3	4·5	+4·4	...	...	5·2	0·08	−0·66	1	3·6	36
St. John, N.B.	1014·6	+0·7	42	−20	21·0	2·9	11·9	−8·0	7·1	73	5·8	1·82	−2·08	4	4·7	45
Victoria, B.C.	1018·1	+1·5	54	35	50·6	40·7	45·7	+5·2	41·4	83	5·5	1·54	−1·72	9	5·0	49

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(22127) Wt. 25/32 1000 8/34 Hw. G.377/6

M.O. 371.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 69

Sept. 1934

No. 824

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

Exceptionally Dry Air, July 10th, 1934

THE synoptic reports of observations at 13h. G.M.T. on July 10th contained some exceptionally low readings of relative humidity. Several stations in southern England recorded values below 25 per cent., the lowest readings being 16 at Kew Observatory, 20 at Ross-on-Wye and 23 at Biggin Hill. As relative humidities of 20 per cent. or lower are decidedly rare in the British Isles, details of the occurrence were collected. At most of the stations dry- and wet-bulb readings are available at 13h., 16h. and 18h. and hair-hygrograms are also available for the purpose of examining the variations of relative humidity during the exceptionally dry period. This examination showed that in all cases the lowest relative humidity occurred during the period 13h. to 18h. and that the extreme value did not differ by more than one or two per cent. from the lowest reading at one or other of the fixed hours when the dry- and wet-bulb thermometers were read. Table I, which shows the lowest such values recorded at various stations, may be taken therefore as giving a close approximation to the extreme values on this occasion.

At Kew Observatory readings were taken at frequent intervals between 13h. and 15h. by means of an Assmann psychrometer. These are shown in Table II. Data relating to other occasions of notably dry air at Kew Observatory are given in Table III. The humidity data in Tables I and III were derived from the wet- and dry-bulb readings by means of the Meteorological Office "Hygrometric Tables"; those in Table II were derived by means of the Tables of the Prussian Meteorological Institute, the wet- and dry-bulb readings (originally in degrees Absolute) being subsequently converted to

TABLE I.—LOWEST HUMIDITIES FROM DRY- AND WET-BULB READINGS, JULY 10TH 1934

Station.	Time.	Dry Bulb.	Wet Bulb.	Rel. Hum.	Vap. Press.	Dew Point.
		°F.	°F.	%	mb.	°F.
Richmond (Kew Obsy.)	13h.	78·3	55·9	16	5·2	28·0
S. Farnborough ...	16h.	82·0	57·8	15	5·5	29·5
Croydon	16h.	77·8	56·8	20	6·4	33·1
Biggin Hill	13h.	76·2	56·9	23	7·2	36·0
Boscombe Down ...	18h.	81·6	61·6	27	9·8	44·1
Manchester	16h.	85·6	63·6	25	10·3	45·5
Birmingham (Edgbaston).	13h.	82·4	63·1	29	11·1	47·4
Ross-on-Wye ...	13h.	83·3	60·4	20	7·7	37·8
Liverpool (Bidston)...	13h.	83·0	62·9	28	10·7	46·2

degrees Fahrenheit. It will be observed that the minimum relative humidity, at Kew on July 10th 1934, was slightly lower than the minimum value on April 1st 1931. This latter occasion was the subject of a note by W. H. Pick in the *Meteorological Magazine* for

TABLE II.—READINGS AT KEW OBSERVATORY, JULY 10TH 1934. WITH ASSMANN PSYCHROMETER

Time G.M.T.	Dry Bulb.	Wet Bulb.	Rel. Hum.	Vap. Press.	Dew Point.
h. m.	°F.	°F.	%	mb.	°F.
13 5	81·9	56·3	16	6·0	31·5
	82·4	56·5	16	5·9	31·1
13 30	81·2	57·2	20	7·3	36·4
	82·1	57·6	19	7·1	35·7
13 45	82·8	57·6	18	6·9	35·0
	82·6	57·4	18	6·8	34·7
14 0	82·8	57·6	18	6·9	35·0
14 30	82·8	59·4	22	8·4	40·0
15 0	82·4	58·9	22	8·3	39·7

May 1931, and he mentioned that a reading of approximately 15 per cent. occurred at Cardington at 12h. 30m. on that day. It seems probably that a value of 15 per cent. represents the lowest relative humidity likely to be recorded in the British Isles.

A point of special interest is that, on July 10th 1934 with an air temperature round about 80° F., the dew point was below freezing point at Kew and South Farnborough. Air cooling at the dry abiabatic lapse rate would have had to rise nearly 10,000 feet before arriving at the dew-point temperature. An observation made at South Farnborough at 15h. 55m. showed a temperature of 46°F. at 9,400 feet and 42°F. at 10,500 feet. It is not surprising therefore that no convectional clouds occurred on the day in question.

Another point to which attention may be drawn is the rise of vapour pressure at Kew Observatory from 5·9 mb. at 13h 5m. to 8·4 mb. at 14h. 30m. in what appears to have been the same air-mass.

TABLE III.—PREVIOUS OCCASIONS OF LOW HUMIDITY AT KEW OBSERVATORY

Date.	Time.	Dry Bulb.	Wet Bulb.	Rel. Hum.	Vap. Press.	Dew Point.
		°F.	°F.	%	mb.	°F.
1921, July 11th ...	14h.	86·2	61·9	19	8·0	38·6
1931, April 1st ...	11h.	46·0	35·2	20	2·2	7·5
	12h.	45·9	34·7	17	1·8	4·0
	13h.	46·4	35·6	21	2·3	8·6
1911, Aug. 13th ...	13h.	88·1	65·6	25	11·5	48·3
	14h.	88·9	66·7	27	12·5	50·5
	15h.	87·5	64·3	23	10·3	45·3
	16h.	88·0	65·8	26	11·8	49·0

At 9h. the vapour pressure in the north-wall screen at Kew had been 14·1 mb. Had the absolute humidity remained at this figure the relative humidity would have fallen no lower than 37 per cent. when the temperature rose to the maximum value of 82·8°F. as measured by the Assmann psychrometer. By some agency, therefore, more than half the moisture content of the atmosphere was removed between 9h. and 13h.

Note on the Synoptic Situation, by R. S. Read. During July 9th to 10th an anticyclone was almost stationary over the North Sea and the circulation of winds around this system was bringing air from the western parts of Germany across Belgium and northern France to south-east England. The dew points of the air lying over Belgium during the afternoon and evening of July 9th were higher than those over all parts of south-east England on that day and also on July 10th. It is thus improbable that this air could have travelled unchanged over south-east England. Another possibility exists in that by convectional movements the damper surface layers may have been mixed with drier air at higher levels or that descent of air may have taken place in the anticyclone over England.

The upper air temperature observations at Hamburg, Utrecht and Duxford cannot be used directly in this case without some qualification. There were however indications of a drier stratum of air at Duxford at a height of about 1,100 feet at midday on July 9th and again during the early morning ascent on July 10th and mixing of these layers would reduce the absolute humidity near the ground. It is possible that similar changes were taking place at Richmond and in other parts of England and that these effects would show more during the afternoon when convection was more active.

The Diurnal Variations of Barometric Tendencies

By C. S. Durst, B.A., and R. M. Stanhope, B.A.

C. K. M. Douglas* has surmised that there is a tendency for depressions to deepen by night, and has supported the supposition by statistics of the frequency with which depressions to the west or south-west of the British Isles deepened by day and by night. This suggested that it would be worth while investigating statistically whether there was a diurnal variation in the frequency with which different barometric tendencies have been reported. The period December, 1929, to February, 1934, was used and two seasons were examined, namely, Summer—June, July and August; Winter—December, January and February. Frequencies were then obtained with which tendencies occurred (grouped to half millibars per three hours) at the hours 0100, 0700, 1300 and 1800 at Inchkeith, Valentia and Croydon. These tendencies were of course affected by the normal diurnal variation of pressure. For this, the normal hourly pressures at Kew, Eskdalemuir, and Valentia given in the Year Book for 1927, were assumed to hold and an allowance was made, but even so this allowance was small. There resulted the figures given in Table I.

It must be remembered that a barometer at a fixed point is affected by a neighbouring depression (*a*) by the depression deepening or filling up, (*b*) by the depression travelling towards or away from the fixed point. Douglas has excluded the latter by his method of investigation, but in using tendencies, as is done here, both these effects are included; there is, however, as far as we know, no evidence that depressions move with varying speeds by day and by night.

Now turning to the consideration of Table I. Large falls are comparatively rare in summer and even moderate falls only occur on about 1 per cent. of occasions. In regard to falls exceeding 1·75 mb. per 3 hours in summer, there are definitely fewer falls at night at Valentia than by day, although at Croydon the frequency of falls is greater by night than by day. In winter at all three stations great falls at 0100 are less frequent than at 0700 and 1800, and at Valentia at any rate less frequent than at 1300. A smaller frequency is shown at Valentia at 0100 than at any of the three other hours,

---

* See *Meteorological Magazine* 66, 1931, pp. 39–41.

even when we include falls of more than 1·75 mb. per 3 hours; but with falls of this amount at Croydon and at Inchkeith, there seem to be more frequent falls by night than at midday.

If depressions were in the habit of deepening by night it would involve a transfer of air from the low pressure areas to the high, and in consequence it was thought that perhaps the effect suggested

TABLE I—PERCENTAGE FREQUENCIES WITH WHICH TENDENCIES EXCEEDED CERTAIN VALUES (AFTER ALLOWANCE HAS BEEN MADE FOR THE NORMAL DIURNAL VARIATION OF PRESSURE)

	Winter.				Summer.			
	Negative tendencies greater than 3·75 mb. per 3 hours.							
	0100	0700	1300	1800	0100	0700	1300	1800
Inchkeith ...	1·6	2·9	1·1	3·3	0·4	0·2	0·0	0·2
Valentia ...	1·8	3·3	3·1	3·1	0·4	0·0	0·7	0·2
Croydon ...	1·8	2·0	2·0	2·4	0·2	0·0	0·0	0·0
	Negative tendencies greater than 2·75 mb. per 3 hours.							
Inchkeith ...	5·8	5·5	2·9	5·5	0·9	1·1	0·4	0·2
Valentia ...	3·4	5·1	7·8	5·1	0·9	0·9	1·5	1·1
Croydon ...	4·1	3·8	3·6	3·8	1·7	1·1	0·4	0·2
	Negative tendencies greater than 1·75 mb. per 3 hours.							
Inchkeith ...	11·4	12·6	7·8	11·8	3·1	4·4	2·7	6·6
Valentia ...	8·3	12·0	14·9	10·2	2·8	4·8	5·0	5·7
Croydon ...	10·0	10·2	8·0	9·1	4·8	4·3	2·4	2·8
	Positive tendencies greater than 1·75 mb. per 3 hours.							
Inchkeith ...	11·8	11·1	14·5	10·2	5·3	3·8	3·6	2·0
Valentia ...	14·9	9·5	11·3	11·3	5·2	3·5	5·2	4·8
Croydon ...	10·2	9·8	10·6	10·2	3·3	5·0	4·6	2·6
	Tendencies, positive or negative, greater than 1·75 mb. per 3 hours.							
Inchkeith ...	23·2	23·7	22·3	22·0	8·4	8·2	6·3	8·6
Valentia ...	23·2	21·5	26·2	21·5	8·0	8·3	10·2	10·5
Croydon ...	20·2	20·0	18·6	19·3	8·1	9·3	7·0	5·4

by Douglas would be most clearly shown if the frequency was taken out with which rather large tendencies, positive or negative, were experienced. That is given in the last panel of the table. In no case is there a marked diurnal variation in frequence.

The conclusion of this examination is that there is no very marked diurnal variation in barometric tendency; at Inchkeith and Croydon falls of 1·75 mb. per 3 hours are least frequent at 1300, while at Valentia they are least frequent at 0100.

Line Squalls and Heavy Rain in Iraq and Palestine on May 14th–15th, 1934

Towards the middle of May, 1934, weather was very disturbed in Palestine and Iraq, culminating in a disastrous "cloudburst" at

Tiberias and a violent squall and sandstorm in Iraq and Palestine, both on May 14th. The following account combines various communications.

The *Daily Weather Reports* from May 7th to 12th show an anticlone over Europe and a persistent low pressure area over the north of Egypt and Arabia. An account by Mr. C. V. Ockenden at Heliopolis continues :—

There is evidence of a small cyclonic disturbance having moved north-eastwards on May 13th from near Baharia in the western Desert of Egypt to the northern part of the Sinai peninsula, and it may be necessary to invoke the movement of the " low " and consequent convergence to account in part for the comparatively heavy falls of rain. Upper air humidities were probably somewhat high on account of the fact that Mediterranean air had already invaded the area two days previously. It was, in fact, the arrival of this initial supply of less stable air on the 11th which marked the break up of an abnormal type of weather which had persisted for five days in Egypt.

A layer of thick altostratus formed early in the morning of the 7th at Heliopolis and remained with but few breaks (chiefly at night) until the 11th. On the 8th and 11th the sunshine amounts were only 0·7hrs. and 0·3hrs., respectively, whereas the average duration for this time of year is well over 10hrs. It is a matter of interest that a film-making company were compelled to suspend operations during this period on account of bad or insufficient light. The wind was consistently NE.'ly fresh at times. The cloud sheet at times covered a very wide area, extending nearly to Rutbah in the east, Sollum and Siwa Oasis in the west, and Aswan in the south. Drizzle or light rain fell at places on the Red Sea coast and at Luxor on the 10th and 11th, and Luxor and Aswan reported a thunderstorm in the past weather on the morning of the 12th. This is very unusual at these places at any time of the year. Throughout the whole period, May 7th to 10th inclusive, the microbarograph and barograph at Heliopolis showed very disturbed traces, short-period oscillations having an amplitude of 1 to 2 millibars at times. The surface of discontinuity between the lower north-east current and an upper westerly was generally found by pilot balloon observation to be at a height of a little over 5,000 ft.*

The disastrous " cloudburst " which occurred at Tiberias on May 14th was due to a severe thunderstorm accompanied by torrential rain. Thunderstorms occurred over a wide area in Syria and northern Palestine on that day and distant thunder and lightning were reported early in the morning from Amman in Trans-Jordan and from Aboukir in Egypt. As far as can be seen from the limited data available, it appears probable that the Tiberias storm did not occur with the arrival of a cold front but some distance behind, and

---

* See *Meteorological Magazine*, **69**, 1934, p. 95.

intense heating of surface air during the course of the morning in the comparatively sheltered Jordan Valley is thought to have provided the trigger action creating abnormally vigorous convexion in an already highly unstable general air current. It is noteworthy that no rain occurred at Amman between 8h. and 20h. hours local time on the 14th, and only "trace" was reported from Ramleh. These places are about 70 miles south-south-east and south-south-west respectively from Tiberias.

The cold front to which reference has been made was probably of the nature of a bent-back occlusion associated with a not very deep depression in the northern Levant. On the afternoon of May 13th in Egypt there were other fronts of cold front type which preceded the bent-back occlusion. One of these reached Heliopolis at about 15h. 15m. G.M.T. (17h. 15m. local time) when temperature fell 15°F. in two distinct stages within 30 minutes ; the second stage was accompanied by heavy showers, rising sand and a gust of 39 m.p.h. Ismailia records show well-marked sudden falls of temperature at 15h. 15m. and 17h. 15m. G.M.T., the first fall of 10°F. was accompanied by rising sand and a gust of 47 m.p.h., but there was no rain. The second fall amounted to 6°F. and 1 mm. of rain was recorded. The main bent-back occlusion arrived at night: a thunderstorm occurred at Heliopolis and 3 mm. of rain fell between 20h. 30m. and 21h. 50m., but there was no pronounced fall of temperature at the ground. At Ismailia a fall of temperature of 4·5°F. occurred at 22h. and 10 mm. of rain fell in 30 minutes.

The positions of the various stations referred to are shown in fig. 1.

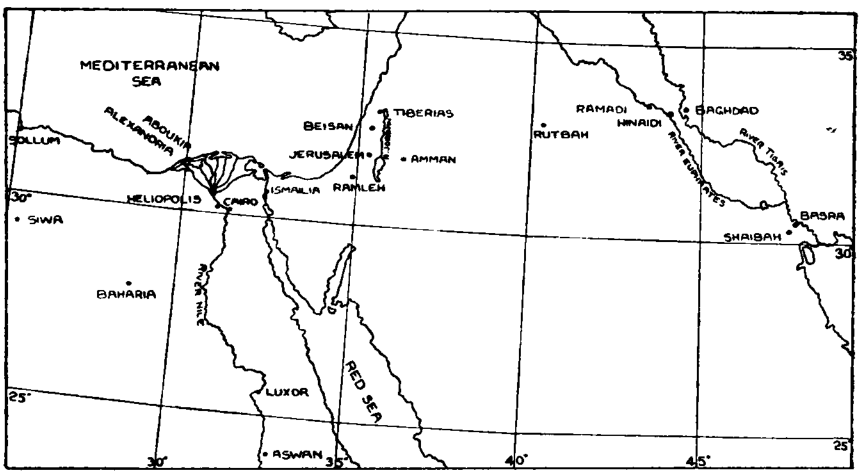


Fig. 1

Mr. H. E. Carter, of Ramleh, states that "no statistics of the rainfall in the centre of the storm area exist, but according to a newspaper report, 53 mm. (2·1 in., more than one-third of the total rainfall in 1933) fell in 45 minutes at Beisan, the nearest rainfall station to Tiberias."

The following detailed description of the "cloudburst" is contributed by Mr. J. R. Morgan, of Ramleh, Palestine.

The disasters which occurred at Tiberias on May 14th and 15th, 1934, are interesting inasmuch as they reveal the possibility of the damage which can be caused by a heavy, sudden rain, if certain initial conditions of situation and environment are combined together. It is probable that the cloudbursts which occurred on those two days were not phenomenal meteorological disturbances, although in the absence of accurate meteorological observations this must be in the nature of a surmise. No rain-gauges were situated in the vicinity of the cloudbursts, and the actual times of duration of the bursts were approximately 90 minutes and 50 minutes on the Monday and Tuesday respectively. Palestine enjoys a Mediterranean climate, and it is a feature of the district in the neighbourhood of Tiberias that at the beginning and end of the rainy season, *i.e.*, at the end of October and the end of April respectively, it experiences heavy torrential showers.

The old city of Tiberias is situated at the foot of a hill rising some 1,600 ft. above the level of the lake, which is itself 600 ft. below sea level. The hill has a surface layer of cotton soil which, in wet weather, is converted into loose mud and carried down the mountain side. During the cloudbursts of May 14th and 15th the maximum rainfall occurred directly over this cotton soil region, and when the surface layer was washed away, it loosened many granite boulders which had been held secure in the hard dry surface for many years. These boulders descended the hill side at a tremendous speed and carried with them in their descent additional boulders, which in turn were carried through to the native Suk (market) below. The rivers of mud and stones which were carried down the mountain side were directed in their journey by the contour of the country in the vicinity and swept through the Municipal Gardens, uprooting trees and tearing down enclosure walls in their progress to the sea. The greatest loss of life and damage to property occured in the native quarter itself, where complete houses were carried away by boulders washed down the hill side. In addition, many of the native population were washed into the sea by the avalanche.

In Iraq the phenomena took the form of a destructive line squall at 13h. 15m. G.M.T. on May 14th. An account by Mr. R. H. Mathews states that this was responsible for considerable structural damage in the Port of Basrah and for the loss of an aeroplane which had landed at the air port. The force of the squall was so great that it lifted the machine, which weighed seven tons, completely off the ground and deposited it in a canal 50 yards away.

The pilot stated that at 11h. 30m. G.M.T. (14h. 30m. Iraq zone time) he noticed a thunderstorm threatening from the west and he decided to go to the landing ground in case it should be necessary to taxi the aeroplane round because of a change of wind. By 13h.

G.M.T. (16h. Iraq zone time) the sky had a very threatening appearance with what appeared to be a wall of dust in the direction of Shaibah (14 miles west-south-west of Basrah). At 13h. 15m. G.M.T. (16h. 15m. Iraq time) the pilot ordered the crew to stand by and a few minutes later he had the engines started. Almost immediately the wind increased and began to veer; the pilot taxied the aeroplane to the right about 45°, but the crew had great difficulty in keeping the chocks behind the wheels to prevent the aircraft riding back on the tail skid. Then an intense squall of wind swept across the landing ground accompanied by a dust storm so thick that the pilot could only see a few feet. The aeroplane was blown back over the chocks, the pilot tried to hold her in place by opening the throttle but he was immediately airborne; as he considered the risk of flying too great he throttled back and tried to hold the aircraft with less throttle. This was impossible, and he was blown back steadily at 5 or 6 m.p.h. The pilot was about to jump when there was a crash and he found that the tail and port wing were lodged against a brick hut. He got clear and as he did so the aeroplane was lifted over

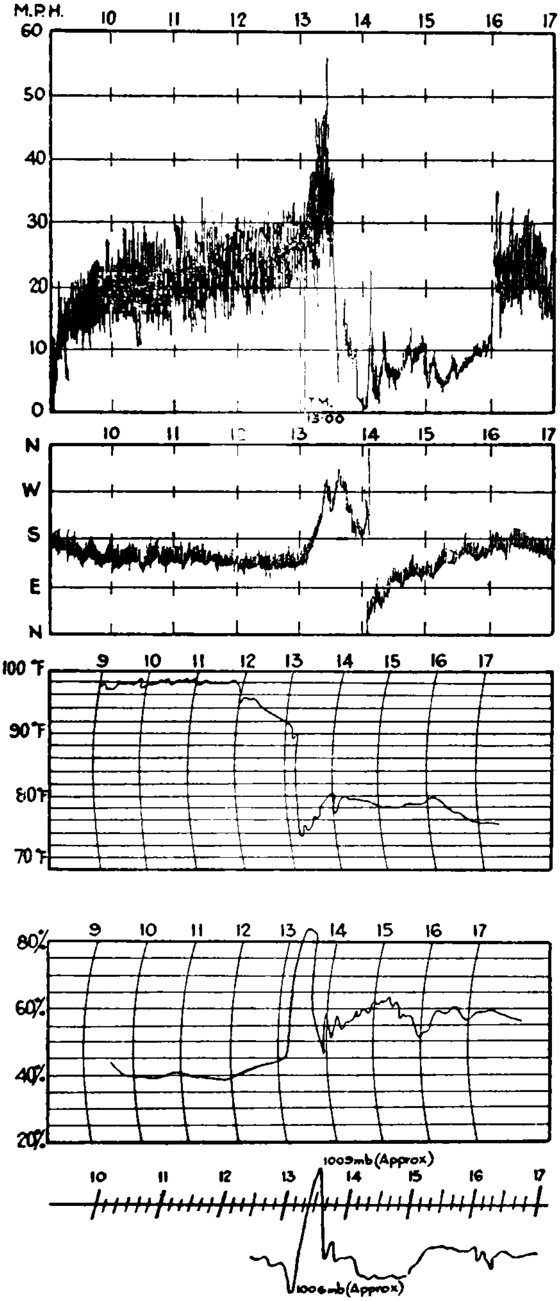


Fig. 2.

the hut and disappeared in the dust. The storm continued at its height for about 10 minutes and then it gradually cleared. The aeroplane was found at the bottom of a canal which is under construction. There were no marks on the ground between the hut and the canal, a distance of 50 yards.

The meteorological records from Shaibah, 14 miles west-south-west of Basrah, are reproduced as fig. 2, and demonstrate the extreme severity of the squall. At Shaibah at 13h. G.M.T. thunder was heard to the west, with a bank of dust approaching from the south, and by 13h. 10m. the visibility had fallen to 50 yards in thick dust, which lasted for 10 minutes. At 13h. 20m. the main squall arrived, and was accompanied by a heavy shower (1 mm. in 0·3 hrs.). The wind rose to 57 m.p.h. in a squall and the temperature fell 18°F. almost instantaneously, while the humidity rose 38 per cent. and the pressure about 3 mb. After 10 minutes the wind had fallen to 5 m.p.h. The changes in wind direction were remarkable. The general meteorological situation at 13h. G.M.T. showed a large low-pressure area over southern Iraq, and it appears that the squall at Basrah was of the local thundery type.

The experiences of Mr. Mathews while flying from Ramleh in Palestine (about 22 miles west-north-west of Jerusalem) to Hinaidi, near Baghdad, on the same day show that the squally weather was general from the Mediterranean Sea to the Persian Gulf. His start from Ramleh was delayed 90 minutes as a line squall which had passed eastwards was enveloping the high ground (3,000 ft.) round the Jordan Valley. At 5h. 30m. G.M.T. (7h. 30m. Palestine zone time) the machine set off, but an hour later had to turn back and land at Amman, about 60 miles east of Ramleh, as the line squall had been overtaken. At 8h. 45m. G.M.T. (10h. 45m. Palestine time) the aeroplane left Amman ; an hour later the tail end of the line-squall was seen ahead, its general movement having been north-eastwards. This end of the squall took the form of a wall of dust like a haboob ; it took about ten minutes to fly through it, the bumps being terrifying. After flying in bright sunshine for about twenty minutes, a large waterspout or whirlwind was seen to the northwards ; this would be ahead of the squall. A landing was made at Rutbah, about 250 miles west of Baghdad, at 10h. 55m. G.M.T. (13h. 55m. Iraq time) and the machine took off again at 12h. 10m. (15h. 10m. Iraq time) ; by this time the haboob was seen approaching Rutbah from the west, looking more intense than ever. For the first 100 miles after leaving Rutbah the weather was showery all round, and then the aeroplane ran into thunderstorms of tropical intensity which lasted for the remaining 150 miles to Hinaidi. The desert below was swamped with water, an unusual appearance at any time of the year. The air was painfully bumpy, the machine losing and gaining height more than a thousand feet at a time. It was altogether an educative if terrifying experience for a meteorologist. Hinaidi was reached at 14h. 50m. G.M.T., a few minutes only before a storm of rain burst over the cantonment.

The sparse network of stations in these parts does not allow of fronts being followed, but it is evident from the above accounts that there were many squall-lines passing across Iraq during the day.

Correspondence

To the Editor, *Meteorological Magazine*

Summer Frosts

Some unusually low minimum temperatures were registered here during the spell of chilly weather at the end of August :—

1934.		Screen. °F.	Grass. °F.
August 26th	...	31·9	24·9
,, 30th	...	33·0	27·3
,, 31st	...	30·1	24·7

There was copious hoar-frost each morning, and at 6h. (G.M.T.) on August 31st a thin coating of ice was found on shallow water in the neighbourhood.

Since continuous records of this markedly " continental " valley-climate were begun, in 1929, the latest " spring " frost in the screen has been on June 10th, 1932 (31·8°F.) : the earliest " autumn " frost is that of August 26th, 1934, reported above. A minimum within half a degree of the freezing-point was noted on the same date of August in 1931. The length of the period during which the air temperature has not once fallen to 32·0°F. is thus 76 days, or a trifle more than one-fifth of the year. Since readings below 35°F. have occurred twice in July, it seems reasonable to suppose that over a long series of years no calendar month would be wholly exempt from frost.

By the thermometer exposed one inch above short grass, minima at or below 32·0°F. have been distributed through June, July and August during the last six years as follows :—

		Number of frosts.		
Dates.		*June.*	*July.*	*August.*
1st–10th	...	12	5	2
11th–20th	...	9	6	3
21st–30th (31st)		17	2	11
Total	...	38	13	16

Ground frosts may thus occur at any time throughout the summer. Since 1929 they have never been sharp enough to damage vegetation noticeably in July, but in both June and August they have wrought considerable destruction on several occasions.

The Greenwich volumes gives the dates of the latest and earliest frosts on the Glaisher stand since 1841 as May 24th, 1867, and

September 27th, 1885, respectively, so that the interval of complete immunity there has been 125 days, or more than one-third of the year. According to data published in "The Book of Normals (Section IV)," Falmouth and St. Mary's, Scilly, experienced no frost in the screen later than April or earlier than November from 1871 to 1921: at Buxton the temperature fell to 31°F. in July, 1921, but among the 30 stations included in the tables Ben Nevis is the only one to record a screen-minimum below 32°F. in every month. It appears that the period of summer freedom from frosts varies in different parts of the British Isles from zero to six months or more.

E. L. HAWKE.

Cænwood, Rickmansworth, Herts. September 1st, 19?4.

A Whirlwind at Horndon-on-the-Hill

Mr. F. Claude Banks of Horndon-on-the-Hill has sent the following notes of a whirlwind which struck that district on Sunday, August 17th, 1934. It was preceded by a thunderstorm beginning at 4 p.m. with fairly heavy rain lasting for half-an-hour and then a sunny interval. The whirlwind struck the district at 5.30 p.m. B.S.T., and lasted two minutes, progressing in an irregular path very narrow and about a mile and a half in length. It appeared to originate at Golden Bridge on the Orsett-Bulphan-Brentwood road and not to have crossed the Horndon-Laindon road on the east. Much damage was done to trees and poultry sheds. Winds were very violent further west and also east (to the foot of Laindon Hills).

After the whirlwind there was a calm spell with a heavy shower, then a fair interval which was followed by a rather severe thunderstorm which slowly moved away to the east-south-east clearing about 7 p.m. The wind was then WNW. A mist developed at 8 p.m., soon clearing when the wind backed to SW. and showers began about 9 p.m.

Funnel-shaped Cloud

You may be interested to hear that the formation of a funnel shaped cloud characteristic of a tornado was observed here at about 19h. 25m. B.S.T. on Saturday, August 11th, and was visible for 5–10 minutes. The sequence of events which led up to the formation of this cloud was as follows:—

From about 18h. B.S.T. rain fell from low cloud travelling almost due east and developed into almost continuous moderate rain. Shortly after 19h. an intense and very low cloud, whose back edge with blue sky beyond could be plainly seen, approached and the rain became torrential. Distant thunder was subsequently heard but no lightning was observed in the neighbourhood. This heavy rain lasted for at least 15 minutes when it eased gradually and the sun came out. A rainbow developed gradually and later a second, both were weak. A small extent of the ragged underside of cloud was then seen to be driven up more and more vigorously until a vertical rotary movement seemed to be in progress. This then developed sideways and downwards till finally there was a funnel shaped mass of whitish vapour whirling horizontally in a clockwise direction and carried along in the same direction as the cloud to which it was attached, almost due east. Pieces of paper were observed to be lifted high in the air in the neighbourhood of its path.

The distance travelled from the spot where it formed to where it seemed to diminish would not be much more than two miles. The ground over which the cloud travelled is open and covered with low saplings having heavy foliage which would greatly aid evaporation.

E. C. PACKHAM.

Woodlands, Bromley Green, Kingsnorth, nr. Ashford, Kent. August 12th, 1934.

Distances travelled by Toy Balloons

I send the following note, in case it is of interest in regard to air-currents.

On July 28th, between 3 and 6 p.m., at a village fête here, some 120 toy balloons, gas-filled, were sent up, each with an addressed card attached for return in case it was found ; a prize was offered for the balloon which travelled farthest, 10 days being allowed for reports to come in. Only 9 were reported ; the winner was picked up east of Stuttgart, the second longest distance was Luxembourg, and 5 were reported from the Pas de Calais, one from Godalming, and one from Alton (Hants). A very strong wind from some point near south-west was blowing when the balloons were released.

ARTHUR F. HORT.

Hurstbourne Tarrant, Andover, Hants. August 19th, 1934.

(The synoptic charts for July 28th show that a depression was centred over southern Scandinavia and that the winds at 1 Km. and 2 Km. above mean sea level were between W. and WNW. Ed. *M.M.*)

The Colour of Moonlight

The interesting correspondence, which resulted from Dr. G. C. Simpson's letter in the *Meteorological Magazine* of November, 1932, raising the question why moonlight appears blue, does not seem to have led to a satisfactory conclusion regarding the cause of the blue colour of moonlight ; the general impression left in one's mind after carefully considering the various views expressed is that the predominant colour in moonlight is blue, but the cause of this phenomenon is perhaps partly physical and partly physiological. However that may be, this correspondence has not brought out any observations of the " green light " of the moon. The object of this note is to put on record a rather striking and probably unusual phenomenon which I observed at Alipore, Calcutta on May 27th, 1934 (nearly full-moon). The observation was corroborated by other persons, so that it could not be attributed to any defect of my colour vision.

At about 6.45 p.m. (Calcutta time) I was struck by a rather peculiar appearance of the sky and my first impulse was to look to the west. There was nothing unusual on that side, the sun had set and the western horizon had a faint pink glow which could be clearly seen through banks of stratified clouds. On looking towards the opposite direction I noticed that the moon was up and stood at an estimated altitude of about 30°. Its colour was an unmistakable green with perhaps a tinge of blue. The sky was about 7/10 covered and the moon was shining through a veil of cirrostratus, which also gave more or less the same colour impression as the moon itself. The colour gradually changed and by 7.15 p.m. it became " bluey-grey ", which is very often observed in this region of the earth. A bright white halo had also appeared round the moon by that time and the clouds had changed to altostratus. By about 7.25 p.m. the sky became practically free from cloud except that region where the moon was, but soon after that the sky again became about 6/10 covered with cumulus ; as a matter of fact, the whole of that evening the sky was remarkably variable.

The bluish-grey colour of the moon so often noticed particularly in the tropics is undoubtedly the result of the reflection of sunlight by the earth and then by the moon, as explained first by Leonardo da Vinci (see Valentiner, " Handwörterbuch der Astronomie," 1899) and as argued by S. Škreb, the first reflection takes place most likely at the cloud layers in the earth's atmosphere. But this double reflection alone would not explain the sequence of optical phenomena mentioned above. I have not been able to find any clear mention of the green light of the moon in meteorological literature accessible to me. The only indication, as far as I have seen, that the green light of the moon has been observed is in Arago's *Astronomie Populaire*, T.III, pp. 481–4, 1856. There it is mentioned that Arago himself and others have sometimes observed a greenish tinge in the *lumière cendrée* of the moon. But the case recorded above is somewhat different, because here the predominant colour is green. It is difficult to arrive at any definite conclusion regarding the cause of this phenomenon from the meagre and only visual observations available, but it seems probable that scattering by cloud particles of appropriate size and selective absorption by water vapour, which has absorption bands in the orange and the yellow (the so-called " rain-bands " in the solar spectrum), were principally responsible for this phenomenon.

A. K. Das.

The Observatory, Alipore, Calcutta. June 1st, 1934.

Sounds accompanying Lightning

While glancing through "The Romance of Electricity," by J. Munro (R.T.S., 1893), I came across the following reference, which may be of interest. A footnote on page 173 runs as follows :—

> "Condensers also emit sounds on being charged and discharged other than the crackle of the spark. In reporting this fact as early as 1863, Sir William Thomson refers to sounds heard at the instant of a flash of lightning a considerable distance from the line of discharge and before the clap of thunder. (Papers on Electrostatics and Magnetism.)"

CICELY M. BOTLEY.

Guildables, 17, *Holmesdale Gardens, Hastings, July 24th*, 1934.

NOTES AND QUERIES

The Effect of Lightning on a Haystack

When lightning strikes sandy soil, the intense heat generated by the passage melts the sand and forms a cylindrical mass of fused silica penetrated by a small hole, which is known as a "fulgurite". Colonel C. Buckle, of 9, Walbrook, has described a somewhat similar process which occurs when lightning strikes a haystack. He writes that "the enamel on the stems of the grasses is, I believe, largely silica from the soil. Ordinarily, of course, if a stack burns the quantities of silica in any one place are too minute to coagulate and they remain in the soft ash. When a stack has been struck by lightning however, you may find masses of fused matter which are hard and ring like a tile and which sometimes take the form of walls of a rough tube, the walls being about an inch thick and the tube up to about a yard in diameter.

The only explanation I can think of is that the heat of the discharge instantaneously consumes the hay or straw in its path and the gaseous products of combustion create an outward pressure against the remaining part of the stack which brings all the silica against the side of the tubular hole. Unfortunately the tube usually collapses with the ultimate destruction of the stack and you only find pieces. I have a fragment here however, which gives a good idea of the shape and size of the whole.

It is several years since I formed this opinion but I have only recently been able to confirm it by getting a specimen from a stack which was undoubtedly struck by lightning as a man was killed whilst sheltering by it. The School of Mines fulgurite has a small hole down it and it seemed to me vastly interesting that the same sort of thing can happen in a haystack but that, owing to the very small quantities of silica present, the hole is vastly bigger and the fused walls very much thinner. If we could get such a "thunderbolt" whole it would look very much like the bark of the trunk of a tree minus the rest of the tree.

Colonel Buckle kindly lent a specimen of part of one of these silica tubes to Dr. G. C. Simpson. The specimen has the appearance on one side of the effect of great heat, and the curvature of the fragment showed that the diameter of the whole tube was about one metre, which is approximately the diameter of the lightning channel in the air.

"Mother-of-Pearl" Clouds at Aberdeen

Throughout the night of February 4th the sky at Aberdeen had gradually cleared, and on the morning of the 5th the day had dawned with a strongly green-tinted sky, in which a band of deep-red cirro-stratus lay low down along the eastern horizon. Temperature had fallen to 31° F. during the night but at 7h. it stood at 34° F. A light south-westerly wind was blowing and the temperature rose steadily, eventually reaching 52° F. in the early afternoon. During the morning the sky had been about two-tenths covered with very slight cirrus and cirro-stratus in lines and patches, but after 13h. alto-cumulus made its appearance and gradually increased in quantity from three-tenths at 15h. to five-tenths by 18h. The alto-cumulus was present in detached patches and bands, very slightly lenticular in arrangement, and was intermixed with some stray wisps of cloud at levels somewhat different from that of the main cloud, and partly above, and partly below the latter. Still farther above this cloud (which in places resembled cirro-cumulus), at 15h. some very small patches of shining cloud were noticed, and were kept under observation because of their brilliant irisation. By 16h. their number had apparently increased, and, though observation was much impeded by the presence of the alto-cumulus, it was nevertheless possible to maintain a fair watch on their development. These shining clouds were confined to an area of the westward sky between azimuths 200° and 330° and a theodolite measurement gave the elevation of the highest one visible as 36° at the moment when the sun's disc was touching the south-western horizon, *i.e.*, about 16h. 30m.

But, since some of these clouds, visible at the same time, were situated well to the north of west (azimuth 300°) and at almost the same elevation, their angular distance from the sun must have been between 70° and 80°. It was therefore obvious that the colouring was not the usual irisation seen sometimes on the intermediate cloud-layers within limits much nearer to the sun's position, but that the clouds were in fact the nacreous high-level clouds called " Perlmütter wolken " by Prof. Carl. Størmer of Oslo, who has studied them extensively in Norway. The individual clouds exhibited all the characteristics mentioned in Størmer's paper " Höhe und

Farbenverteilungen der Perlmütter-Wolken "—*Geofys. Publ.*, Vol. IX, No. 4, so far as appearance, variation and colours were concerned, but of course I was unable to make any height-determination.

At 15h. the clouds nearest to the sun's position showed intense colours ; prominent amongst which was a very cold clear " electric-blue " tint, whose intensity far exceeded that of any of the other tints, and which seemed to be present chiefly on the upper edges of the clouds. The larger masses of the clouds were situated about azimuth 270° to 290°, and at an elevation of 20°–30°, and had a pale milky hue, called blue-grey by Størmer, until about 16h. 30m., after which they became tinted with pale rose-pink, violet and green, in the customary " contour " pattern, having in the meantime either (1) actually moved southwards to about azimuth 260°, or (2) developed in that direction while dispersing at their northern extremities, much after the manner of the internal changes seen in the ordinary lenticular clouds. The nacreous clouds themselves were decidedly lenticular in form, but continuous observation of the individual clouds was seriously interrupted by the presence of the lower alto-cumulus cloud sheets which tended to increase in quantity.

After sunset the lower cloud (alto-cumulus) assumed very brilliant orange to crimson colouring from about 16h. 45m. until at least 17h. 30m. ; at about 17h. the rose-red colour spread right across the sky to the eastern horizon, the whole sky thus appearing tinted in varying shades of red at the same time. As the sunset colours faded and the alto-cumulus became dark and grey, the mother-of-pearl clouds shone out more brilliantly and sharply, and showed more red and yellowish-green than formerly, with brownish and violet here and there. I hoped to obtain a photograph of them when the sky became dark enough but unfortunately the alto-cumulus cloud now began rapidly to overspread the western sky in the region where the chief group of these nacreous clouds lay, and I was disappointed. The last view I had of these beautiful clouds was at 18h. 30m. when one single small perfectly lenticular cloud was shining with a flame-like colour in the dark twilight sky, close to the edge of the alto-cumulus layer which soon advanced and hid the cloud from view.

It is worthy of note too that on the evening of the next day, Tuesday, February 6th, a very fine display of sunset colouring was again seen on the under-surface of a widely extended alto-cumulus to alto-stratus cloud sheet, which had covered eight- to nine-tenths of the sky all day, leaving a narrow band of clear sky along the western horizon. Low in the north-west where the edge of this cloud-sheet thinned out and became striated, three small lenticular mother-of-pearl clouds were seen for a short time shining blue-white above the lower layer.

During both February 5th and 6th the surface wind was chiefly SW.ly, very variable in force, and somewhat squally and gusty.

The alto-cumulus and cirro-cumulus clouds moved steadily from west. Temperature was high for the time of year, 47° F. to 52° F., during the daytime, and the usual local slight föhn effect was noticeable. The mother-of-pearl clouds, as mentioned above, seemed to be moving from either north or north-north-east, but this is not certain because of the great difficulty of proper observation.

G. A. CLARKE.

BOOKS RECEIVED

Falmouth Observatory. Meteorological Notes and Tables, 1932, also additional meteorological tables of temperature, rainfall and sunshine, 1880–1932. By W. T. Hooper, Falmouth, 1933.

Deutsches Meteorologisches Jahrbuch, 1930. Freistaat Sachsen. Edited by Prof. Dr. E. Alt. Jahrgang 48, Dresden, 1933.

OBITUARY

We regret to announce the death, from pneumonia on September 8th, of Mr. C. H. Kellett, B.Sc., Senior Professional Assistant in the Meteorological Office.

We regret to learn of the death on August 11th, 1934, of Mr. A. Latchmore who maintained a climatological station at Hitchin and contributed observations which were published in the *Monthly Weather Report* from 1918 to 1926. His rainfall readings were published in *British Rainfall* for subsequent years.

NEWS IN BRIEF

Rear-Admiral Dr. F. Spiess has been appointed President of the Deutsche Seewarte in succession to Vice-Admiral H. Dominik, who died on September 15th, 1933.*

The Weather of August, 1934

Pressure was above normal over Spitsbergen, northern Russia, northern Scandinavia, southern Iberian Peninsula, north-west African coast and across the North Atlantic to the eastern United States, central and west Canada and Alaska, the greatest excesses being 6·2 mb. at Kodiak and 4·2 mb. at Ekaterinburg. Pressure was below normal elsewhere in Europe, Iceland, south Greenland, eastern Canada and most of the central and western United States, the greatest deficits being 6·9 mb. at 60° N., 60° W. Temperature was above normal in northern Europe but below normal in south-west Europe while rainfall was in excess in Switzerland and deficient in northern Norway. In Sweden the rainfall for the country as a whole was 10 per cent. above normal.

* See *Meteorological Magazine* **68**, 1933, p. 217.

The weather of August over the British Isles was generally unsettled with rain in excess in most parts of Scotland and Ireland, while the distribution of bright sunshine was irregular. Thunderstorms occurred fairly frequently. From the 1st to 7th, complex systems of low pressure passed across the British Isles giving unsettled conditions with heavy rain on occasions but long bright periods; 2·07 in. of rain occurred at Fofanny (Co. Down) and at Castlecaulfield (Co. Tyrone) on the 1st, 1·97 in. at St. Austell (Cornwall) on the 5th and 2·04 in. at Cockle Park (Northumberland) on the 6th, while 14·3 hrs. bright sunshine were registered at Morecambe, 14·2 hrs. at Eastbourne and 14·1hrs. at Aberdeen on the 4th. Thunderstorms occurred in the north and west on the 2nd and 3rd and strong winds between S. and W. reaching gale force in places were experienced in the south-west on the night of the 1st–2nd, and later reached north-east England, having moderated slightly. Fair to fine weather occurred generally in the north and west on the 7th and on the 8th in England as a wedge of high pressure passed across the country; day temperatures rose above 75° F. in parts of the south, east and Midlands, 82° F. being registered at Norwich and 81° F. at Cambridge on the 8th. From the 9th to 13th a deep depression centred between Iceland and Scotland was moving slowly eastwards and conditions again became unsettled. Thunderstorms occurred in the south and east on the 12th and 13th. On the 14th a wedge of high pressure extended over the whole country and from then to the 19th fair or fine warm weather was enjoyed in the south though depressions moving to the north of the British Isles caused alternations of sunny weather and unsettled rainy periods in the north and west. On the 19th a depression moved south-east and the next day SW.–W. gales were experienced generally at exposed places in England and north Ireland, Spurn Head recording Beaufort Force 9 at 13h. Unsettled conditions continued until the 23rd, but there were long sunny periods. Thunderstorms occurred in parts of north England and north Ireland on the 22nd and 23rd. For the next 3 or 4 days the high pressure area from the Azores extended over the British Isles and a period of fine, warm, sunny weather was experienced except that on the 25th severe thunderstorms occurred on parts of the Kent coast; 2·09 in. were recorded at Deal on the night of the 24th–25th. The 25th and 26th were the sunniest days of this period with 13·5hrs. of bright sunshine at Weymouth on the 26th and 13·0hrs. at Morecambe on the 25th. From the 27th to 31st a deep depression over the North Atlantic gradually approached and then extended over the British Isles causing a renewal of unsettled conditions with heavy rain at times, but long sunny intervals. Gales occurred in north Scotland on the 28th and 29th, and thunderstorms were experienced in England and south Ireland from the 29th–31st. With the advent of southerly winds on the 27th temperature rose somewhat but fell in the south on the

28th and 29th and remained low for the time of year with local ground frosts at night. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	99	−32	Liverpool ...	167	+ 8
Aberdeen ...	173	+34	Ross-on-Wye ...	181	+14
Dublin	144	−12	Falmouth ...	207	+ 9
Birr Castle ...	149	+11	Gorleston ...	212	+17
Valentia... ...	139	−11	Kew	192	+ 9

Miscellaneous notes on weather abroad culled from various sources.

Six people were drowned by floods caused by cloudbursts in the Zhupa district of Yugoslavia about the 7th. Vineyards and fields in the district of Nierstein on the Rhine suffered heavy damage from a severe thunderstorm on the evening of the 9th. Gales occurred on the 14th on the Dutch coast and in the Cattegat. In consequence of torrential rain on the 17th several of the lower lying districts in Bucharest were flooded—damage by floods is also reported from other parts of Roumania. Severe storms accompanied by hail occurred on the 23rd on the Chiem See, Upper Bavaria and over the Neuchatel and Bernese Jura in Switzerland ; 5 people were drowned.

Ten people were drowned and many houses in Sidi-Aissa, Algeria, destroyed by floods following heavy rains about the 21st. The Nile flood water was unusually high this year but the precautions taken had prevented any serious damage before August 31st.

The monsoon was generally active in India except over the Peninsula at the beginning of the month, but later heavy rains fell also in Madras. In Bombay the rainfall during the month was considerably above the average. Severe floods occurred in Bihar, Orissa and Bengal from the 24th to 31st when the water was receding in all parts. The damage to towns was generally small but many villages were washed away, crops destroyed and communications broken. Drought accompanied by high temperatures prevailed in the four provinces of China adjacent to the lower Yangtze during most of the month and was reported to have spread to Hupeh and Hunan about the 13th—the crops, especially the rice crop suffered much damage. Severe frost damaged some of the tea plantations in the high districts of east Java about the 20th.

Satisfactory rains in South Australia before the 16th averted crop failures, but storms did damage along the coast and Port Pirie was flooded by sea-water on the 14th.

Drought and high temperatures were experienced generally in Canada during the month although parts of the country and even of the prairie provinces received abundant rain at times. During the first half of the month temperature was above normal in western and central United States (more than 10°F. in parts of the Missouri

Valley) and about or below normal in the eastern States but later temperature fell below normal in the central States as well. The rainfall was mainly deficient. Eight people were killed and much damage done to property by a storm over Michigan on the 2nd. A heat wave passed across the Missouri Valley from the 6th–11th, 110°F. being reached at several places on the 8th, 9th and 10th. The drought continued in the middle States until about the 10th when rain fell in many parts of the middle West—heavy rains were also reported from more of the drought stricken areas on the 16th.

Daily Readings at Kew Observatory, August, 1934

• Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
	mb.		°F.	°F.	%	in.	hrs.	
1	1011·1	SW.3	57	72	50	0·04	5·7	r_0 17h. 15m.–23h.15m.
2	998·8	SW.4	61	67	60	0·02	1·2	ir_0 1 h.–4 h.
3	1006·2	SSW.4	54	70	55	trace	9·1	pr_0 18h., T 18h. 30 m.
4	1010·0	W.3	49	72	41	—	9·9	w early.
5	1013·0	S.3	52	71	55	trace	5·1	r_0 21h.–21h. 15m.
6	1009·3	SSE.3	62	71	72	trace	0·7	pr_0 10h. 30m.
7	1009·8	NE.4	59	72	77	0·15	0·1	r 7h.–9h. 40m.
8	1015·4	N.3	58	75	80	—	3·5	
9	1011·5	WNW.4	61	69	47	0·08	5·1	r 6h. 5m.–7h. [25m.
10	1009·6	SW.5	57	69	83	0·02	0·8	r_0–r 19h. 50m.–20h.
11	1010·9	SW.3	53	65	63	0·02	3·9	pr 11h.25m.–11h.35m.
12	1010·7	SW.4	54	65	86	0·34	2·0	lT 17h. 23m.
13	1012·1	NW.3	53	66	54	0·03	3·4	pr 14h. 5m.–14h. 20m.
14	1018·3	NNW.2	54	66	66	—	5·4	w early.
15	1019·2	SW.3	52	72	56	—	11·6	w early.
16	1019·7	W.2	55	74	68	—	5·7	
17	1022·4	WSW.1	60	73	59	—	1·3	
18	1021·0	NW.2	58	79	47	—	8·3	w early.
19	1016·2	W.3	59	72	45	—	8·2	
20	1008·2	WSW.5	52	70	51	trace	9·3	d_0 8h. 35m.–9h. 45m.
21	1012·3	SW.4	54	70	52	—	10·5	
22	1008·8	SSW.4	58	71	57	0·16	5·4	ir 19h.50m.–23h.15m.
23	1010·5	SW.3	53	70	53	trace	11·8	pr_0 13h. 40m.
24	1018·3	WNW.2	48	68	51	—	9·3	w early.
25	1020·9	NE.3	51	69	42	—	11·2	w early.
26	1024·5	E.3	47	70	41	—	12·3	f w early.
27	1016·9	SE.2	54	77	51	—	6·5	f early.
28	1006·7	SSW.3	54	71	74	0·59	2·9	rr_0 14h.–20h.
29	1001·6	WSW.3	52	64	52	0·29	8·4	T 10h., PR 16h.
30	1007·6	WSW.2	45	62	48	0·01	4·7	pr 14h., T 16h.
31	1009·5	SW.2	43	65	53	—	8·6	F till 8h.
	1012·6		54·2	69·9	58	1·75	6·2	

General Rainfall for August, 1934

England and Wales ...	95	per cent of the average 1881–1915.
Scotland	122	
Ireland	113	
British Isles	106	

Rainfall : August, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	1·94	88	*Leics* .	Thornton Reservoir	2·35	84
Sur .	Reigate, Wray Pk. Rd.	2·04	83	,, .	Belvoir Castle	1·95	74
Kent .	Tenterden, Ashenden	1·69	74	*Rut* .	Ridlington	1·62	64
,, .	Folkestone, Boro. San.	1·79	...	*Lincs* .	Boston, Skirbeck	2·09	87
,, .	Eden'bdg., Falconhurst	1·59	61	,, .	Cranwell Aerodrome	2·13	78
,, .	Sevenoaks, Speldhurst.	1·95	...	,, .	Skegness, Marine Gdns.	2·55	105
Sus .	Compton, Compton Ho.	3·68	119	,, .	Louth, Westgate	2·28	81
,, .	Patching Farm	2·76	110	,, .	Brigg, Wrawby St.	2·02	...
,, .	Eastbourne, Wil. Sq.	3·26	131	*Notts* .	Worksop, Hodsock	1·26	51
,, .	Heathfield, Barklye	2·69	100	*Derby*.	Derby, L. M. & S. Rly.	2·56	98
Hants.	Ventnor, Roy.Nat.Hos.	1·75	88	,, .	Buxton, Terr. Slopes	3·19	73
,, .	Fordingbridge, Oaklnds	3·74	142	*Ches* .	Runcorn, Weston Pt.	2·42	67
,, .	Ovington Rectory	3·41	126	*Lancs*.	Manchester, Whit. Pk.	3·02	87
,, .	Sherborne St. John	2·75	114	,, .	Stonyhurst College	5·46	108
Herts .	Welwyn Garden City	1·90	80	,, .	Southport, Bedford Pk.	3·30	95
Bucks.	Slough, Upton	2·71	125	,, .	Lancaster, Greg Obsy.	4·64	103
,, .	H. Wycombe, Flackwell	2·51	104	*Yorks*.	Wath-upon-Dearne	·68	28
Oxf .	Oxford, Mag. College	1·67	74	,, .	Wakefield,Clarence Pk.	·91	35
Nor .	Pitsford, Sedgebrook	1·79	74	,, .	Oughtershaw Hall	5·25	...
,, .	Oundle	1·41	...	,, .	Wetherby, Ribston H.	1·32	48
Beds .	Woburn, Exptl. Farm	1·91	83	,, .	Hull, Pearson Park	2.51	86
Cam .	Cambridge, Bot. Gdns.	1·92	82	,, .	Holme-on-Spalding	2·59	97
Essex.	Chelmsford, County Lab	1·46	67	,, .	West Witton, Ivy Ho.	2·21	75
,, .	Lexden Hill House	1·31	...	,, .	Felixkirk, Mt. St. John.	2·66	93
Suff .	Haughley House	1·69	...	,, .	York, Museum Gdns.	1·42	56
,, .	Campsea Ashe	2·13	108	,, .	Pickering, Hungate	3·19	124
,, .	Lowestoft Sec. School	1·70	77	,, .	Scarborough	2·43	87
,, .	Bury St. Ed., WestleyH.	1·73	67	,, .	Middlesbrough	2·26	82
Norf. .	Wells, Holkham Hall	1·59	66	,, .	Baldersdale, Hury Res.	...	...
Wilts .	Calne, Castleway	2·32	82	*Durh* .	Ushaw College	2·93	101
,, .	Porton, W.D. Exp'l. Stn	2·51	111	*Nor* .	Newcastle, Town Moor.	2·85	98
Dor .	Evershot, Melbury Ho.	5·10	162	,, .	Bellingham, Highgreen	4·22	119
,, .	Weymouth, Westham.	2·50	117	,, .	Lilburn Tower Gdns.	3·57	127
,, .	Shaftesbury,Abbey Ho.	2·75	95	*Cumb*.	Carlisle, Scaleby Hall	4·12	100
Devon.	Plymouth, The Hoe	4·71	152	,, .	Borrowdale, Seathwaite	15·00	138
,, .	Holne, Church Pk. Cott.	5·92	132	,, .	Borrowdale, Moraine	12·25	141
,, .	Teignmouth, Den Gdns.	3·28	144	,, .	Keswick, High Hill	6·14	117
,, .	Cullompton	3·00	98	*West* .	Appleby, Castle Bank	3·53	107
,, .	Sidmouth, U.D.C.	3·64	...	*Mon* .	Abergavenny, Larchf'd	3·40	114
,, .	Barnstaple, N. Dev.Ath	3.82	116	*Glam* .	Ystalyfera, Wern Ho.	4·99	81
,, .	Dartm'r,Cranmere Pool	7·10	...	,, .	Cardiff, Ely P. Stn.	3·86	89
,, .	Okehampton, Uplands.	4·90	116	,, .	Treherbert, Tynywaun.	8·48	...
Corn .	Redruth, Trewirgie	5·00	146	*Carm* .	Carmarthen, Priory St.	4·05	87
,, .	Penzance, Morrab Gdn.	3·11	98	*Pemb* .	Haverfordwest, School.	...	...
,, .	St. Austell, Trevarna	5·27	146	*Card* .	Aberystwyth	4·48	...
Soms .	Chewton Mendip	4·22	94	*Rad* .	BirmW.W.Tyrmynydd	7·08	131
,, .	Long Ashton	3·08	88	*Mont* .	Lake Vyrnwy	5·39	104
,, .	Street, Millfield	3·70	135	*Flint* .	Sealand Aerodrome	1·94	68
Glos .	Blockley	2·01	...	*Mer* .	Dolgelley, Bontddu	8·79	156
,, .	Cirencester, Gwynfa	2·21	74	*Carn* .	Llandudno	2·97	105
Here .	Ross, Birchlea	1·95	76	,, .	Snowdon, L. Llydaw 9.	19·24	...
Salop.	Church Stretton	3·09	95	*Ang* .	Holyhead, Salt Island	2·80	88
,, .	Shifnal, Hatton Grange	2·37	84	,, .	Lligwy	3·50	...
Staffs.	Market Drayt'n, Old Sp.	2·39	72	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	2·06	77		Douglas, Boro' Cem.	3·43	88
War .	Alcester, Ragley Hall	2·15	78	*Guernsey*			
,, .	Birminghm, Edgbaston	2·31	85		St. PeterP't.Grange Rd.	3·14	134

Errata : Treherbert, Tynywaun, July, for 2·68 read 2·55.

Rainfall: August, 1934: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	4·61	120	*Suth* .	Melvich	5·93	199
,, .	New Luce School	4·26	95	,, .	Loch More, Achfary	9·09	155
Kirk .	Dalry, Glendarroch	4·92	103	*Caith* .	Wick	4·09	149
,, .	Carsphairn, Shiel	7·34	109	*Ork* .	Deerness	3·79	132
Dumf.	Dumfries, Crichton, R.I.	6·64	174	*Shet* .	Lerwick	2·79	93
,, .	Eskdalemuir Obs	7·00	136	*Cork* .	Caheragh Rectory	2·80	...
Roxb .	Branxholm	4.28	133	,, .	Dunmanway Rectory	3·59	76
Selk .	Ettrick Manse	6.46	124	,, .	Cork, University Coll	3·31	98
Peeb .	West Linton	3·67	...	,, .	Ballinacurra	4·36	117
Berw .	Marchmont House	3·25	98	,, .	Mallow, Longueville	2·82	91
E.Lot.	North Berwick Res	2·97	94	*Kerry*.	Valentia Obsy	5·43	113
Midl .	Edinburgh, Roy. Obs.	3·27	102	,, .	Gearhameen	7·20	95
Lan .	Auchtyfardle	3·96	...	,, .	Darrynane Abbey	3·99	92
Ayr .	Kilmarnock, Kay Pk	3·77	...	*Wat* .	Waterford, Gortmore	4·53	119
,, .	Girvan, Pinmore	4·96	111	*Tip* .	Nenagh, Cas. Lough	5·08	129
Renf .	Glasgow, Queen's Pk	4·54	128	,, .	Roscrea, Timoney Park	4·76	...
,, .	Greenock, Prospect H.	5·27	97	,, .	Cashel, Ballinamona	3·37	95
Bute .	Rothesay, Ardencraig	5·68	...	*Lim* .	Foynes, Coolnanes	4·20	109
,, .	Dougarie Lodge	5·01	...	,, .	Castleconnel Rec	3·45	...
Arg .	Ardgour House	9·16	...	*Clare* .	Inagh, Mount Callan	7·07	...
,, .	Glen Etive	11·95	159	,, .	Broadford, Hurdlest'n.	4·01	...
,, .	Oban	5·16	...	*Wexf* .	Gorey, Courtown Ho	2·85	86
,, .	Poltalloch	4·95	101	*Wick* .	Rathnew, Clonmannon.	3·62	...
,, .	Inveraray Castle	6·72	102	*Carl* .	Hacketstown Rectory	5·01	124
,, .	Islay, Eallabus	3·95	91	*Leix* .	Blandsfort House	4·64	117
,, .	Mull, Benmore	13·30	114	,, .	Mountmellick	5.16	...
,, .	Tiree	4·43	106	*Offaly*.	Birr Castle	4·58	120
Kinr .	Loch Leven Sluice	4.44	116	*Dublin*	Dublin, FitzWm. Sq.	3·01	99
Perth .	Loch Dhu	...	...	,, .	Balbriggan, Ardgillan	3·08	90
,, .	Balquhidder, Stronvar.	5·95	...	*Meath*.	Beauparc, St. Cloud	4·32	...
,, .	Crieff, Strathearn Hyd.	4·20	100	,, .	Kells, Headfort	3·73	90
,, .	Blair Castle Gardens	4·25	126	*W.M* .	Moate, Coolatore	3·60	...
Angus.	Kettins School	5·32	145	,, .	Mullingar, Belvedere	4·01	96
,, .	Pearsie House	4·06	...	*Long* .	Castle Forbes Gdns	5·88	144
,, .	Montrose, Sunnyside	3·02	108	*Gal* .	Galway, Grammar Sch.	...	...
Aber .	Braemar, Bank	4·52	132	,, .	Ballynahinch Castle	5·95	108
,, .	Logie Coldstone Sch	3.49	110	,, .	Ahascragh, Clonbrock.	5·92	141
,, .	Aberdeen, King's Coll.	4·38	160	*Mayo*.	Blacksod Point	3.66	80
,, .	Fyvie Castle	4·97	156	,, .	Mallaranny	5.77	...
Moray	Gordon Castle	3·58	113	,, .	Westport House	5·20	128
,, .	Grantown-on-Spey	...	...	,, .	Delphi Lodge	10·82	126
Nairn.	Nairn	1·75	73	*Sligo* .	Markree Obsy	6·37	147
Inv's .	Ben Alder Lodge	3·82	...	*Cavan*.	Crossdoney, Kevit Cas.	5·01	...
,, .	Kingussie, The Birches.	2·17	...	*Ferm* .	Enniskillen, Portora	...	...
,, .	Inverness, Culduthel R.	2·11	...	*Arm* .	Armagh Obsy	5·48	152
,, .	Loch Quoich, Loan	...	...	*Down*.	Fofanny Reservoir	9·72	...
,, .	Glenquoich	...	...	,, .	Seaforde	4·99	133
,, .	Arisaig, Faire-na-Sguir.	...	...	,, .	Donaghadee, C. Stn.	4·72	142
,, .	Fort William, Glasdrum	7·26	...	,, .	Banbridge, Milltown	4·55	130
,, .	Skye, Dunvegan	6·44	...	*Antr* .	Belfast, Cavehill Rd	5·50	...
,, .	Barra, Skallary	4·39	...	,, .	Aldergrove Aerodrome.	4·46	124
R&C .	Alness, Ardross Castle.	3·24	110	,, .	Ballymena, Harryville.	5·42	127
,, .	Ullapool	4·11	116	*Lon* .	Garvagh, Moneydig	5·26	...
,, .	Achnashellach	8·35	125	,, .	Londonderry, Creggan.	5·52	119
,, .	Stornoway	4·71	118	*Tyr* .	Omagh, Edenfel	4·76	112
Suth .	Lairg	4·08	129	*Don* .	Malin Head	4·89	...
,, .	Tongue	4·95	155	,, .	Killybegs, Rockmount.	...	...

Climatological Table for the British Empire, March, 1934

STATIONS.	PRESSURE. Mean of Day M.S.L. mb.	PRESSURE. Diff. from Normal. mb.	TEMPERATURE. Absolute. Max. °F.	TEMPERATURE. Absolute. Min. °F.	TEMPERATURE. Mean Values. Max. °F.	TEMPERATURE. Mean Values. Min. °F.	TEMPERATURE. Mean Values. ½ Max. and Min. °F.	TEMPERATURE. Mean Values. Diff. from Normal. °F.	TEMPERATURE. Mean. Wet Bulb. °F.	Relative Humidity. %	Mean Cloud Am'nt 0–10	PRECIPITATION. Am'nt. in.	PRECIPITATION. Diff. from Normal. in.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
London, Kew Obsy.	1006·0	− 7·4	57	28	48·9	35·8	42·3	− 0·1	36·3	89	7·3	2·12	+ 0·43	14	3·56	30
Gibraltar	1015·5	− 1·6	70	39	62·6	47·3	54·9	− 2·7	47·1	79	4·7	5·07	+ 0·33	15	...	...
Malta	1010·9	− 3·3	68	44	60·9	51·8	56·3	− 0·8	51·9	75	5·8	1·81	+ 0·33	10	7·15	60
St. Helena	1011·1	− 0·3	74	60	68·6	62·3	65·5	− 0·8	63·3	97	9·3	5·08	...	25	...	...
Freetown, Sierra Leone	1011·6	+ 0·9	90	64	86·8	67·9	77·3	− 5·1	73·5	80	5·8	0·06	− 1·10	2	...	...
Lagos, Nigeria	1008·6	− 0·3	91	72	89·1	77·1	83·1	− 0·3	77·1	83	7·4	4·75	+ 1·00	6	6·3	53
Kaduna, Nigeria	1005·6	...	101	53	95·9	64·9	80·4	− 0·7	63·2	47	2·7	0·74	+ 0·20	2	8·0	67
Zomba, Nyasaland	1009·1	− 0·6	86	61	80·1	64·4	72·3	+ 1·0	68·6	79	7·5	9·90	+ 0·82	24	...	...
Salisbury, Rhodesia	1011·1	− 0·8	84	51	79·5	58·7	69·1	+ 0·9	62·5	72	6·3	1·65	− 3·05	8	7·7	63
Cape Town	1014·6	+ 0·1	88	51	77·8	58·8	68·3	+ 0·2	59·5	78	3·9	0·60	− 0·28	6	...	...
Johannesburg	1012·4	0·0	81	50	74·8	54·9	64·9	+ 1·5	57·4	80	5·5	1·99	− 2·45	12	7·5	61
Mauritius	1012·5	+ 0·5	88	68	84·4	71·8	78·1	+ 0·1	73·6	70	4·8	1·87	− 7·50	24	9·7	79
Calcutta, Alipore Obsy.	1009·2	− 0·7	104	62	94·4	70·5	82·5	+ 2·3	69·7	74	2·1	0·16	− 1·22	1*	...	...
Bombay	1009·8	− 1·1	95	66	85·6	71·8	78·7	− 0·8	70·4	74	1·0	0·04	+ 0·02	0*	...	...
Madras	1009·6	− 1·3	95	65	88·5	71·5	80·0	− 1·1	74·9	82	4·3	0·00	− 0·34	0*	...	...
Colombo, Ceylon	1009·9	− 0·2	87	64	85·2	72·5	78·9	− 2·9	75·8	78	5·8	7·57	+ 3·29	18	7·5	62
Singapore	1008·6	− 1·1	90	69	85·5	71·8	78·7	− 2·5	75·3	83	8·3	10·65	+ 3·25	22	5·1	42
Hongkong	1015·2	− 0·8	82	50	68·9	59·4	64·1	+ 0·8	59·1	74	7·4	1·75	− 1·19	12	3·9	32
Sandakan	1009·6	...	91	71	86·3	74·2	80·3	− 0·7	76·4	87	8·0	12·18	+ 3·71	22	...	...
Sydney, N.S.W.	1019·0	+ 2·7	95	57	77·7	63·8	70·7	+ 1·4	66·0	74	6·2	1·93	− 3·05	14	7·2	59
Melbourne	1018·5	+ 1·6	103	45	82·1	59·3	70·7	+ 6·2	61·6	59	6·4	0·14	− 2·04	7	6·7	54
Adelaide	1017·3	+ 0·2	111	54	88·3	65·6	76·9	+ 7·1	61·7	36	4·7	0·66	− 0·37	8	7·5	62
Perth, W. Australia	1012·8	− 2·5	101	56	82·5	65·2	73·9	+ 2·7	62·9	58	4·6	5·71	+ 4·90	7	7·2	59
Coolgardie	1012·8	− 2·0	110	50	85·1	62·0	73·5	+ 1·6	65·5	65	5·5	1·81	+ 0·87	5	...	...
Brisbane	1017·4	+ 3·0	86	60	81·2	65·4	73·3	− 1·0	67·4	67	5·8	0·82	− 4·95	10	8·6	69
Hobart, Tasmania	1018·8	+ 4·6	88	44	70·3	53·0	61·7	+ 2·4	54·5	63	7·1	0·64	− 1·06	11	5·7	46
Wellington, N.Z.	1020·1	+ 2·9	77	42	64·1	52·4	58·3	− 2·3	54·8	75	7·2	2·44	− 0·89	12	5·8	47
Suva, Fiji	1008·2	− 0·2	91	70	86·5	74·7	80·6	+ 0·5	76·3	83	7·2	22·65	+ 8·16	26	5·0	41
Apia, Samoa	1008·3	− 0·9	87	72	83·7	74·3	79·0	− 0·3	76·1	84	8·8	20·03	+ 6·05	23	...	...
Kingston, Jamaica	1014·7	− 0·2	88	65	84·7	67·0	75·9	− 1·2	65·8	83	4·0	1·44	+ 0·42	5	7·0	58
Grenada, W.I.	1010·5	− 2·5	90	71	87·0	73·0	80·0	+ 2·2	72·0	70	4·0	6·76	+ 4·10	20	...	...
Toronto	1020·9	+ 3·6	53	1	34·7	21·3	28·0	− 1·6	22·7	68	6·3	1·59	− 0·82	11	4·2	35
Winnipeg	1021·1	+ 1·9	44	−19	24·5	4·3	14·4	− 0·6	...	...	4·1	0·27	− 0·89	1	5·8	49
St. John, N.B.	1019·7	+ 5·6	46	2	35·1	20·4	27·7	− 0·7	23·4	78	5·9	3·07	− 1·47	9	5·8	49
Victoria, B.C.	1019·1	+ 3·2	63	37	54·6	42·8	48·7	+ 5·2	45·1	78	6·0	4·12	+ 1·69	13	5·8	49

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(22470) Wt. 25/32 1000 9/34 Hw. G.377

M.O. 371.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 69

Oct. 1934

No. 825

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120, GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1, ST. ANDREW'S CRESCENT, CARDIFF; 80, CHICHESTER STREET, BELFAST; or through any Bookseller.

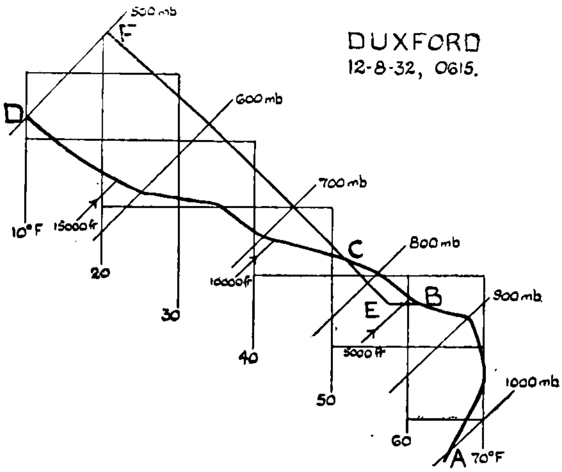
A Note on Frontal Thunderstorms

THE principles of frontal thunderstorms can be most easily discussed by means of a particular case. The cold front storm on the early morning of August 12th, 1932, is very suitable, since the Duxford aeroplane ascent was made just in front of it, and the pilot had to land further east at Martlesham so as to avoid flying back through it. In the accompanying diagram (a tephigram, with temperature as abscissa and potential temperature as ordinate, the horizontal lines being dry adiabatics) the curve A B C D represents the observed state of the atmosphere, while B E C F is a theoretical curve followed by an air mass starting with the observed temperature, pressure, and humidity at B, and ascending under adiabatic conditions. The curve is horizontal to E, the point of saturation, and then follows the saturated adiabatic E F, crossing the other curve at C. The pressure at E, namely 830 mb., agrees exactly with the observed cloud base,* and if we started from any lower point in the observed curve, the area B E C would be increased. Up to the point C the air would be colder than the undisturbed air and would have to be forced upwards, the necessary energy being presumably supplied by the

* The actual observations by the pilot were "Turreted cumulus with nimbus base, base 830 mb., tops 570 mb., to westward, amount nine-tenths; fracto-cumulus 660 to 610 mb., six-tenths, mammato-cumulus, ten-tenths, base 500 mb." The mammillated upper layer was the forward extension of the anvil, and the turreted clouds were no doubt growing up and feeding the storm.

horizontal temperature difference. At 900 mb. temperature fell 6° F. between 6h. and 12h. Above C the rising air would be warmer than its environment and inherently buoyant. The large area between C D and C F, which probably extended to the base of the stratosphere, shows that much energy was available, and it is not surprising that the storm was locally very violent and that large hail fell.*

Although the area B E C is small in comparison with that between C F and C D, it does not follow that it is unimportant. It implies that the rising air was colder than the adjacent air through a layer nearly 2,000 feet thick, the difference exceeding 1° F. for over 1,000 feet. There is no real proof as to exactly what happened on this occasion, but there is no doubt that forced ascent of this kind does often take place, sometimes to a greater extent than that indicated by B E C, and that sometimes the rising air has warmer air all round it, not on one side only. I have noted many clouds to be colder than their environment, including some in thundery weather. As an extreme example, I quote the following extract from a lengthy description of the clouds over Berck at 18h. on August 23rd, 1918. "The alto-cumulus castellatus clouds at 8,000 feet were 5° F. colder than the surrounding air, at 10,000 feet 1° F. colder. The clouds at 15,000 feet were 1° F. warmer than the surrounding air." (These had a stratified base at 14,000 feet, and high cumulo-nimbus tops.) Thunder occurred a few hours later, though high up and of no great intensity. Further investigation is required on these problems.



An excellent example of the practical importance of this trigger action is that of August 27th to 29th, 1930. According to the figures for Kew given by F. H. Dight,† this was the most notable spell of damp heat during the present century. The lapse-rate on all three days was very exceptional, the difference between the afternoon temperature at the ground and the temperature at 17,000 feet in the morning being about 73° F. There were no afternoon ascents, but one can estimate that there was probably a very thin stable layer at

* See *Meteorological Magazine* **67**, 1932, p. 186.

† *Meteorological Magazine* **69**, 1934, p. 112.

3,000 feet which checked convection. At all events the three days passed with practically no cloud and no thunder in the south-east of England, but on the night of the 29th a feeble cold front advanced and there was a memorable storm, in which S. C. Russell* noted sixty-three flashes per minute, the highest rate he ever recorded.

The storm on the night of July 9th, 1923, was probably the most notable night storm of the present century in south-east England, as the lightning and thunder were of a severe type, even though the frequency did not quite equal that of the 1930 storm. Its interest for our purpose lies in the fact that it was associated with a rather feeble warm front. A cold front which crossed England on the 7th became stationary over Holland and eastern France, and subsequently came back as a warm front, owing to the development of an anticyclone over Scandinavia. There were no observations of upper air temperature, but surface temperature showed a rise in the extreme south-east on the 10th, and subsequently over most of England, 90° F. being reached at many places. The upper wind on the evening of the 9th and on the morning of the 10th was ESE. at 2,000 feet and SSE. at 6,000 feet, indicating rising temperature between the two levels. There was little variation above 6,000 feet. It is only in special conditions that instability up above accompanies warm fronts, but warm front storms of fair severity may occur almost anywhere in the British Isles, and in the south-east they average about one in two years. There was a good example on the night of May 26th, 1929.

I have observed large banks of cumulus, associated with local or general fronts, often feeble, with a temperature in the cloud lower than in the air on both sides of the cloud bank through a considerable range of height, but these never gave thunder, and only occasionally even showers. One cannot rule out the possibility of thunder being occasionally due entirely to the horizontal temperature difference, for example in a severe winter line-squall, but there is no doubt that the vast majority of storms derive most of their energy above the condensation level, and that both fronts and surface heating† only serve to start the disturbance. The rising of saturated air through its environment cannot accurately be described as a "convectional over-turning," since it is almost certain that the surrounding dry air only sinks slowly. The only downrush of air is that due to the precipitation, but though the out-flowing cold air helps to maintain the storm, it is a secondary effect and cannot be given primary importance. Even during the night heavy squalls with thunderstorms are usually due to the precipitation, which evidently cools the air above the surface inversion.

Most diurnal convectional storms have some frontal characteristics, especially really severe storms, which are normally of the type first

---

* *Meteorological Magazine* **65**, 1930, p. 185.

† This of course refers to one day's heating, not to prolonged heating.

investigated by J. Fairgrieve,* developing along belts of the order of 40 or 50 miles in length and 10 miles in width. The surface winds (after allowing for any general motion) conform to the general rules found by Fairgrieve. During development there is convergence into the belt, but later on the cold air mass formed by the rain spreads out laterally, with divergence in the middle but convergence at its boundaries. Sometimes the storm belt splits into two before it finally breaks up. As a rule there is some general drift at the cloud level, which as a first approximation may be superposed on the movements due to development.

The recent heavy storm over south London on July 22nd, 1934,† illustrated these features. There were large cumulus clouds from noon onwards, but they only became threatening in the evening, when they gathered over south London in an enormous darkening mass. The clouds drifted slowly south-east, but development in the rear made the edge of the dark mass stationary. There was marked wind convergence during development, the wind being WSW. at Croydon and NNE. at Kingsway. The storm was some miles south of Kingsway, but the outflowing air arrived at 20h. G.M.T., and temperature quickly fell 5° F. The wind remained S. to SE. for some time afterwards.

The "surface heating" and "frontal" types of thunderstorms form overlapping rather than sharply defined categories, and the classification refers only to the lower layers, leaving out of account the main source of the thunderstorm energy. A classification which took into account both the lower and the upper layer would inevitably be rather clumsy, and the simple classification is probably the most practically useful, but it is important to keep its limitations in mind. True knowledge of the atmosphere consists not in forming simple generalisations, but rather in following out the actual processes of nature in all their complexity.

C. K. M. DOUGLAS.

Wind Pressures on Buildings

During recent years the investigations into the wind pressure on buildings, which were initiated by Sir Thomas Stanton at the National Physical Laboratory, have been pursued further by the measurement of pressures on buildings and the comparison with the pressures found on small scale models in the wind tunnels at the N.P.L. A paper on Wind Pressures on Buildings by A. Bailey‡ gives the

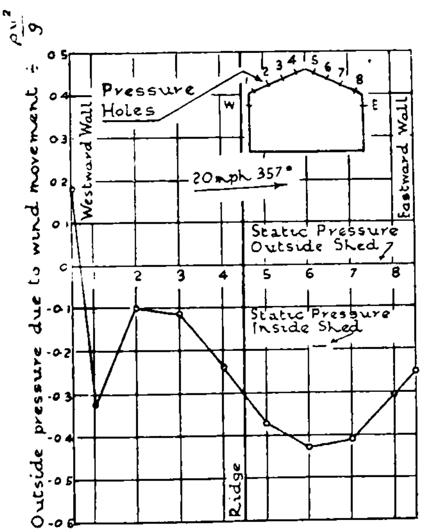
---

* See *British Rainfall*, 1911 and 1914. Also *London Q.J.R. Meteor. Soc.* **44**, p. 245.

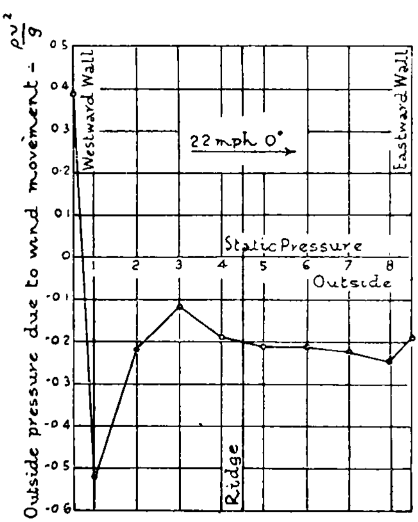
† *Meteorological Magazine* **69**, 1934, p. 163.

‡ "Wind Pressures on Buildings," by Alfred Bailey, M.Sc., Assoc.M.Inst.C.E. *London Inst. Civ. Engin., Selected Engin. Papers, No.* 139.

results of one such investigation, that on a large shed belonging to the Metropolitan-Vickers Electrical Manufacturing Co., at Manchester. Other investigations on similar lines are being carried on at a bridge over the Severn and on a hangar at Manston. The latter is an even more elaborate investigation than that conducted at Manchester and when it is completed it will be of great interest to compare its results with those which are given in the present paper. The problem is (*a*) to discover qualitatively how wind pressure (or suction) is exerted on the different parts of the roof and sides of a building ; (*b*) to determine quantitatively the scale effects produced in models, the ultimate objective being to be able to predict from the examination of a model in a wind tunnel to what strains the full size building will be subjected. The method used in the Manchester experiment was briefly as follows :—Pressure holes at a number of points on the roof and sides of the building were connected with a multimanometer gauge which the observer photographed when he estimated that suitable wind conditions were in operation. The measurements from these photographs were then compared with measurements of pressure made at similar holes in a small model in the wind tunnel. The type of result obtained is best seen from an example such as that shown in the figure below in



Wind pressure on Shed



Wind pressure on Model

which the right-hand diagram refers to the full scale measurements, the left-hand to those on the small model. The points at which measurements were made are shown by numbers corresponding to those on the section of the shed. In this case the wind was normal to the roof ridge. The points that stand out are (*a*) there are two positions where suction is great, one just behind the windward eves (at point 1) and the other over the lee slope of the roof ; (*b*) the latter area is subjected to greater suction on the full scale than would be expected from the model experiment; (c) pressure on the windward wall is greater on the model than on the full scale shed. The ratios of the suctions have been determined for the Manchester shed as 1·51 and for the pressures as 0·64. The physical process to which this discrepancy between full scale and model is due is not understood. It may be due to differences between the structure of the wind in the tunnel and that in nature.

From the practical point of view the suction effect on the lee side of the roof is of considerable importance, a statement which is brought home in this paper by photographs of damage to buildings in Birmingham by wind in which the roofs of houses were lifted off and gable walls were pulled outwards.

This same effect of the *outward* falling of buildings when struck by tornadoes has been explained as an explosive action of the air inside the building owing to the sudden reduction of pressure in the core of the tornado (*vide* Gregg's Aeronautical Meteorology, p. 228). It would seem to the writer of this note that this view may need modification in the light of these investigations on wind pressure, and that the outward falling of the buildings is due rather to the creation of lee eddies than to the explosion of air prisoned in the building.

C. S. Durst.

Meteorological Observations in central Greenland

Previous to the winter of 1930–1, meteorological observations in Greenland were restricted to those of coastal stations and occasional observations by sledge parties traversing the inland ice during the warmer months. Inferences about conditions in central Greenland during the " winter " had not been checked by observation.

During the period mentioned, however, two meteorological stations were being maintained on the ice cap and a recent Geophysical Memoir* gives a summary of some seven months' observations at a station in lat. 63° 3′ N., long.41° 49′ W., at an altitude of 8,000 ft., manned by members of the British Arctic Air Route Expedition. This expedition was led by H. G. Watkins, who unfortunately lost his life while leading a subsequent expedition to Greenland. In addition to the extensive programme of exploration and surveying, meteorological work was also carried on at the base camp of the expedition, near Angmagssalik, in east Greenland, and a summary of almost a complete year's observations at the Base is given.

The observations at the Base fit in with what was already known

* *London, Meteor. Office, Geophysical Memoirs, No.* 61. Meteorological results of the British Arctic Air Route Expedition. By S. T. A. Mirrlees, M.A. (M.O.356d).

of the climate of the Greenland fjords : the prevailing winds blow up and down the fjords, and fog is rare within them, though it is common on the outer coasts in summer. Where the air flow is suitably concentrated by the topography the wind blowing off the ice-cap may at times attain hurricane velocity ; force 12 (Beaufort Scale) was observed on 11 days and wind velocities up to 129 m.p.h. were recorded. Temperature varied between extremes of 63°F. and − 6°F.

From the point of view of aviation the main feature of the observations at the station on the ice-cap was the fact that drifting snow may cause the horizontal visibility near the surface to fall below 1 kilometre at nearly 50 per cent. of the observation hours. Often it seems to be the case that the snow of the surface is whirled along in a shallow layer, but at times blizzard conditions may prevail up to a considerable height. The prevailing direction of wind was from between N. and NW., *i.e.*, downhill, but gales were experienced from both downhill and uphill directions. The temperature varied between extremes of 8°F. and − 64°F., the mean for October–February was about − 25°F., the same as the normal for Jakutsk. The coldest month at Jakutsk, however, has a normal temperature of − 46°F., and the coldest month at the Ice-cap station averaged −33°F. Presumably the drainage of cold air from the ice-cap is free enough to prevent the occurrence of any remarkable extremes of temperature such as are experienced at enclosed valley stations in northern Siberia. On the ice-cap in quiet conditions a large inversion of the temperature lapse rate forms near the surface and any increase of wind disturbs this, so that an increase of wind may be associated with a rise in temperature of 30° or 40°F. in a few hours.

Apart from their bearing on the question of whether an air-route across Greenland is practicable these observations are of interest in regard to the more general question of the atmospheric circulation over Greenland. Discussion of this point has been limited owing to the fact that only part of the simultaneous observations from other stations in Greenland has as yet been available and the following conclusions are given tentatively.

It appears that outflowing winds from Greenland may in suitable circumstances attain hurricane force, but such outflow is limited in extent, appears to have no direct influence for disturbed weather in the north-east Atlantic, and is probably not on a large enough scale to provide motive power for the atmospheric circulation. (Somewhat similar localised outflows have been observed on the margin of the Antarctic Continent). The semi-permanent " central cold zone " is a statistical production ; the setting-in of strong winds either from east or west may bring " plus " temperatures to the Ice-cap station even in the coldest months.

At the Ice-cap station the changes of wind and barometric pressure are often those appropriate to the passage of a depression with centre to the southward; less frequently to the passage of a depression with centre to the northward. Isobaric charts drawn from observations at coastal stations could frequently be used to forecast wind and weather at the Ice-cap station, but there are also occasions when the M.S.L. isobars could not be so used. Some evidence for the existence of " fronts " of a kind crossing the inland ice is found. The difference between the temperatures of air at the Ice-cap and Base stations corresponds remarkably closely with a " saturated adiabatic " lapse rate when strong winds blow uphill between the two stations, and less closely with a " dry adiabatic " lapse rate when they blow downhill.

From what has been published of the results of the observations made by the German expedition, under the leadership of the late Alfred Wegener, at a station on the ice-cap 275 miles farther north during the same winter, it appears that the observations at the British station may be representative only of conditions on the southern part of the ice-cap. Tables and diagrams of the observations are given, therefore, for use in further investigations.

S. T. A. Mirrlees.

OFFICIAL NOTICES

Discussions at the Meteorological Office

The series of meetings for the discussion of recent contributions to meteorological literature, especially in foreign and colonial journals, were resumed at the Meteorological Office, South Kensington, for the session 1934–5, on Monday, October 15th. The subject for this meeting was a paper by H. U. Sverdrup, entitled " The Norwegian North Polar Expedition with the ' Maud,' 1918–25, Scientific Results, Vol. II, Meteorology." The discussion was opened by Dr. G. C. Simpson, C.B., F.R.S.

The meeting are held on alternate Mondays at 5 p.m. The subjects for the next two meetings are :—

October 29th, 1934. *A survey of the air currents in the Bay of Gibraltar, 1929–30.* By J. H. Field and R. Warden (London, Meteor. Off., Geophys. Mem. Vol. 7, No. 59, 1933). *Opener*—Mr. J. S. Dines, M.A.

November 12th, 1934. (1) *Aerological investigations of atmospheric disturbances with special reference to processes in the stratosphere.* By E. Palmén (Helsingfors, Mitt. Met. Inst. Univ., No. 25, 1933) (in German), and (2) *On the distribution of temperature in the stratosphere and its influence on the dynamics of weather.* By E. Palmén (Meteor. Zs., Braunschweig, **51,** 1934, pp. 17–23) (in German). *Opener*—Mr. C. K. M. Douglas, B.A.

The dates for subsequent meetings are as follows :—

November 26th and December 10th, 1934 ; January 14th and 28th; February 11th and 25th; and March 11th, 1935.

The Director of the Meteorological Office wishes it to be known that visitors are welcomed at these meetings.

Course of Training for Observers

Provided enough applications are received, an elementary course of training for meteorological observers and deputy observers at climatological stations in connexion with the Meteorological Office (including stations that come under the Health Resort Scheme) will be held at the Meteorological Office, Exhibition Road, South Kensington, on Tuesday and Wednesday, November 27th and 28th, 1934. The Course is intended primarily for beginners, and for those who have not yet taken observations in accordance with official regulations.

There will be no fee. Travelling and other incidental expenses incurred by observers attending the Course will not be paid by the Meteorological Office. Applications for admission to the Course should be made before November 1st to The Director (M.O.7), Air Ministry, Kingsway, London, W.C.2.

OFFICIAL PUBLICATIONS

The following publications have recently been issued :—

Annual Report *of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council for the year ending March* 31*st*, 1934.

Much of the work of the Meteorological Office deals with the rapid collection of observations of weather on and above a large part of the earth's surface, both land and sea, and the marshalling of the information so obtained to give a picture of the conditions existing at any moment. This information is used for answering inquiries about " weather " as well as forming the basis for a large variety of forecasts. The efficient performance of this work, involving the interchange of weather information by wireless telegraphy over most of the northern hemisphere, requires an elaborate international organisation, which is described in detail in the first part of this report, together with a summary of the use made of the information for forecasting and otherwise. The demands for information continue to grow, and the number of " weather " inquiries rose from 8,705 in 1932–3 to 10,166 in 1933–4, these figures being exclusive of inquiries relating to aviation and climate.

Other features of the report describe the various special investigations which were in progress during the year, especially a series of researches at Kew Observatory into problems of atmospheric electricity, airwaves from gunfire, and visibility. The report also refers to the various activities in connexion with the International

Polar Year 1932–3, which were described in greater detail in the preceding report. In October 1933 the British party returned safely from Fort Rae in Canada with complete records of work in all branches of meteorology, and these records are now being tabulated and analysed.

PROFESSIONAL NOTES

No. 66. *Lightning and Aircraft.* By G. C. Simpson, C.B., F.R.S. (M.O. 336f).

There is always some electrical force in the earth's atmosphere, especially near the surface, and the first part of this paper describes the electrical effects which may be expected to accompany various types of weather. The generation of lightning and the ways in which the presence of aircraft may influence an electric discharge are then discussed and lastly the dangers to, and the measures of protection that can be adopted for aeroplanes, airships and kite balloons, are considered separately. The general conclusion is that "on aeroplanes without aerials there is practically no danger to the personnel .... the position, however, is much more serious if the machine has a trailing aerial .... the most important thing, therefore, to be done when it is known that the plane is in a danger area or is about to enter a danger area is to withdraw the aerial." Even though not actually struck, an aeroplane including metal parts not connected by conductors may collect charges able to give unpleasant though not dangerous shocks.

No authentic case is on record of an aeroplane having been wrecked as the result of being struck by lightning, and since January, 1925, when the first report of a British aeroplane being struck by lightning was made, only ten cases have been reported. A short account of each of these occurrences is given in the first appendix and a second appendix contains the report of the committee which examined the problem of the protection of R.101 from the risks of lightning.

Correspondence

To the Editor, *Meteorological Magazine*

Waterspout seen from Pentonwarra

At 8h. 55m. G.M.T. (9h. 55m. B.S.T.) on September 25th 1934, a waterspout was seen about two miles north-north-east of Pentonwarra Point, Trevone, Padstow, Cornwall. There was a fairly thick but partially broken up layer of fracto-cumulus moving north-east and from a dark portion of this, but by no means a stormy looking portion, there descended a thin pencil, almost straight, of tube-like structure, the sides darker than the centre and hanging down to near the edge of the cloud below which was clear sky. It was only noted because the clouds were being looked at at the time for the purpose of the 9h. meteorological record. As soon as its nature was realised a look at the sea revealed the other end in the shape of a small dish-shaped disturbance estimated at 12 to 15 feet in height and perhaps 20 feet in diameter. It was rather like the shape shown by an instantaneous photograph of the formation of a splash made by a drop of water on a water surface, but of course there were no sharp edges but rather a splash of water more intense at the edges than the centre. It moved at perhaps 12 m.p.h. towards the north-east, i.e., with the wind which was force 4 from the south-west. No connexion between the cloud and sea ends was seen except a slight rainbow coloured band for a few seconds above the sea but about 4 times as wide at least as the spout. No funnel shape widening of the spout at the cloud end was noted. It was quite a delicate structure and during the 7 minutes or so of its visibility partially disappeared at times and then reformed. The cloud spout was ahead of the water spout but did not point in its direction.

W. M. LINDLEY.

Pentonwarra, Trevone, Padstow, Cornwall, September 25th, 1934.

Cloudburst in Vallay

On Saturday, September 1st, about 5 p.m., there was a cloudburst in the island of Vallay. It came down for 10 minutes in torrents and all who were out in it where it fell were soaked to the skin. The curious thing is that it did not fall on the south side of my house where I keep the rain-gauge, and on the following morning the rain taken was only ·05 in. The distance from the rain-gauge to where the rain fell was only 70 yards. It fell to the north of the gauge close to the back door of the house. This seems a curious enough occurrence to record to you.

GEORGE BEVERIDGE.

Vallay, Lochmaddy, North Uist, Hebrides, September 7th, 1934.

Rainfall in Westmorland

The enclosed figures for the rainfall here for some days in September may interest you :—

September 22nd 1·7 inches.
,, 26th 1·1 ,,
,, 30th 1·88 ,,

In the last case heavy rain began about noon and lasted till midnight, accompanied by a strong south wind.

The total rainfall, September 23rd–30th was 5·8 inches, as measured in my own gauge. Windermere Lake is very full, the piers for motor-boats being completely under water. Thirlmere, however, is still very much below its normal level.

E. M. BULLOCK.

St. Rule, Windermere, Westmorland, October 1st, 1934.

Halo Phenomenon seen from Grayshott

While at Grayshott, Hindhead, on August 24th, I observed the halo phenomenon here described. At 8h. 46m. G.M.T. there were small areas of the sky occupied by very thin cirro-stratus. Directly above the sun was a perfectly straight spectral band, its length subtending an angle of about 30° at the observer's eye. Its colours were red nearest the sun and blue outside. Its nearest approach to the sun was about 22° and consequently I took it for an upper arc of contact to the 22° halo, which had not yet appeared. The band justifies mention on account of its straightness. There was no sign of curvature even at the point where one could imagine it to touch the absent 22° halo. Another interesting feature was the fact that it was not horizontal—the left hand end was appreciably lower than the right. Mr. A. Moon describes a similar occurrence in the *Meteorological Magazine* for January, 1931, pp. 287–9.

As time went on the band slowly curved down, by reason of the growing altitude of the sun. This change of the shape of the tangent arc is discussed fully by Dr. Whipple in the *Meteorological Magazine*, June, 1932, pp. 109–11. At 9h. 30m. the arc had become very faint, and not until it had completely vanished did the 22° halo appear.

All the observations were made with the aid of spectacles of Crookes glass, which I find invaluable in the study of optical displays.

S. E. Ashmore.

19, *Vicarage Road, Handsworth, Birmingham. August 26th,* 1934.

Anti-Solar Rays

The rays referred to by Mr. W. L. Baxter in the June issue of the *Meteorological Magazine* were presumably the anti-solar or crepuscular rays described (with an accompanying sketch) by Mr. G. A. Clarke in the *Meteorological Magazine* for February, 1923. The phenomenon is mentioned in the following issues of this publication :—

June, 1923 ; September and December, 1925 ; January and September, 1926.

Also in the April, 1923, issue, Mr. C. F. Talman refers to the voluminous literature on the subject.

These rays are quite often seen during the summer months in the hilly regions of the North-west Frontier Province and Kashmir. The irregularities in the western horizon, the almost daily formation of cumulus clouds on the mountain ranges and the frequent dustiness of the atmosphere, all favour the appearance of this phenomenon.

I observed these rays myself at Gulmarg on August 15th and 16th, and on September 12th and 16th, 1931 ; at Thandiani on August 22nd, and September 4th, 5th, 6th and 7th in 1932, and on August 18th, 1933. This year I had the good fortune to see the rays on eleven consecutive days, from July 14th to 24th inclusive, at Ganderbal in the vale of Kashmir. On each occasion the visibility at Ganderbal was good, and the sky was clear except for a little detached cumulus over very high peaks to the north. The rays appeared to occupy the same positions every evening but to vary in intensity. By climbing an adjacent hill it was possible, owing to the uneven spacing of the rays, to identify one or two of the most prominent peaks which produced the most conspicuous shadows. The rays extended well beyond the zenith, lasted from ten to twenty minutes and varied from purple to pink in colour.

An examination of the observations made at stations to the west of Ganderbal (e.g. Peshawar, nearly 200 miles away) showed that there was considerable dust-haze every day from July 14th to 24th and also occasional dust-storms. The monsoon over the extreme north of India was very weak during this period. Similar conditions prevailed on the days when I observed the rays in 1931–3, but on these occasions, except for the four consecutive days in September, 1932, the effect was apparently due to broken belts of cumulus cloud lying very low on the western horizon.

R. G. VERYARD.

No. 1 (Indian) Group Headquarters, R.A.F., Peshawar, August 26th, 1934.

Remarkable Cloud Movements

The article in the May *Meteorological Magazine* on the above and especially the references, p. 85, to a warm front effect, and p. 86, to possible wave motion, makes me wonder whether a "cloud ripple," which I observed on December 23rd,* 1883, and which I was puzzled how to explain, may have any bearing on the subject. A description and sketch will be found on p. 44, vol. I, "History and Work of the Warner Observatory, Rochester, N.Y. (1883–1886)," in a paper by me on "The Recent Sky-glows." After referring to Kiessling's correlations between them and abnormally high temperatures at Säntis, north-east Switzerland, at 3,300 feet I continued :—

"The following confirms independently the existence of such marked lines of contact. On December 23rd,* 1883, the writer observed at 2.45 p.m. a ripple of clear sky $\frac{1}{4}°$ to $\frac{3}{4}°$ broad, traversing a beautifully marked lofty cirrus above the sun, travelling 90° in 10 minutes, ending 40° to 50° long. The cloud, as this passed along, melted entirely except in its densest portions, which turned from opaque dark to transparent white. Evidently the crest of a lofty warm wave penetrated right through the cirrus cloud, which was fringed with exquisite bands."

The last point is a significant indication of its great height. By

---

*As below the figure; 25th in the text is a printer's error.

the sketch and my diary I see that the base of the cloud was twice the height of the sun from south by west to west-south-west; the upper margin was about six times the sun's height; the extremes at south and west about five times. There was a background of clear sky and the ripple is described as blue. The upper edge was from 30° to 40° altitude. The ripple began at the west ending due south at its top, convergent all through below by perspective. There was a slight brief rose glow at 2.52 p.m. The sun, golden, touched the horizon at 3.34. Similar clouds, forming between 2.30 and 3, joined the former cloud up to the zenith in the west; "now again dissolving and changing to (and ? being obscured by) cirro-stratus and cumulus at lower level, rosy tipped by sun."

No record is entered as to a glow or after-glow. On the 22nd there was a fair glow at 4.50 to 5.5 up to 60°. On the 25th it was bright, small print legible at 4.35; the after-glow pronounced at 4.55 but Porrs' comet visible at 4.57, when the smallest print of the Weekly Report of the Meteorological Office was still legible at the window.

J. EDMUND CLARK.

Street, Somerset. May 25th, 1934.

Peculiar Features of the Summer of 1934

Although superficially the summer of 1934 has borne a good deal of resemblance, especially in the early part, to that of 1933, its detailed meteorological topography, so to speak, has been very distinct. Two very unusual features call for comment. The first was the geographical distribution of great heat during the first half of July. Ordinarily London and the south-east are as hot as any part of the country during a heat wave, and often hotter. In July, 1934, however, a very vigorous easterly wind off the North Sea prevented the temperature from rising much above 80° F. anywhere on the eastern side of England, notwithstanding cloudless skies. On the western side of England, on the contrary, from Lancashire to Devonshire, the temperature frequently rose to the vicinity of 90°.

The second remarkable feature was the persistent high winds of the last week in July and first three weeks in August. The strong westerly winds with cool temperature made August a more bracing month inland than it often is, but their strength at times was a little disconcerting to campers and others on holiday. Besides a number of more or less widespread gales or semi-gales there was a good deal of rather puzzling local high wind. Thus at Handcross, on the forested Wealden heights of Sussex, where I happened to be, there sprang up suddenly during the night of August 7th, a high NE. wind which lasted about two hours and then quite suddenly subsided to be followed by a calm and sultry day. The weather chart for the morning of the 8th showed a light gradient for northerly winds, and there did not appear to be thunderstorms anywhere near such as might account for the local gale during the night. On the 10th at the same place a SW. gale from the channel blew all day accompanied by a heavy driving drizzle, probably in part of " orographic " origin.

L. C. W. BONACINA.

35, Parliament Hill, London, N.W.3, August 28th, 1934.

NOTES AND QUERIES

The Typhoon in Japan

A typhoon, said to be the most severe since 1917, swept across south-west Japan on September 21st, and maintained its intensity there during most of the day. It first struck Nagasaki in the extreme south-west of Japan in the early morning, and then passed north-eastwards to the neighbourhood of Wakasa Bay about 400 miles distant. The velocity of the winds is said to have reached 60 m/s or over 130 m.p.h. In *The Times* of October 2nd, the London representative of the *Asahi* gives the latest figure as 4,232 killed and 36,051 injured, with a total of 8,789 houses completely demolished and 18,405 houses partly demolished. He says " the most striking fact is the great number of schools which collapsed and of school children killed or injured." Some 3,000 ships were damaged. The effect of the typhoon was felt most severely in Osaka, Kyoto and Kobe. In Japan typhoons may be experienced at any time of the year. They are, however, rare in January to March, and most frequent in the relatively calm periods in which no prevailing winds exist, i.e., in August and September, the period of transition of the monsoon. The typhoons which reach Japan originate generally in the Marshall and Marianne Islands, move in a westerly direction at first, then recurve and travel north-east to the neighbourhood of Japan. By the time they are north of the 30° parallel, in the temperate latitudes in which Japan lies, they usually increase in size and diminish in intensity as they move north-east. This recent typhoon was followed as usual by huge tidal waves which penetrated a considerable distance inland. Heavy rain also caused floods in the surrounding country which destroyed bridges, caused damage to the crops and flooded thousands of houses.

REVIEWS

Red-shifts in the spectra of nebulae, being the Halley Lecture delivered on 8 May 1934. By Edwin Hubble. Size 9 × 6 in., pp. 17. *Illus.* Published by Mr. Milford at the Clarendon Press, Oxford, 1934. 2*s.* net.

This Halley Lecture is of absorbing interest to all who follow, even as the veriest amateurs, the most modern science of astrophysics. It is concerned with the attempt to verify the startling theory of an expanding universe, from the observed fact that the dark lines in the spectra of nebulae are shifted towards the red end of the spectrum. Such a "red-shift" is a logical result of rapid motion away from us, and apart from the assumption that some quite new and unrecognised physical principle is in operation, the observations can only mean that the more distant nebulae are rushing outwards at some thousands of miles a second. The investigation is not without its difficulties however, and apart from its cosmological fascination, it has the interest which must always attach to the development of new methods to meet new problems. The study of nebulae is regarded as a gigantic piece of sampling, and the mathematical treatment, which is quite simple, is based on this assumption. That nebulae, like molecules, can be discussed in terms of the law of averages may be obvious, but is none the less unexpected.

Batavia, K. Magn. en Meteor. Observatorium. Verh. No. 26. Further researches into the possibility of long-range forecasting in Netherlands India. By H. P. Berlage. Jr. *Verh.* No. 27. Daily forecast of wind-force on Java. By J. Boerema. Batavia, 1934.

In the first of these papers Dr. Berlage examines the theoretical basis of various ideas of seasonal forecasting. Analysis of Sir Gilbert Walker's "oscillations" shows that they can practically all be expressed as oscillations between a high-pressure centre and a low-pressure centre. Such oscillations differ in character according to whether the high-pressure centre is in colder or warmer regions than the low-pressure centre. If the high-pressure centre is the colder, the equilibrium of the system is stable and any deviations set up a closed cycle. The best example of this is the 3-year "Southern Oscillation" between the sub-tropical South Pacific high and the tropical low centred near Darwin in January and Bombay in July. If on the other hand the high-pressure centre is the warmer, the system is not stable and the oscillations become violent but irregular, as in the Azores-Iceland oscillation.

The 3-year oscillation, however, is not persistent but breaks down from time to time, and studies of tree-rings in Java from 1519 to 1929 shows that its average length is 3·32 years. Nevertheless the author considers that it is a real 3-year period which suffers disturbance by a 7-year oscillation natural to the Pacific and represented by the 7-year recurrence of rainfall in Peru and Ecuador. He regards these, and an oscillation of 2 years, as almost the only natural weather periods of terrestrial origin, and remarks that "of those many weather-periodicities revealed by harmonic analysis most are to be interpreted as compromise phenomena of only a few long-periodic cycles having a clear physical significance." The 3-year oscillation is definitely of tropical origin. It would seem that these oscillations should give a promising basis for long-range forecasting, but the difficulty is that they are probably started and controlled by variations of solar radiation which cannot be foreseen. The author concludes that while "the view of this paper on the practical attempts to forecast the character of coming monsoons is a rather pessimistic one," there are many hopeful pointers for future research.

The second paper, by Dr. J. Boerema, gives an interesting example of a local forecast based purely on statistical considerations. In tobacco-drying it is useful to have an estimate of the wind velocity during the day. At 7h. the surface velocity at Batavia is small, but with the increasing elevation of the sun there is an exchange of air with higher levels by convection, and the velocity at the ground increases rapidly. It was found that the velocity at 1,000 m. at 7h. obtained by pilot balloon, gave an indication of the ground velocity to be expected later in the day, and experiments are being carried out with a view to making practical forecasts on this basis.

BOOKS RECEIVED

Monthly Rainfall of India for 1930. Published by the various Provincial Governments and issued by the Meteorological Dept., Calcutta, 1932.

Anales del Observatorio Nacional de San Bartolomé en los Andes Colombianos. Observaciones meteorologicas de 1931. Bogotá 1933.

OBITUARY

Charles Henry Kellett, B.Sc.—The news of the death, from pneumonia, on September 8th, 1934, of C. H. Kellett, came as a great shock to his colleagues in the Meteorological Office. He had been on leave for about a fortnight, and none of his friends knew of the illness which proved fatal.

Kellett was born in Yorkshire on November 16th, 1887. He went to Baines's Grammar School, Poulton-le Fylde, and received his later general scientific training at the Manchester School of Technology and London University. For a few years before the War he was a science and mathematics master at the Warehousemen and Clerks Schools, Cheadle Hulme, Cheshire. During the War he served in the Special Brigade, Royal Engineers, on the Western front, and later, a few months before the Armistice, proceeded to No. 5 Officers' Cadet Battalion at Cambridge. On being appointed to the professional staff of the Meteorological Office in April, 1919, he was resident observer at Kew Observatory until the close of 1923, when he was transferred to Eskdalemuir Observatory. His tour of duty there, broken only by a few weeks spent at Lerwick Observatory, continued until nearly the end of 1928, after which time he served in the Forecast and Aviation Services Divisions at Headquarters and at Croydon.

Kellett was a very loyal colleague with whom it was a pleasure to work. His likeable and genial personality, his faculty of co-operation and of rising above the common difficulties and irritations of life endeared him to all sections of the staff and to a much wider circle. His general sociability, his interest in music and games counted for much in the small community at Eskdalemuir and among his friends in that district. He was a prominent member of the old boys' association of his school and was recently the president of the London branch.

We grieve the untimely passing of a friend, and extend to Mrs. Kellett and her two infant daughters our deepest sympathy in their great loss.

We regret to learn of the death on August 11th, 1934, of Nicolas G. Martinez, Director of the Meteorological and Astronomical Observatory at Quito, Ecuador.

NEWS IN BRIEF

We learn that Prof. F. Akerblom retired from the directorship of the Meteorological Observatory at Upsala on September 3rd, 1934, and that Herr Hilding Köhler, of the University of Upsala is, in the interim, acting as Director.

We learn that Heer P. M. van Riel, Director of the Oceanographic and Marine Meteorological Department of the Royal Dutch Meteorological Institute at De Bilt, has been appointed Director of the Meteorological Office at Amsterdam in place of the late Heer P. H. Gallé.*

Erratum

September, 1934, p. 192. The whirlwind at Horndon-on-the-Hill occurred on Sunday, August 12th, 1934, not on Sunday, August 17th, as stated.

The Weather of September, 1934

Pressure was above normal over Spitsbergen, most of Europe, the Mediterranean, Madeira, the Azores, western North Atlantic, the Atlantic coasts of the United States, Newfoundland, Canada and Alaska, the greatest excesses being 10·5 mb. at Waigatz and 6·3 mb. at Kodiak. Pressure was below normal over most of the United

---

*See *Meteorological Magazine* **69**, 1934, p. 124.

States, the eastern North Atlantic, Jan Mayen, Iceland, the British Isles and western France, the greatest deficits being 8·4 mb. at Reykjavik and 2·8 mb. at 30° N., 100° W. Temperature was considerably above normal in northern and central Europe but below normal in Portugal, while rainfall was in excess generally and nearly twice the normal in the neighbourhood of Värmland, Sweden.

The weather of September over the British Isles was generally unsettled but sunnier than usual. Rainfall was in excess in Scotland, Ireland and parts of south-west England and the Midlands, but still deficient in the south and east. From the 1st to the 4th depressions passed across the country and the weather was generally unsettled and thundery with heavy rain locally but bright intervals, 1·38 in. of rain fell at Compton (Sussex) and Holne (Devon) on the 2nd. Gales occurred in the north and west on the 3rd and thunderstorms in many places on the 1st, 3rd and 4th. Fog was experienced locally in the early morning. On the 5th there was a change to fine sunny weather as the anticyclone extending over most of Europe had moved also across the British Isles. Over 10 hrs. bright sunshine were experienced over most of the country with 11·8 hrs. at Nairn and Troon and 11·6 hrs at Hastings and Dunbar. On the 6th however another depression was advancing from the Atlantic and the weather again became unsettled until the 10th. Thunderstorms occurred in eastern England and north Scotland on the 8th—at Kirkwall, Orkney, 0·75 in. of rain fell during a thunderstorm in ¾ hr. Except locally in Scotland (Dumfries had 1·29 in. on the 8th) the rainfall during this period was slight or moderate and the bright intervals long though mist or fog occurred at times. The 7th was the warmest day when 83° F. was recorded at Maldon, 82° F. at Tunbridge Wells and 81° F. at Norwich. As the depression moved away northwards on the 11th, strong winds and gales were experienced in the extreme north-west but the anticyclone over northern and central Europe was advancing over the British Isles at the same time and the weather became fair or fine and warm generally over the whole country from the 11th–15th except for local fog or mist which persisted through part of the day occasionally in the Midlands, north-east England and east Scotland. Temperature was generally above normal, reaching 82° F. at Cambridge on the 13th and Greenwich on the 15th and exceeding 80° F. in several parts of the south and Midlands on the 13th and 14th; minimum temperatures also rose over 60° F. in parts of the south. On the night of the 14th the approach of a depression caused rain in Ireland and this spread slowly across Scotland and England the following day. From then until the 30th depressions continued to move north-eastwards across the country giving unsettled weather with heavy rain at times but long bright sunny intervals especially in the south-east. The heaviest rainfall was generally on the 15th, 16th and 30th, 1·79 in. fell at Trowbridge (Wilts) on the 15th, 1·85 in. at Florencecourt (Co. Fermanagh) on the 16th and 3·49 in. at Borrowdale

(Cumberland) followed by floods and 4·16 in. at Snowdon (Carnarvon) on the 30th. Sunshine records were variable but exceeded 10 hrs. on a few days, Lerwick had 11·3 hrs. on the 18th, Lowestoft 10·7 hrs. on the 25th and 28th, and Ilfracombe and Rhyl 10·5 hrs on the 25th and 18th respectively. Thunderstorms were experienced locally on the 15th–17th and again on the 29th and gales occurred at exposed places in the west and north. Temperature was generally about normal during this period, but the 28th was an outstandingly warm day, 81° F. was reached at Cambridge and Greenwich, followed by a warm night. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	115	+ 1	Liverpool ...	142	+11
Aberdeen ...	143	+19	Ross-on-Wye ...	141	+ 5
Dublin	150	−17	Falmouth ...	152	− 8
Birr Castle ...	132	+13	Gorleston ...	204	+46
Valentia... ...	123	− 1	Kew	186	+41

Miscellaneous notes on weather abroad culled from various sources.

A severe storm accompanied by hail swept over south-west France on the 1st, killing several persons and causing much damage to property and crops; the wind at Perpignan is stated to have reached 112 m.p.h. This was followed by a sudden drop in temperature generally in France and snow fell in the Pyrenees. A violent storm passed across central Switzerland on the 9th, causing dislocation of traffic by the blocking of roads and railways, and inundating many houses. Cloudbursts on the 17th caused much damage in the Saxon mountain district of Luchau and Glashütte—in some places the hailstones were lying 3 ft. deep. Hot weather was experienced in Finland just after the middle of the month.

Egypt is stated to have experienced the highest Nile flood for over 40 years. Many towns and villages and some of the suburbs of Cairo were partly inundated and the Nile water level was prevented from rising even higher only by holding up a certain amount of water in the Aswan reservoir and by the Delta barrage. By the 11th the water level was falling rapidly on the Upper Nile.

Gales were experienced over the greater part of Manchuria about the 1st. The flood waters were rapidly draining away from most parts of Bihar by the 3rd. West of Rajshabi the embankments of the Ganges gave way and hundreds of villages were reported on the 3rd to have been flooded. The monsoon was generally weak in India during the first part of the month, becoming strong in Burma, and strengthening in north-east India by the middle of the month but continuing weak elsewhere until the end of the month. A severe typhoon was experienced in south-west Japan on the 21st (see p. 219).

Continual rain and snow seriously impeded the harvest in the prairie areas of Canada about the 20th, and again on the 24th. Damage had also been done to the grain by frosts earlier in the season. Temperature was above normal at first in the western United States and below normal generally elsewhere but later warmth spread in from the Atlantic seaboard and extended over the southern States while temperature in the north-western States became considerably below normal. Rainfall was mainly variable but considerably above normal in the eastern States in the middle of the month.

Daily Readings at Kew Observatory, September, 1934

* Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
	mb.		°F.	°F.	%	in.	hrs.	
1	1006·9	W.2	45	65	41	—	9·1	F early.
2	1008·7	SSW.3	44	66	49	0·02	8·4	r_0–r18h.45m.-19h.35m
3	1010·5	SW.4	57	70	57	0·56	7·0	r–r_0 0h. 40m.–6h. 25m.
4	1018·4	SW.4	55	68	61	trace	2·8	pr_0 17h. 45m.
5	1025·6	W.2	49	68	48	—	10·6	
6	1021·4	E.3	48	69	48	—	6·3	F f early
7	1014·0	S.2	59	79	64	—	9·7	
8	1011·3	SW.4	62	73	55	0·08	5·0	r_0–r 19h.–23h.
9	1012·2	WSW.4	58	67	60	trace	7·9	pr_0 9h. 20m.
10	1021·6	SW.2	46	68	59	—	9·9	
11	1025·4	SW.2	47	70	52	—	8·9	f early.
12	1028·2	ESE.2	53	71	51	—	6·5	f early.
13	1023·8	ENE.3	58	79	61	—	6·4	f early.
14	1019·7	E.4	61	79	44	—	10·0	M z early.
15	1012·4	S.2	60	81	59	0·02	7·1	fz early; T16h.; r19h. [–20h.
16	1016·6	SW.4	59	71	52	—	8·9	
17	1012·7	SSW.5	56	72	58	trace	6·6	pr_0 15h. and 16h.
18	1016·2	SSW.3	52	68	54	trace	2·0	pr_0 18h.
19	1010·9	SW.4	48	65	62	0·06	6·6	r–r_0 20h. 20m.–23h.
20	1008·5	W.3	56	62	74	0·01	0·2	pr 12h. 50m.–13h.
21	1014·2	WNW.3	54	62	52	—	1·7	Z 21h.
22	1009·1	SSW.4	45	63	91	0·14	0·0	r–r_0 12h.–20h.
23	1013·6	WNW.4	48	61	52	—	7·6	
24	1002·6	S.5	51	61	87	0·20	0·1	r_0–r 9h.–11h.; R 15h. [15m.–40m.
25	1018·1	WSW.2	45	62	54	—	8·6	
26	1011·3	SW.5	50	65	74	0·01	0·7	$r_0$18h.; $rr_0$20h. 25m.– [45m
27	1023·3	SW.2	47	64	54	—	9·0	
28	1016·6	SSE.3	57	77	58	—	8·2	
29	1013·7	S.4	64	72	71	0·16	1·9	r 16h. 30m.–17h. 45m.
30	1021·3	S.5	49	65	61	—	8·2	
*	1015·6	—	53	69	59	1·26	6·2	* Means or totals.

General Rainfall for September, 1934

England and Wales ...	109	per cent of the average 1881–1915.
Scotland	134	
Ireland	208	
British Isles	134	

Rainfall : September, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.........	2·78	153
Sur .	Reigate, Wray Pk. Rd..	1·79	86
Kent .	Tenterden, Ashenden...	1·47	69
,, .	Folkestone, Boro. San.	2·34	...
,, .	Eden'bdg., Falconhurst	1·81	80
,, .	Sevenoaks, Speldhurst.	1·28	...
Sus .	Compton, Compton Ho.	3·07	110
,, .	Patching Farm..........	1·75	73
,, .	Eastbourne, Wil. Sq....	1·63	65
,, .	Heathfield, Barklye....	2·21	90
Hants.	Ventnor, Roy.Nat.Hos.	2·87	116
,, .	Fordingbridge, Oaklnds	2·69	125
,, .	Ovington Rectory.......	2·41	105
,, .	Sherborne St. John......	1·62	79
Herts .	Welwyn Garden City ...	2·15	119
Bucks.	Slough, Upton...........	1·41	80
,, .	H. Wycombe, Flackwell	1·99	102
Oxf .	Oxford, Mag. College...	2·09	124
Nor .	Pitsford, Sedgebrook...	2·74	152
,, .	Oundle	1·51	...
Beds .	Woburn, Exptl. Farm...	2·05	114
Cam .	Cambridge, Bot. Gdns.	1·84	114
Essex.	Chelmsford, County Lab	·95	55
,, .	Lexden Hill House......	1·27	...
Suff .	Haughley House.........	1·77	...
,, .	Campsea Ashe...........	1·70	89
,, .	Lowestoft Sec. School...	1·69	86
,, .	Bury St. Ed., WestleyH.	1·54	77
Norf. .	Wells, Holkham Hall...	1·49	78
Wilts .	Calne, Castleway.........	2·77	134
,, .	Porton, W.D. Exp'l. Stn	1·65	94
Dor .	Evershot, Melbury Ho.	3·94	148
,, .	Weymouth, Westham.	2·59	125
,, .	Shaftesbury,Abbey Ho.	2·43	100
Devon.	Plymouth, The Hoe....	3·32	130
,, .	Holne, Church Pk. Cott.	6·03	168
,, .	Teignmouth, Den Gdns.	2·33	117
,, .	Cullompton	3·05	135
,, .	Sidmouth, U.D.C........	2·35	...
,, .	Barnstaple, N. Dev.Ath	3.33	123
,, .	Dartm'r,Cranmere Pool	6·30	...
,, .	Okehampton, Uplands.	4·71	145
Corn .	Redruth, Trewirgie......	3·91	125
,, .	Penzance, Morrab Gdn.	3·41	116
,, .	St. Austell, Trevarna...	4·23	133
Soms .	Chewton Mendip.........	4·62	150
,, .	Long Ashton............	2·55	107
,, .	Street, Millfield..........	2·46	109
Glos .	Blockley	2·08	...
,, .	Cirencester, Gwynfa....	3·19	145
Here .	Ross, Birchlea...........	1·91	100
Salop.	Church Stretton.........	2·58	127
,, .	Shifnal, Hatton Grange	1·75	91
Staffs.	Market Drayt'n, Old Sp.	1·81	89
Worc .	Ombersley, Holt Lock.	1·62	92
War .	Alcester, Ragley Hall...	1·82	102
,, .	Birminghm, Edgbaston	2·07	116
Leics .	Thornton Reservoir ...	1·62	89
,, .	Belvoir Castle............	1·28	68
Rut .	Ridlington	1·76	92
Lincs .	Boston, Skirbeck.........	1·24	70
,, .	Cranwell Aerodrome...	1·06	60
,, .	Skegness, Marine Gdns.	1·17	65
,, .	Louth, Westgate.........	1·52	75
,, .	Brigg, Wrawby St.......	1·89	...
Notts .	Worksop, Hodsock......	1·37	90
Derby.	Derby, L. M. & S. Rly.	2·00	121
,, .	Buxton, Terr. Slopes...	4·15	128
Ches .	Runcorn, Weston Pt....	2·25	84
Lancs.	Manchester, Whit. Pk.	2·50	105
,, .	Stonyhurst College......	4·21	110
,, .	Southport, Bedford Pk.	3·22	117
,, .	Lancaster, Greg Obsy.	5·24	155
Yorks.	Wath-upon-Dearne......	1·68	106
,, .	Wakefield,Clarence Pk.	1·82	114
,, .	Oughtershaw Hall.......	5·20	...
,, .	Wetherby, Ribston H..	2·53	141
,, .	Hull, Pearson Park......	1·67	97
,, .	Holme-on-Spalding......	2·17	125
,, .	West Witton, Ivy Ho.	2·27	106
,, .	Felixkirk, Mt. St. John.	1·91	105
,, .	York, Museum Gdns....	1·43	88
,, .	Pickering, Hungate......	1·26	66
,, .	Scarborough..............	1·64	92
,, .	Middlesbrough...........	1·72	104
,, .	Baldersdale, Hury Res.	2·43	97
Durh .	Ushaw College...........	1·76	88
Nor .	Newcastle, Town Moor.	1·13	55
,, .	Bellingham, Highgreen	2·31	96
,, .	Lilburn Tower Gdns....	1·49	63
Cumb.	Carlisle, Scaleby Hall...	4·06	150
,, .	Borrowdale, Seathwaite	16·25	173
,, .	Borrowdale, Moraine...	13·35	178
,, .	Keswick, High Hill......	7·03	166
West .	Appleby, Castle Bank...	3·30	130
Mon .	Abergavenny, Larchf'd	2·02	86
Glam .	Ystalyfera, Wern Ho....	7·63	175
,, .	Cardiff, Ely P. Stn.......	3·70	119
,, .	Treherbert, Tynywaun.	8·40	...
Carm .	Carmarthen, Priory St..	5·61	162
Pemb .	Haverfordwest, School.	...	...
Card .	Aberystwyth	3·98	...
Rad .	BirmW.W.Tyrmynydd	4·61	119
Mont .	Lake Vyrnwy	5·17	146
Flint .	Sealand Aerodrome......	1·35	66
Mer .	Dolgelley, Bontddu......	4·90	115
Carn .	Llandudno	1·76	83
,, .	Snowdon, L. Llydaw 9..	21·10	...
Ang .	Holyhead, Salt Island...	3·67	137
,, .	Lligwy	5·36	...
Isle of Man	Douglas, Boro' Cem....	4·61	140
Guernsey	St. PeterP't.Grange Rd.	3·24	125

Rainfall: September, 1934: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	5·02	172	*Suth* .	Melvich	1·73	62
„ .	New Luce School	5·36	149	„ .	Loch More, Achfary	5·64	98
Kirk .	Dalry, Glendarroch	6·45	175	*Caith* .	Wick	2·30	92
„ .	Carsphairn, Shiel	10·35	195	*Ork* .	Deerness	3·49	120
Dumf.	Dumfries, Crichton, R.I.	6·30	247	*Shet* .	Lerwick	3·17	105
„ .	Eskdalemuir Obs.	7·14	193	*Cork* .	Caheragh Rectory	8·90	...
Roxb .	Branxholm	3·27	146	„ .	Dunmanway Rectory	9·10	222
Selk .	Ettrick Manse	7.23	200	„ .	Cork, University Coll.	5·98	223
Peeb .	West Linton	2·75	...	„ .	Ballinacurra	6·82	270
Berw .	Marchmont House	2·62	109	„ .	Mallow, Longueville	6·06	252
E.Lot .	North Berwick Res.	1·67	80	*Kerry*.	Valentia Obsy.	8·06	194
Midl .	Edinburgh, Roy. Obs.	1·69	82	„ .	Gearhameen	11·90	195
Lan .	Auchtyfardle	3·67	...	„ .	Darrynane Abbey	5·82	163
Ayr .	Kilmarnock, Kay Pk.	4·94	...	*Wat* .	Waterford, Gortmore	6·09	223
„ .	Girvan, Pinmore	6·44	168	*Tip* .	Nenagh, Cas. Lough	5·82	207
Renf .	Glasgow, Queen's Pk.	4·57	165	„ .	Roscrea, Timoney Park	6·05	...
„ .	Greenock, Prospect H.	6·55	138	„ .	Cashel, Ballinamona	5·70	232
Bute .	Rothesay, Ardencraig	6·69	...	*Lim* .	Foynes, Coolnanes	4·41	158
„ .	Dougarie Lodge	5·88	...	„ .	Castleconnel Rec.	5·02	...
Arg .	Ardgour House	12·17	...	*Clare* .	Inagh, Mount Callan	7·75	...
„ .	Glen Etive	13·71	178	„ .	Broadford, Hurdlest'n.	5·91	...
„ .	Oban	6·90	...	*Wexf* .	Gorey, Courtown Ho.	5·08	205
„ .	Poltalloch	8·84	193	*Wick* .	Rathnew, Clonmannon.	5·42	...
„ .	Inveraray Castle	10·89	169	*Carl* .	Hacketstown Rectory	5·91	211
„ .	Islay, Eallabus	6·15	147	*Leix* .	Blandsfort House	6·01	221
„ .	Mull, Benmore	13·70	117	„ .	Mountmellick	...	...
„ .	Tiree	8·01	216	*Offaly*.	Birr Castle	5·02	219
Kinr .	Loch Leven Sluice	3·01	117	*Dublin*	Dublin, FitzWm. Sq.	2·81	146
Perth .	Loch Dhu	10·50	183	„ .	Balbriggan, Ardgillan	3·60	176
„ .	Balquhidder, Stronvar.	9·71	...	*Meath*.	Beauparc, St. Cloud	4·75	...
„ .	Crieff, Strathearn Hyd.	5·33	186	„ .	Kells, Headfort	4·65	175
„ .	Blair Castle Gardens	5·08	214	*W.M* .	Moate, Coolatore	5·13	...
Angus.	Kettins School	3·51	159	„ .	Mullingar, Belvedere	6·06	227
„ .	Pearsie House	5·08	...	*Long* .	Castle Forbes Gdns.	5·92	205
„ .	Montrose, Sunnyside	3·03	152	*Gal* .	Galway, Grammar Sch.	5·07	...
Aber .	Braemar, Bank	2·94	117	„ .	Ballynahinch Castle	10·19	214
„ .	Logie Coldstone Sch.	1·63	70	„ .	Ahascragh, Clonbrock.	5·86	189
„ .	Aberdeen, King's Coll.	2·90	131	*Mayo*.	Blacksod Point	...	...
„ .	Fyvie Castle	2·31	88	„ .	Mallaranny	8.09	...
Moray	Gordon Castle	1·43	57	„ .	Westport House	8·42	237
„ .	Grantown-on-Spey	...	...	„ .	Delphi Lodge	14·32	190
Nairn.	Nairn	1·16	53	*Sligo* .	Markree Obsy.	6·58	194
Inv's .	Ben Alder Lodge	5·90	...	*Cavan*.	Crossdoney, Kevit Cas.	6·48	...
„ .	Kingussie, The Birches	3·11	...	*Ferm* .	Enniskillen, Portora	6·07	...
„ .	Inverness, Culduthel R.	1·41	...	*Arm* .	Armagh Obsy.	4·62	188
„ .	Loch Quoich, Loan	...	...	*Down*.	Fofanny Reservoir	10·39	...
„ .	Glenquoich	13·88	160	„ .	Seaforde	6·93	252
„ .	Arisaig, Faire-na-Sguir.	9·55	...	„ .	Donaghadee, C. Stn.	5·55	232
„ .	Fort William, Glasdrum	9·54	...	„ .	Banbridge, Milltown	4·45	181
„ .	Skye, Dunvegan	9·79	...	*Antr* .	Belfast, Cavehill Rd.	5·03	...
„ .	Barra, Skallary	7·21	...	„ .	Aldergrove Aerodrome.	5·65	228
R&C .	Alness, Ardross Castle.	2·31	79	„ .	Ballymena, Harryville.	6·17	198
„ .	Ullapool	3·61	96	*Lon* .	Garvagh, Moneydig	6·13	...
„ .	Achnashellach	7·05	97	„ .	Londonderry, Creggan.	5·76	175
„ .	Stornoway	5·51	139	*Tyr* .	Omagh, Edenfel	6·75	221
Suth .	Lairg	1·71	60	*Don* .	Malin Head	6·43	...
„ .	Tongue	2·26	72	„ .	Killybegs, Rockmount.	...	...

Climatological Table for the British Empire, April, 1934

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1007·8	− 6·6	75	28	55·8	41·4	48·6	+ 1·3	42·4	85	8·0	1·46	+ 0·01	15	4·39	32
Gibraltar	1014·3	− 2·1	73	46	66·9	51·4	59·1	− 1·8	51·3	83	5·2	5·31	+ 2·62	14	...	...
Malta	1013·4	0·0	77	50	68·0	56·6	62·3	+ 1·4	56·8	75	4·4	0·27	− 0·59	4	9·06	69
St. Helena	1011·8	− 0·2	70	60	67·6	62·2	64·9	− 0·4	63·1	95	9·5	7·53	...	19	...	...
Freetown, Sierra Leone	1012·1	+ 1·3	91	64	87·4	68·5	77·9	− 4·5	76·7	83	7·4	2·09	− 1·97	6	...	...
Lagos, Nigeria	1010·1	+ 0·7	90	71	87·4	76·5	81·9	− 0·9	77·1	83	7·7	5·73	− 0·35	9	6·1	50
Kaduna, Nigeria	1006·0	...	105	67	93·9	71·8	82·9	+ 1·4	72·7	73	7·0	2·78	− 0·30	8	7·5	61
Zomba, Nyasaland	1012·5	0·0	83	56	79·6	62·8	71·2	+ 1·9	66·3	76	6·7	2·98	− 0·68	11	...	...
Salisbury, Rhodesia	1014·6	− 0·1	83	43	78·5	55·2	66·9	+ 1·2	59·8	65	3·0	1·76	+ 0·77	6	8·2	70
Cape Town	1016·9	+ 0·5	96	46	77·3	57·4	67·3	+ 4·1	58·7	84	4·5	0·16	− 1·71	5	...	...
Johannesburg	1016·5	+ 0·9	78	44	72·4	53·1	62·7	+ 2·7	53·4	60	4·2	0·64	− 1·10	5	8·1	70
Mauritius	1015·5	+ 1·5	85	64	83·3	69·8	76·5	+ 0·7	72·1	73	5·7	9·70	+ 5·23	21	8·2	71
Calcutta, Alipore Obsy.	1005·3	− 1·0	105	70	96·4	77·7	87·1	+ 1·5	78·0	82	4·3	1·95	− 0·23	4*	...	...
Bombay	1008·1	− 0·7	93	75	90·1	77·4	83·7	+ 0·6	76·6	77	2·6	0·00	− 0·05	0*	...	...
Madras	1007·4	− 1·0	102	71	92·1	77·6	84·9	− 0·4	78·7	77	5·6	0·74	+ 0·11	2*	...	...
Colombo, Ceylon	1009·4	+ 0·7	88	72	86·1	75·5	80·8	− 1·9	77·6	80	6·2	17·04	+ 7·31	17	7·3	59
Singapore	1008·7	− 0·2	90	70	86·6	73·6	80·1	− 1·5	77·0	80	7·6	3·62	− 4·01	16	6·4	53
Hongkong	1013·3	+ 0·7	85	55	72·8	64·9	68·9	− 1·9	65·6	81	9·6	2·45	− 3·20	15	1·8	14
Sandakan	1009·5	...	90	73	87·9	75·0	81·5	− 0·7	77·4	85	7·7	10·21	+ 5·72	19	...	...
Sydney, N.S.W.	1016·8	− 1·6	85	47	71·1	57·5	64·3	− 0·4	59·2	77	...	7·94	+ 2·42	18	6·8	60
Melbourne	1019·2	− 0·3	86	39	66·2	50·3	58·3	− 1·2	54·4	77	7·2	5·68	+ 3·51	20	3·6	32
Adelaide	1021·0	+ 1·1	91	42	70·8	53·3	62·1	− 1·8	55·2	60	6·1	1·51	− 0·22	13	5·4	49
Perth, W. Australia	1020·0	+ 1·6	80	53	73·9	57·2	65·5	− 1·3	57·3	63	4·6	1·28	− 0·37	7	7·3	65
Coolgardie	1019·6	+ 1·0	82	43	69·8	53·2	61·5	− 3·5	57·3	77	4·8	3·20	+ 2·24	9	...	...
Brisbane	1016·2	− 1·4	86	50	77·9	61·6	69·7	− 0·6	64·1	75	6·1	6·33	+ 2·56	16	6·1	54
Hobart, Tasmania	1019·0	+ 4·2	78	39	58·7	47·6	53·1	− 2·1	49·2	71	7·7	2·64	+ 0·79	22	3·0	28
Wellington, N.Z.	1021·1	+ 3·0	67	41	61·8	51·0	56·4	− 0·7	53·9	81	6·9	3·50	− 0·38	9	5·0	45
Suva, Fiji	1012·3	+ 1·7	89	71	84·5	73·8	79·1	+ 0·5	75·0	79	6·3	10·77	− 1·44	23	5·2	44
Apia, Samoa	1010·0	+ 0·1	89	70	85·5	74·0	79·7	+ 0·8	75·9	79	6·5	7·42	− 2·73	17	...	...
Kingston, Jamaica	1013·9	− 0·2	88	67	85·2	69·0	77·1	− 1·3	69·3	79	2·8	0·37	− 0·87	7	5·6	45
Grenada, W.I.	1010·7	− 1·8	90	72	86	72	79	+ 0·1	74	74	5	4·16	+ 2·00	13	...	...
Toronto	1014·0	− 2·1	71	27	50·0	34·1	42·1	0·0	36·2	70	6·9	2·42	+ 0·13	12	5·0	37
Winnipeg	1014·3	− 2·4	85	17	46·2	29·7	37·9	+ 0·2	30·5	79	6·6	0·64	− 0·76	4	5·7	42
St. John, N.B.	1015·9	+ 2·5	59	22	48·8	32·7	40·7	+ 1·7	36·5	77	5·8	5·42	+ 1·91	14	6·3	47
Victoria, B.C.	1017·6	+ 0·1	75	36	60·4	46·3	53·3	+ 5·4	49·1	77	4·9	1·06	− 0·46	11	8·2	60

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(22767) Wt.25/32 1000 10/34 Hw. G.377/6

(facing p. 229)

Dominion Photo

BALLOON CARRYING RADIO-SONDE BEFORE BEING RELEASED AT WELLINGTON, NEW ZEALAND, (SEE P. 238)

M.O. 371.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 69

Nov. 1934

No. 826

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: Adastral House, Kingsway, London, W.C.2; 120, George Street, Edinburgh 2; York Street, Manchester 1; 1, St. Andrew's Crescent, Cardiff; 80, Chichester Street, Belfast; or through any Bookseller.

Sir Arthur Schuster

By the death of Sir Arthur Schuster on October 14th, 1934, the geophysical sciences lost one who had been an active worker for over half a century. This is not the place, nor is the present writer qualified, to give a detailed account of Sir Arthur Schuster's career*. But there are some aspects of his work which are of particular interest to meteorologists. Sir Arthur's connexion with the Meteorological Office began with his appointment as a member of the Meteorological Council in 1901. When the Meteorological Committee was formed in 1905, he was appointed as a representative of the Royal Society, and he continued to serve in this capacity until failing health forced him to retire in 1932. When, on the transfer of the Meteorological Office to the Air Ministry, the Meteorological Committee was reorganised, Schuster was appointed as its first Vice-Chairman, and he retained this office until he retired from the Committee. He presided at many of the meetings in the absence of the Chairman (the Under-Secretary of State for Air), who was frequently prevented from attending by the pressure of Parliamentary and other business.

Sir Arthur Schuster's interest in Meteorology was not confined to his membership of the Meteorological Committee. In 1905 he founded a Department of Meteorology in the University of Manchester. The first lecturer in this department was G. C. Simpson, the present Director of the Meteorological Office, and it was he who

* An account of Sir Arthur Schuster's more general activities, by Dr. G. C. Simpson, C.B., F.R.S., is to be found in *Nature, London*, 134, 1934, p. 595.

initiated the upper air observations at Manchester. His successor in charge of the department was J. E. Petavel, now Sir Joseph Petavel, Director of the National Physical Laboratory. In 1906 Schuster founded a Readership in Meteorology in the University of Cambridge, and this Readership was held by E. Gold from 1907 to 1910, and by G. I. Taylor from 1912 to 1915. These two foundations were thus effective in starting four striking careers.

In 1910 Schuster presented to Eskdalemuir Observatory a Galitzin seismograph (which later was removed to Kew), and so made it possible for the Observatory to co-operate in seismological research. Schuster was familiar with the needs of Seismology, as he had served as Chairman of the Seismological Committee of the old International Association of Academies.

During the whole of his career Schuster maintained an active interest in Geophysics. His studies in Terrestrial Magnetism led him to devise the "Schuster Periodogram," which for the first time laid down a practical criterion for estimating the utility of the results of harmonic analysis. This method was first described in *Terrestrial Magnetism* in 1898, but it was later modified and improved in a paper published in the *Transactions of the Cambridge Philosophical Society*. The periodogram has been adopted as a standard method in many sciences, but more particularly in Meteorology, and it has formed the basis of all subsequent investigations of periodicity.

In addition to his direct contributions to the geophysical sciences, and what we may call his material contributions of instruments and foundations, we owe to Schuster no small debt for his readiness and capacity in matters of organisation. As a member of the Meteorological Committee he took the liveliest interest in the work of the Office, and he usually had quite definite and well-founded views on the matters brought before the Committee. It was through being Secretary of the Meteorological Committee that the present writer came into contact with Sir Arthur Schuster. Up to the time when his health began to fail, Schuster never failed to impress by the keenness of his interest and the clarity of his views ; and at all times he left the clear impression of a gracious and kindly personality.

D. BRUNT.

Nocturnal Cooling and the Prediction of Minimum Temperatures

The note by Col. Gold* on the results obtained by Mr. Andrews† in connexion with prediction of minimum temperatures at Larkhill has been read with much interest as, in the course of an investigation

* See *Meteorological Magazine*, 69, 1934, p. 88.
† Ibid 69, 1934, p. 61.

by one of us, the effect of temperature and aqueous vapour pressure on the decrease of the lapse rate of temperature in the lowest layers of the atmosphere in the early evening, when the sky was clear, was considered. The radiation from the ground to a clear sky at night, and even before sunset, rapidly cools the surface and consequently the air in contact with the surface: this radiative cooling will gradually extend upwards with the result that the lapse rate will be reversed and an inversion will develop in a shallow layer of air in contact with the ground. The problem considered was the relation between the time interval, in minutes after sunset, of the occurrence of zero lapse rate between heights of 1·1m. and 16·2m. above the desert at Ismailia, Egypt, and temperature and vapour pressure at 1·1m. for a given value of the wind velocity at the upper level when the sky was clear. It was found that the time interval plus a constant was directly proportional to the vapour pressure and inversely proportional to the absolute temperature.

Thus for a given value of the wind velocity

$$t + A = B\frac{e}{T}$$

where t = the time interval after sunset,
e = vapour pressure at time of zero lapse rate,
T = absolute temperature at time of zero lapse rate.

The relative humidity on the occasions fulfilling the specified conditions of state of sky was less than 90 per cent. in every case, but if it is assumed that the derived equation can be extrapolated to occasions when the air is saturated, it is seen that the time of occurrence of zero lapse rate gets later if both temperature and vapour pressure increase to maintain 100 per cent. relative humidity, or in other words the rate of cooling decreases with increasing temperature for constant relative humidity. Mr. Andrews' figures, however, shew that at Larkhill the amount of cooling between 15h. and the time of minimum temperature increases with the temperature for constant relative humidity, and in order to determine whether the cooling during the night at Ismailia bore a similar relation to the relative humidity as that derived from considerations of the formation of nocturnal inversions, observations of temperature and relative humidity at 15h. zone time, and the depression of the minimum temperature below the temperature at 15h. zone time, were extracted for all occasions during the winter months November, 1931, to February, 1932, when the sky cleared at any time during the night and the mean wind velocity between 15h. and 8h. the following morning was less than 10 m.p.h. The number of occasions available was sufficient to enable isopleths of temperature at 15h. to be plotted as a function of the relative humidity at 15h. and the difference between the temperature at 15h. and the minimum temperature, (T—M), for the three values 60°, 70° and 80° F.

TABLE I

Mean Difference between 15h. temperature and minimum screen temperature, on clear or partly clear nights when the mean wind speed was less than 10 m.p.h. at Ismailia, November, 1931, to February, 1932.

Temperature at 15h.	55°–64° F.	65°–74° F.	75°–84° F.	85°–94° F.
Rel. Hum. 15h.	Temperature Difference (T—M) °F.			
80–89 per cent. ...	9	—	—	—
70–79 „ ...	12	—	—	—
60–69 „ ...	—	—	—	—
50–59 „ ...	15	19	21	—
40–49 „ ...	17	21	22	—
30–39 „ ...	20	22	24	—
20–29 „ ...	—	27	29	—
10–19 „ ...	28	29	31	—
<10 „ ...	31	—	29	36

Table I shews that the cooling in this case increases with temperature for constant relative humidity which is in agreement with the result obtained by Mr. Andrews. The relation referred to in connexion with the time of occurrence of zero lapse rate is in agreement with what one would expect if radiation operated alone, and suggests that any cause other than radiation which is operative in increasing the nocturnal cooling does not have any effect before an inversion has developed at the surface.

If the amount of cooling $(T - M)$ is plotted against the difference between the temperature and the dew point temperature $(T - D)$ a series of approximately parallel straight lines is obtained, the formula for which is found to be :—

$$(T - M) = 0{\cdot}4\,(T - D) + 0{\cdot}25\,T - 6$$

compared with the following for Larkhill :—

$$(T - M) = 0{\cdot}4\,(T - D) + 0{\cdot}15\,T + 5{\cdot}5$$

where T = temperature at 15h. in degrees F.,
D = dew point temperature at 15h. in degrees F.,
M = minimum temperature in degrees F.

It will be seen that the values of the constants in this formula differ from those obtained for Larkhill under similar conditions of sky and wind velocity although the slope of the series of lines connecting $(T - M)$ and $(T - D)$ is approximately the same for both places. This leads to the inference that the rate at which the difference between the temperature at 15h. and the minimum temperature changes with respect to the difference between the air temperature at 15h. and the dew point at 15h. is the same for both places, but that the amount of cooling is dependent on locality and length of night. In connexion with the amount of cooling it might be mentioned that the mean wind velocity during the nights considered was approximately 6 m.p.h.

In order to consider the matter further the observations of temperature and relative humidity at 17h. and the depression of the minimum temperature below the 17h. temperature were extracted for the postulated conditions of sky and wind velocity in June to August, 1932. The time of 17h. was chosen as being very approximately the same time before sunset as was 15h. in winter. The figures thus obtained are given in Table II below :—

TABLE II

Mean Difference between the 17h. temperature and the minimum screen temperature on clear or partly clear nights when the mean wind speed was less than 10 m.p.h. at Ismailia, June to August, 1932.

Temperature at 17h.	65°–74° F.	75°–84° F.	85°–94° F.	95°–104° F.
Rel. Hum. 17h.	Temperature Difference (T—M) °F.			
60–69 per cent. ...	14	—	—	—
50–59 ,, ...	—	18·5	19	—
40–49 ,, ...	18	19	20	—
30–39 ,, ...	—	22	22	—
20–29 ,, ...	23	25	26	24
10–20 ,, ...	—	—	28	31

The values of $(T - M)$ 17h. derived from the above figures when plotted against the corresponding value of $(T - D)$ 17 h., excluding those for 100° F., give points lying on three approximately parallel straight lines the equations of which are of the form

$$(T - M) = 0{\cdot}35\ (T - D) + \text{Const.}$$

so that at Ismailia, Egypt even in summer the rate at which $(T - M)$ varies with respect to $(T - D)$ is very nearly the same as at Larkhill, England in winter. The value of the constant is smaller than in the case of the figures in Table I and this is probably due to the occurrence of a higher mean wind velocity during the night in summer and also to a shorter night.

The foregoing results thus suggest that the formula obtained for the prediction of minimum temperature at Larkhill requires to be modified only as regards the value of the numerical constant and the coefficient of the term involving temperature alone before it can be applied to other localities.

WILLIAM D. FLOWER.
F. DAVIES.

The reading of Mr. Andrews' note on the prediction of minimum temperatures in the April issue of the *Meteorological Magazine* and the subsequent note on the formula connecting $(T - M)$ and

T and $(T - D)$ derived by Col. Gold from Mr. Andrews' diagram in the May issue has led to an investigation of the minimum and 15h. temperature readings observed at Catterick in order to see whether the Larkhill formula $(T - M) = 5{\cdot}5 + 3/20T + 2/5 (T - D)$ applies here.

In the original note 13 years observations were available for investigation whereas, only 3 years are available at Catterick;

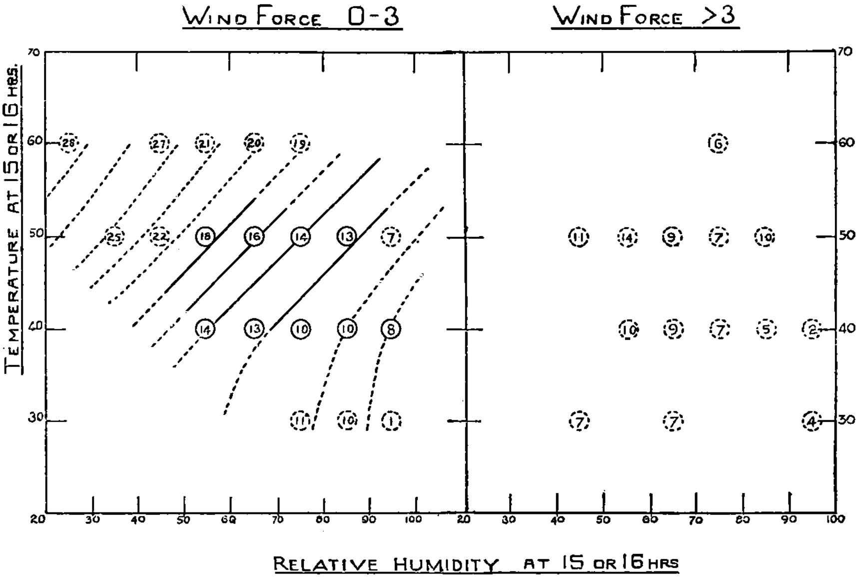


FIG. 1.

however, it was found that for winds of force 0–3 there were a sufficient number of occasions for use that would give an isopleth diagram similar to the one produced at Larkhill. See Fig. 1. From the little data available deviations from the means are to be expected; to differentiate between the reliable and the unreliable readings dotted circles have been used in the diagram to denote that 10 or less occasions were available for the plotting of the points.

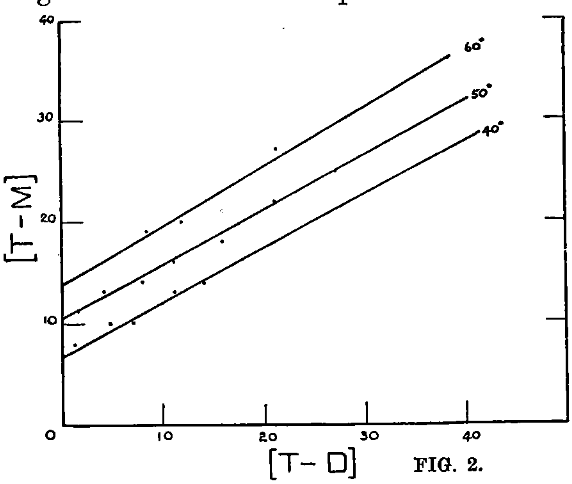


FIG. 2.

The amount of cooling $(T - M)$ was then plotted against $(T - D)$ as suggested by Col. Gold and from the resulting straight line graph the following formula was derived.

$$(T - M) = - 7 + 7/20T + \tfrac{1}{2}(T - D)$$

This formula applicable to Catterick tends to show that the values of the constants are variable, this is what one would expect when considering the varying topographical surroundings of different stations.

W. R. MORGANS.

OFFICIAL PUBLICATION

The Meteorological Observer's Handbook. New Edition, 1934 (M.O. 191).

The "Meteorological Observer's Handbook" in continuation of Dr. Scott's "Instructions in the Use of Meteorological Instruments" (1875, reprinted 1885) was originally issued in 1908. The new edition forms a complete guide to the care and manipulation of meteorological instruments, and in the making of observations at ground level, both instrumental and non-instrumental. The book is divided into three parts. Part I contains instructions for making the observations which constitute the routine of a normal climatological station. Part II is devoted to autographic instruments and Part III consists of Tables. A collection of photographs of clouds is added as an Appendix. The numerous illustrations have in most cases been specially prepared for this edition.

The Handbook is addressed primarily to observers in the British Isles, but in order to meet the requirements of observers in Crown Colonies who are not in close touch with the meteorological services of any of the Dominions, modifications in the practice commonly followed at home, which are made necessary by differences of climate, are referred to in footnotes or otherwise.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are :—

November 26th, 1934. (1) *The Indian south-west monsoon and the structure of depressions associated with it.* By K. R. Ramanathan and K. P. Ramakrishnan ; and (2) *On the physical characteristics of fronts during the Indian south-west monsoon.* By N. K. Sur. (Ind. Meteor. Mem., Poona, Vol. 26, 1933, Parts 2 and 3.) *Opener*—Mr. R. P. Batty, B.A.

December 10th, 1934. *Ionization balance of the atmosphere.* By V. F. Hess. (Beitr. Geophysik, Leipzig, SuppBd. II, 1933, p. 95.) (In German.) *Opener*—Mr. P. A. Sheppard, B.Sc.

Correspondence

To the Editor, *Meteorological Magazine*

Rain in Advance of True "Warm-front" Rain

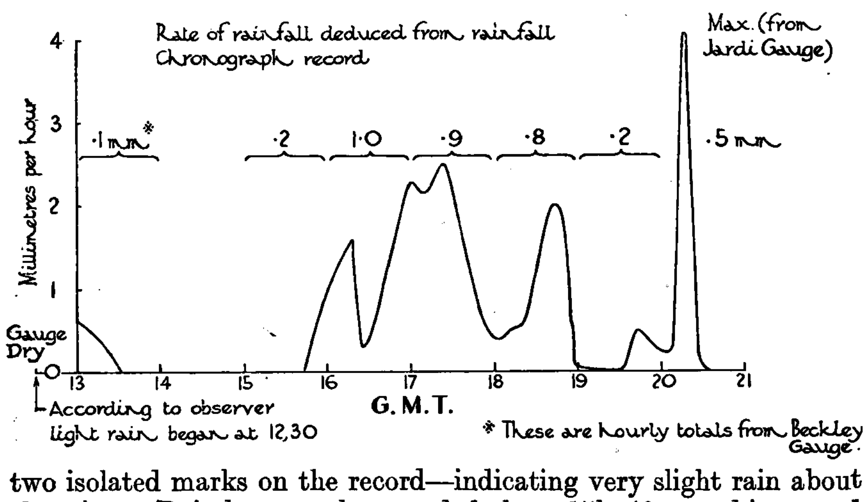
The weather of Saturday, October 6th, is very interesting to a student of synoptic meteorology. A deep depression with its centre in about Latitude 54°N. Longitude 25°W. was moving north-east. It had a well-marked warm front which ran south-east from the centre passing nearly through Valentia and Brest at 7h. G.M.T. The rain in advance of the warm front had by that time reached Plymouth.

In the course of the morning the rain extended eastwards, and at Golders Green a few drops fell between 12h. 15m. and 12h. 30m. G.M.T. There was then a short interval with no rain, and rain began again between 12h. 30m. and 13h. This rain, which was slight or moderate in intensity, continued until about 13h. 30m., after which it practically ceased for about two hours. About 15h. 30m. drizzle began, and turned to rain which continued for three or four hours.

The course of weather as observed at Golders Green was practically confirmed by the chronograph record from Kew Observatory. According to that, recordable rain began just before 13h. G.M.T.* This rain continued, at first at an intensity of about ½ mm. per hour, gradually diminishing in intensity until by 13h. 30m. it had practically ceased. No more rain was recorded by the chronograph until between 15h. 20m. and 15h. 30m., when there were

SATURDAY OCT. 6TH 1934

— Kew Observatory —



two isolated marks on the record—indicating very slight rain about that time. Rain began to be recorded about 15h. 40m. and increased in intensity to about 1½ mm. per hour at 16h. 20m., and then diminished in intensity to about 0·3 mm. per hour by 16h. 30m., and afterwards increased again to over 2 mm. per hour. This rain continued, with further substantial variations in intensity, until about 20h. 30m.

The point which, to my mind, is of most outstanding interest is the preliminary period of rain extending over nearly an hour, followed by an interval of more than two hours with practically no rain, before what one may call the true warm-front rain began.

* The observer at Kew observed light rain beginning about 12h. 30m.

It is not unusual for there to be a few drops of rain some time in advance of the commencement of the true warm-front rain, and on Saturday, October 6th, I thought the few drops which fell between 12h. 15m. and 12h. 30m. were these preliminary drops, and that when the rain began again about 12h. 45m. that this was the real warm-front rain. I had therefore anticipated that this rain would continue during the afternoon, and I was much surprised when it ceased, or practically ceased, for so long an interval.

I do not know what the explanation of this advance rain lasting nearly an hour is, nor if it has been previously noted in the literature of frontal variations of weather. It deserves investigation.

The diagram (Fig. I) kindly supplied by Dr. Whipple shows the course of the rain at Kew Observatory during the period in question.

E. GOLD.

October 9th, 1934

Lowest Pressure in a Tropical Cyclone

On the morning of September 21st, 1934, a terrible typhoon struck Osaka and neighbourhood, and caused a great deal of damage to life and property. The typhoon was first traced in our weather chart to the south-west of the Island of Saipan, the Carolines, on September 13th. Moving toward the north-west the cyclonic centre approached the Okinawa islands on the morning of the 20th, where it recurved north-east. Then the typhoon-centre passed over Cape Muroto on the south-east corner of Shiko-ku. At the Muroto Meteorological Station (33° 15′N., 134° 11′E., 186 m.) the barometer fell to 684·0 mm. (911·9 mb.) at 5h. 10 m. on the 21st. At the same time a wind velocity of 45 m./s. was observed, the direction being west. It is the mean velocity for the 20 minutes. This is much lower than 687·8 mm. (917·1 mb.) observed at False Point, India, at 6h. 30 m. on September 22nd, 1885, the record of the lowest depth of a cyclonic centre. The barometric reading at Muroto referred to is the reading of the mercurial barometer of the Fortin type, reduced to standard gravity and to sea-level, according to the formula given in " International Meteorological Tables ". The instrument was carefully tested by the Central Meteorological Observatory, Tokyo, before it was brought to the station.

T. OKADA.

Central Meteorological Observatory, Tokyo, September 27th, 1934.

[An even lower reading is that of 665·2 mm. (886·8 mb.) on August 18th, 1927 on the Dutch steamship *Sapœrœa* in the Pacific, 460 miles east of Luzon (Philippines). This reading was quoted in *Nature*, August 18th, 1928, p. 251, and in the *Meteorological Magazine* 68, 1933, p. 18 Ed. *M.M.*]

Gusty Winds at Wellington

The photograph reproduced as the frontispiece of this number of the magazine shows one of the balloons used to carry "radio-sondes" by Mr. J. Holmboe, the Norwegian meteorologist attached to the Lincoln Ellsworth Antarctic Expedition. The sondes were provided by the International Polar Year Commission and this is one of a number launched at Wellington, New Zealand.

The distortion of the balloon in the wind is rather surprising. The northerly wind at Wellington is extremely gusty. This was only a light one but even so the balloon was at one stage forced below the level of Mr. Holmboe, who is holding it in the picture. Nevertheless, in a lull it came back overhead and was released without difficulty.

EDWARD KIDSON.

Meteorological Office, Wellington, New Zealand, August 28th, 1934.

Peculiar Squall Cloud

Following a sharp squall at 17h. 10m. on October 4th, the peculiar cloud formation shewn in the sketch on the opposite page was observed in the east.

The squall cloud had the usual stratified base and cumuliform top, but at 17h. 20m. the curious protuberance in the centre appeared. The rapid formation of the phenomenon indicated that the currents in the cloud producing it must have been fairly violent, the whole appearing in a few seconds, looked like the blast of steam from a locomotive when starting from rest. After about five minutes, the mushroom shaped top suddenly spread out horizontally, forming an "anvil" of cirrus, such as is usually associated with thunder clouds, but no thunder or lightning was observed.

The cloud while passing overhead from the west, was accompanied by a sharp squall of about force 6 and 10 minutes of very heavy rainfall. The wind veered slightly from SW. to WSW. at the time and shade temperature, which had reached 60°F. before the squall, had fallen to 58°F. immediately after its passing.

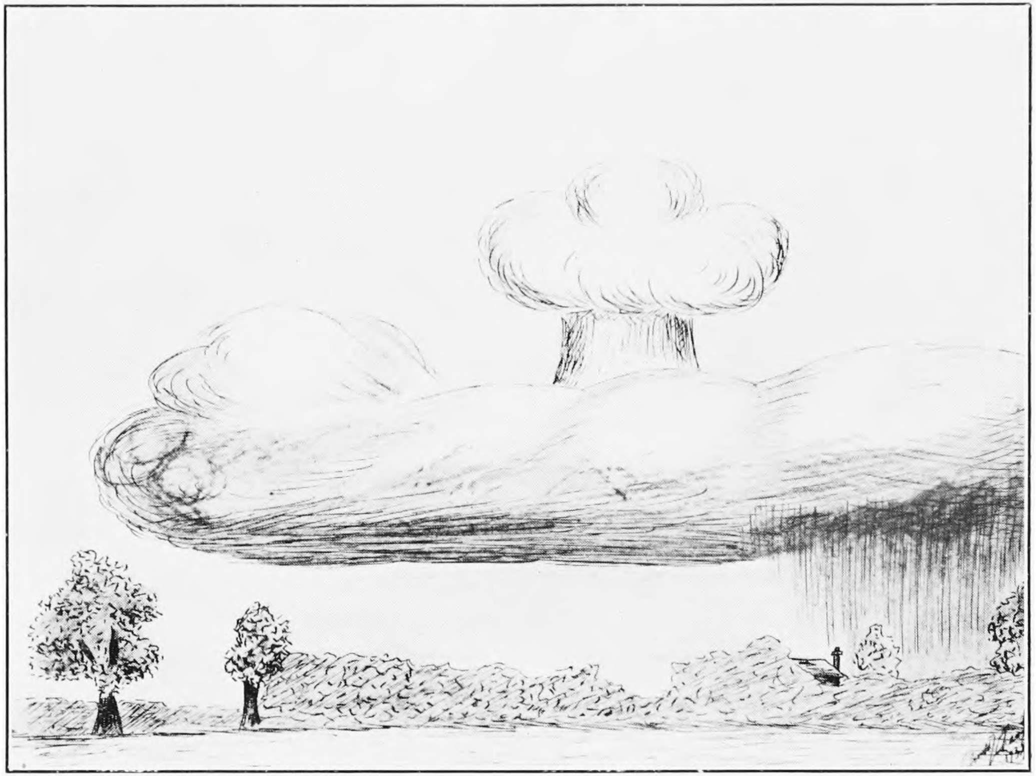
DONALD L. CHAMPION.

7, *Robinson Avenue, Goff's Oak, Waltham Cross, Herts, October 8th,* 1934.

Unusual Rainbow

An unusual rainbow was seen at 15h. 15m. (local time) on September 13th, 1934, at the base of a nimbus cloud which hung over the sea about six miles to the eastward of Bermuda; the appearance of the rainbow was as if it had just risen above the top of the horizon. The top arc was only about 5° in elevation above the sea and the inner colours of the bow were actually in contact with the sea. The rainbow seemed to be resting on a false horizon, slightly below the true horizon, probably caused by a line of heavy rain on the calm and rather glassy sea.

(facing p. 238)

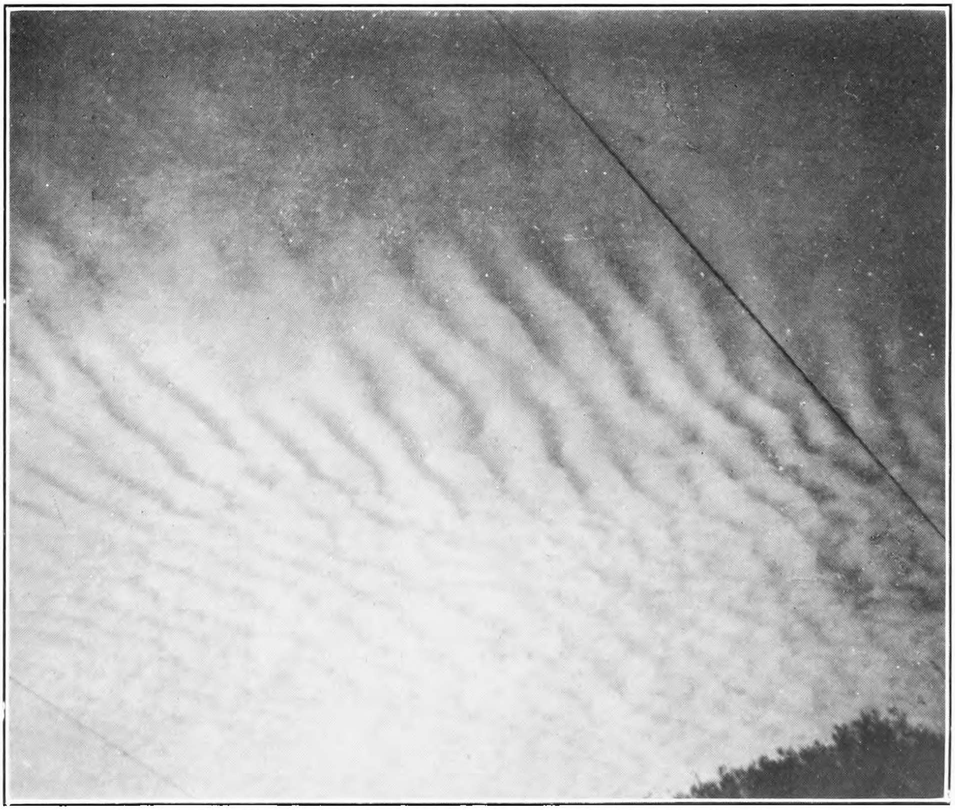


Squall Cloud, October 4th, 1934

(reproduced by the courtesy of Mr. D. L. Champion)

(facing p. 239)

LUMINOUS NIGHT CLOUDS, AUGUST 11TH, 1934
(*reproduced by the courtesy of Mr. S. N. Plummer*)



WAVED ALTO-CUMULUS, AUGUST 18TH, 1934
(*reproduced by the courtesy of Mr. R. M. Poulter*)

This aspect continued for from ten to fifteen minutes, after which the rainbow gradually rose out of the sea, the top of the bow eventually subtending an angle of about 15° from the horizontal.

Throughout this time the sky was clear to the westward except for a few fine weather cumulus and there was no cloud in the vicinity of the sun. The colours of the rainbow at first though all present were rather subordinated to the orange and red which rather gave the appearance of a ball of fire resting just below the horizon.

H. B. Moorhead.

Meteorological Station, St. Georges, Bermuda, October 2nd, 1934.

Luminous Night Clouds

As reported in a letter published in *Nature* for August 11th, 1934, p. 219, Prof. Carl Störmer observed large masses of luminous night clouds over southern Norway on the night of June 30th–July 1st. Mr. S. N. Plummer observed similar clouds at Holyhead on the nights of July 1st–2nd and 2nd–3rd. On the first of these nights Mr. Plummer succeeded in obtaining a photograph, reproduced on the opposite page, using a Miniature camera, Selochrome film, with an exposure of 5 minutes at f.3·5. The photograph was taken at 0h. 30m., G.M.T., on July 2nd.

Waved Alto-Cumulus

The photograph of waved alto-cumulus against blue sky, on the opposite page, was taken at 6h. 40m. G.M.T., August 18th, 1934, at North Harrow (Middlesex) with the camera pointing south-east by east, elevation 25°, and reference wires running north-north-west to south-south-east. The table below shows conditions in the upper air over south and east England that morning.

Croydon, 6h. G.M.T.			Duxford, 6h. G.M.T.		
	Wind.			*Temperature.*	*Humidity.*
Ft.	°	m.p.h.	Ft.	°F.	%
Surf.	—	0	100	56·6	99
1,000	—	0	1,100	58·5	86
2,000	285	7	2,020	56·8	88
3,000	265	9	3,500	52·5	79
4,000	285	8	—	—	—
5,000	285	9	5,090	49·0	76
6,000	270	14	6,700	46·2	71
8,000	310	15	8,480	41·5	64
10,000	300	15	10,300	36·6	34
12,000	290	12	12,280	32·0	61
Nephoscope Observation.			14,380	25·2	65
10h. G.M.T.			16,650	16·5	—
alto-cumulus 310° 21 m.p.h.			19,080	7·7	—

From the above table it seems that the cloud was from 8,000 to 10,000 ft. R. M. POULTER.

29, Pinner Park Avenue, Headstone Lane, Harrow, September 17th, 1934.

Atmospheric Refraction and the Moon's Globularity

At night when the moon's disc is yellow we see it more or less flat, but during the daylight hours when it is white the spherical curvature of the moon is sometimes discernible. The best time to observe this is on a very clear morning when the moon is on the wane between full and last quarter. I noticed a striking case of this phenomenon at a scout camp in Sussex one morning last August, and drew the attention of some of the boys to it, who agreed with me that the moon's surface did not look flat but "bulged right out like a ball."

The phenomenon, therefore, cannot be psychological—the moon appearing spherical because we know it is—for the simple reason that it only occasionally strikes the eye. As we cannot suppose that the eye in the ordinary way can distinguish the curvature of a surface nearly a quarter of a million miles away we must assume that some refractive effect of the atmosphere is capable of making the moon look what it is, namely a round globe.

Here, then, is another lunar atmospheric problem, like that of the blue moonlit sky, for the consideration of physicists. I need hardly add that I am not referring to the common lunar phenomenon known as "earthshine," when we see darkly part of the surface which is having night.

I may add as bearing on the question that when Peary first saw the sun rise after the long Arctic night in March, 1909, whilst on his 400-mile journey to the North Pole over the sea-ice from Grant Land he described it as "like a football owing to excessive refraction." L. C. W. BONACINA.

35, Parliament Hill, London, N.W.3. March 3rd, 1934.

NOTES AND QUERIES

The Deepening of Depressions

The note* by C. S. Durst and R. M. Stanhope brings out the absence of any appreciable diurnal variation of barometric tendencies. There remains the possibility that there may be some diurnal variation at cyclonic centres, at least in extreme cases, although on theoretical ground it seems unlikely. My previous note† referred only to unusually marked deepening in the winter half year for the period 1922–30, and the need for caution was mentioned. The result was purely empirical and against expectation. I have now examined the charts from 1931 onwards. The extreme cases of deepening close to or over the British Isles occurred on the nights

* *Meteorological Magazine* 69, 1934, p. 184.

† *Meteorological Magazine* 66, 1931, p. 39.

preceding February 28th, 1931, February 24th and March 17th, 1933, and September 8th, 1934. (On February 24th, 1933, the 7h. pressure at Pembroke was 986 mb.; the message was delayed by the snowstorm.) It is quite possibly a pure coincidence that all four cases were at night. I have also tried to pick out cases on the eastern Atlantic when the deepening at the centre averaged fully 1 mb. per hour for at least a half-day period. Though it is easy to establish marked deepening, it is impossible to obtain an exact quantitative measurement, since there is seldom a ship very near the centre, and an active new depression may entirely elude the network of ships' observations. I still think that the empirical evidence favours a slight diurnal effect, though it is impossible to prove it at present. I can think of no satisfactory explanation, as even on land the diurnal variation of temperature is very small during precipitation, especially in winter.

In view of the general interest of the problem of deepening, I give a list of dates when there was undoubtedly very marked deepening.

(*a*) Nine cases on nights preceding following dates:—February 28th, November 13th, 1931; September 18th, October 8th and 19th, 1932; January 17th, February 24th, March 17th, 1933; September 8th, 1934.

(*b*) Three day cases:—November 7th, 1931; December 30th, 1932; August 19th, 1934.

(*c*) Eight cases of prolonged deepening for periods exceeding 24 hours (ranging up to 35 mb. in amount) about following dates:—October 1st, November 3rd and 18th, 1931; January 6th, 1932; January 5th to 7th (2 cases), 14th and 17th, 1934.

If the charts for these 20 cases are examined, it can be seen that on only two occasions (October 1st, 1931, and January 5th to 6th, 1934) was there anticyclonic development to east or south of the deepening depression. A phrase used by Durst and Stanhope, namely "a transfer of air from the low pressure areas to the high" requires great care in its interpretation, and there is certainly no relation between large rising tendencies and deepening depressions. It is only over a very large area that the mean pressure remains constant. The chief rise of pressure is behind an active depression, and an anticyclone occasionally develops there, though there is usually no definite anticyclonic development within 2,000 miles of a rapidly deepening depression. I have discussed the question of air transfer and associated problems in a paper not yet published. It is a complex question, involving various layers of the atmosphere. If we consider the air motion relative to the centre of the depression, by super-posing at all points a motion equal and opposite to that of the centre, it is clear that the mean motion of the polar air in the lower troposphere is directed towards the rear. It is true that the cold front, and then the occlusion, sweeps far round an intense depression, but this is due to the rotation of the system. A depression in its final stage has the nature of a vortex drifting in the general current, if any. While it is still active, perhaps for a time after occlusion, there is usually no genuine vortex centre, but there is rotation round a centre moving forward relative to the air mass, and some convergence into a region just ahead of the centre. The mean relative motion of the air is towards the rear of the depression, and this may be of some importance, in view of the facts mentioned above. Nearly one-third of the entire atmosphere lies below 10,000 feet.

The upper layers must also be taken into account. At cirrus levels a depression apparently develops, and certainly exists, over the subsiding polar air behind the low-level centre, and during the deepening of the latter the high-level system is sheared forward till there is a more or less vertical axis. There is a corresponding development of a wedge of high pressure at cirrus levels where the rising warm air spreads out up above. This moves forward relative to the depression, but its effect on sea level pressure depends on the air movements and other changes in the layers underneath, which may neutralise or reverse its influence. Such high-level wedges are very common, and may be necessary for the development of pronounced anticyclones, but the subsidence of cold air is also necessary, and is probably the primary factor in most cases. It is only occasionally that all the factors required for the development of an anticyclone over western Europe and of a deep depression on the Atlantic are present simultaneously. Sometimes an anticyclone greatly intensifies when a depression to westward is filling up, as on November 11th to 13th, 1932.

C. K. M. Douglas.

Exceptionally High Maximum Temperatures at Bridgwater, July 7th-10th, 1934

The unusual warmth of July, 1934, has already been fully described in the *Monthly Weather Report* of the Meteorological Office for July and it was referred to again by Mr. L. C. W. Bonacina in a letter in the October number of the *Meteorological Magazine*. It seems worth while, however, to put on record some further information recently received from Major A. C. F. Luttrell, Edington, Bridgwater. He says that on four consecutive days, July 7th to 10th inclusive, the maximum temperature at his station reached or slightly exceeded 90° F. The actual readings were 90° F. on the 7th, 91° F. on the 8th, 90° F. on the 9th and 91° F. on the 10th. The instrument recording these temperatures was a Kew tested thermometer and it was housed in a regulation Stevenson Screen. These figures are very remarkable. The writer has examined figures at Kew, Greenwich and the Radcliffe Observatory, Oxford, during the notable warm spells of July, 1900; July, 1901; August to September, 1906; July and August, 1911; July, 1921; July, 1923; August, 1930; August, 1932, and July and August, 1933, and only on one occasion was there a run of four consecutive days with a maximum of 90° F. or above. This was at Greenwich from August 31st to September 3rd, 1906, and the readings were 94·3° F., 91·9° F., 93·5° F. and 91·0° F., respectively. The thermometer at Greenwich is, however, on a Glaisher stand and there is a tendency for the temperature to be higher than in a Stevenson screen. There have been a few cases of three consecutive days with readings of 90° F. or above ; for example, July 11th–13th, 1923, and August 18th–20th, 1932, at Greenwich, and August 31st–September 2nd, 1906, at Oxford and Kew. Cases of two consecutive days are much less rare. L. F. LEWIS.

REVIEWS

Naturbeobachtungen. By Arthur Döring. Deutsches Meteorologisches Jahrbuch für 1931, Freistaat Sachsen, Appendix. Dresden, 1933.

This paper discusses life reaction to altitude as the *Phenological Reports of the Royal Meteorological Society* do to latitude tempered by oceanic influence, which is practically negligible in Saxony. There, two selected stations, Böhlitz Ehrenberg near Leipzig at 100 metres and Eibenstock, Erzgebirge, 600 to 700 metres, lie between 51° and 50° N, or roughly the latitude of England south of the Thames. Herr Döring discusses the 462 records observed between 1901–14, the observations being taken at Böhlitz Ehrenberg from 1901–6 and at Eibenstock, Erzgebirge from 1907–14. As the mean meteorological conditions at both stations were practically identical for the two periods phenological comparisons are satisfactory.

Twenty-two of the 34 quarto pages are tables. These give for each plant or animal event the mean dates and extremes with years ; also snowfall, thunderstorms, etc., with monthly mean temperatures from adjoining weather stations. The results are here briefly tabulated :—

Quarters and Year.	1st	2nd	3rd	4th	Year.
Mean temp., °C., at 100 metres ...	1·8	13·0	16·6	4·5	9·0
Mean temp., °C., at 650 metres ...	− 1·2	9·1	12·6	2·7	5·8
Difference	3·0	3·9	4·0	1·8	3·2
Difference in days, animals... ...	12·4	10·6	− 0·2	−4·0	4·7
Difference in days, per 100 metres...	2·2	1·9	0·0	−1·0	0·6
Difference in days, plants	23·2	16·4	17·4	−5·3	13·8
Difference in days, per 100 metres	4·2	3·0	3·2	−1·0	2·4

Mean annual rainfalls, 436 and 955 mm. ; Late frosts, May 1st and June 5th ; Last snow, April 20th and May 3rd.

Fourteen plants, 14 birds and the frog appear also in the Royal Meteorological Society's lists. They are nearly all earlier south of the Thames, save for departures ; house martin and swallow 25 and 13 days later here. The martin precedes the swallow ten days instead of rather after ; our swift a day later. Missel and Song thrush first arrive in early and middle March. The dog rose, R. canina, averages here half a month before white acacia, which there flowers first. Croaking and mating of frogs are a full month later; the ten flowerings 13 days and migrants 4 days. As in the table and with us bird divergences are small compared with plants.

Space precludes further comments on results over a range double that possible here. Yet even so an examination of contiguous high and low stations would be well worth while, based on data in our annual reports from 1891. J. EDMUND CLARK.

Praktische Orkankunde mit Anweisungen zum Manövrieren in Stürmen. By Kapitän L. Schubart. Size $10\frac{1}{2} \times 7\frac{1}{2}$ in., pp. 143, *Illus.* Berlin, 1934.

The word "Orkan"—hurricane—is interpreted in its double sense of meaning either a wind of Beaufort force 12 or more, or a tropical revolving storm. Parts of the introductory section are concerned with the occurrence of winds of force 8 and above, and the last part, 3, deals with the navigation of ships in relation to the barometric depressions of middle latitudes; the remainder of the introductory chapter and the whole of Parts 1 and 2 are devoted to tropical revolving storms, the relation of these to navigation being the principal object of the book. This is essentially one for practical use, and the author has rightly avoided purely theoretical considerations, which would be out of place in such a treatise. He has, however, brought out very clearly the underlying uniformity in all tropical cyclones. This is in fact a theme which is sustained *sotto voce* throughout the work, and welds it into a pleasantly cohesive whole. In particular it is shown how the conditions in which tropical cyclones are formed are similar in all regions where they occur; the variations that are observed in their seasonal frequency and tracks arise from differences in the atmospheric environment, not from peculiarities in the cyclones themselves.

Part 1 (38 pages) is concerned with the explanation and description of hurricanes, the wind and weather associated with them, their tracks and regions of occurrence, etc. In Part 2 (63 pages) the emphasis is on the navigational aspect; section 1 gives rules for the recognition of the approach of a tropical cyclone at sea, and how to avoid it; section 2 deals with the navigation of a ship when under the influence of a cyclone. Among the usual indications of a distant cyclone, considerable space is devoted to the difference between the actual mean pressure for the day as estimated, and the true normal pressure. For this (and other) purposes, tables for barometer correction and conversion tables for temperature and pressure are included; it is shown how to make allowance for the semi-diurnal oscillation in estimating the mean pressure; and eight charts of normal pressures are reproduced covering the principal months and regions of cyclones. Whether the barometer is below or above normal is far from being an infallible test for the approach of a cyclone, and has to be considered in conjunction with all other available signs, but it is worthy of mention here as an illustration of the thoroughness which on the whole is maintained throughout the book.

The author accepts Meldrum's statement* that a large number of the cyclones of the South Indian Ocean are stationary, but this view has not found much favour with recent writers, and there is no apparent reason why these particular cyclones should be exceptional as a class. In this connexion he quotes a statement by R. A. Watson,† who gives the average life of a cyclone as 4½ days, but this appears to be a misunderstanding, for Watson's figure refers only to the existence of cyclones within certain limits, viz., between the equator and lat. 30° S., and long. 50° E. and 70° E., and therefore does not include the whole duration of many of those which pass through this region.

Apart from a few minor slips, the book is well produced and amply supplied with charts and diagrams. There is no index, but this defect is balanced by a full list of contents, while in the text the sectional headings are conspicuous and cross-references abound. As the book contains what every navigator should know about tropical cyclones, it ought soon to find a place on every ship—but it needs translating first. A. F. CROSSLEY.

Meteorological Observations for 1932. Prepared in the Meteorological Office, Wellington. E. Kidson, D.Sc., Director, Wellington, N.Z. 1933.

The volume of New Zealand Meteorological Observations for 1932 contains much interesting material. In addition to the monthly tables of pressure, bright sunshine, wind velocity and earth temperatures at various stations, there are full climatological summaries for 54 places, including not only New Zealand but such outlying districts as the Cook Islands, Niue Island and Danger Island. Robinson cup anemometers are in use at 13 stations, and Campbell-Stokes sunshine recorders at 27. The last part of the report gives for Wellington for each month the average diurnal variation of pressure, temperature, rainfall and sunshine, and a number of measurements of solar radiation. The introduction includes a summary of the weather, from which we learn that the year 1932 was among the driest experienced in New Zealand during the last 70 years or more. The temperatures were generally below the average, and this is attributed to the canopy of volcanic ash from the Chilian volcanoes which was observed over New Zealand in the winter months.

---

* On a Periodicity in the Frequency of Cyclones in the Indian Ocean south of the Equator. *London Rep. Brit. Ass. II*, 1872, *p.* 56.

† The cyclone season 1928–1929 at Mauritius. *Misc. Pub., Royal Alfred Observatory, Mauritius, No.* 10.

BOOKS RECEIVED

Summary of the Meteorological Observations made at the Meteorological Stations in the Netherlands West Indies during the Years, 1932 *and* 1933, compiled by the Royal Dutch Meteor. Inst., The Hague, 1933 and 1934.

OBITUARY

Professor Thomas Agius.—We regret to learn of the death on October 19th of Prof. Thomas Agius, M.A., M.D., M.R.M.S., at the age of 63. Prof. Agius was keenly interested in the meteorology of Malta, and in 1902 he was appointed Professor of Physics in the University of Malta and Director of the University Observatory. He regularly prepared the climatological summaries which are published in the annual Colonial Reports for Malta; 200 reprints of these summaries are sent each year to the Air Ministry and are grouped with similar reprints from other Colonies in sets which are distributed to a number of meteorological institutions and libraries in all parts of the world. Until the establishment of a branch of the British Meteorological Office at Malta these reports were almost our only source of information about the climate and weather of the island of Malta. Prof. Agius also did much to popularise meteorology in Malta by lectures and articles, among which was an interesting account of the Gregale, and he wrote the chapter on the Climate of Malta in the book on "Malta and Gibraltar" published by Macmillan in 1915. He was Rector of the University from 1926 until he retired in March, 1933.

NEWS IN BRIEF

H.M. the King of Denmark and Iceland has nominated Dr. H. G. Cannegieter, Assistant Director of the Royal Meteorological Institute of Holland, a Great-Knight in the Order of the Icelandic Falcon as a recognition for the work done in Iceland during the Polar Year.

The Weather of October, 1934

Pressure was below normal over most of Alaska, the extreme north of Canada, northern Greenland, Spitsbergen, Iceland, Scandinavia and north Russia, and also over the southern North Atlantic, most of the eastern and central United States and California, the greatest deficits being 10·4 mb. at Thorshavn and 6·1 mb. at Barrow. Pressure was above normal in a band covering the Rocky Mountains, most of Canada and the Great Lakes, south Greenland, the Azores, south and central Europe and Asia Minor, the greatest excess being 4·6 mb. at Bayonne. Temperature and rainfall were both above normal in Sweden.

The main features of the weather of October over the British Isles were the deficiency of sunshine, the deficiency of rain in the south and the excess of rain in the north, and the high temperatures which prevailed except for a short period near the middle of the month and after the 28th. From the 1st to 8th depressions and associated secondaries crossed the British Isles, giving unsettled weather with bright intervals. Strong south-westerly winds veering to west and reaching gale force in places prevailed in the south on the 4th, and gales also occurred in north-west Scotland on the 6th and 7th and in the Shetlands on the 8th. Thunderstorms sometimes accompanied by hail or heavy rain were experienced fairly generally over the whole country on the 4th and 5th, but the heaviest rain fell on the 6th, 3·18 in. at Snowdon and 1·93 in. at Brecon. Temperature was high during this time, reaching 71° F. at Norwich and 70° F. at Gorleston on the 7th ; the 5th was generally the sunniest day with 9·4 hrs. bright sunshine at Lowestoft and 9·2 hrs. at the Scilly Isles. From the 9th to 13th depressions moving eastwards caused unsettled conditions with rain and bright intervals in the north while the south came under the influence of the anticyclone extending from the Azores. Sunshine records were best on the 9th, when Edinburgh and Berwick-on-Tweed both recorded 10·0 hrs. bright sunshine and Scarborough 9·9 hrs. Westerly gales occurred in the Shetlands on the 10th and 12th. By the 14th the anticyclone over the Azores had spread northwards to Greenland in the rear of the depression which was moving south-east to the Baltic, and strong cold north-westerly winds veering north swept across the country. Gales were experienced at many exposed places and gusts of 79 m.p.h. were recorded at Fleetwood on the 14th and of 76 m.p.h. at Holyhead on the 15th. Temperature fell considerably but much sun was experienced on the 15th and 16th, 9·5 hrs. at Penzance on the 16th. Rain occurred at times over most of the country with hail and sleet at many places and snow in parts of Scotland. By the 18th the winds had backed between NW. and W. and the weather became mild again until the 28th ; 68° F. was recorded at Aberdeen on the 20th and 66° F. at Cambridge and Tottenham on the 25th. During the 19th the wind backed to SW. and from then to the 28th depressions passed north-eastwards across the country, giving cloudy unsettled weather with heavy rain in the north and west at times and slight rain elsewhere ; 3·81 in. fell at Aasleagh (Co. Mayo) on the 24th, 3·33 in. at Valentia (Co. Kerry) on the 24th (a record for 24 hrs. at this station), 2·11 in. at Snowdon on the 20th and 1·82 in. at Borrowdale on the 26th. Strong winds were experienced frequently and gales occurred in south-west England on the 25th and in various parts of Scotland on the 21st, 22nd, 25–28th. From the 29th to 31st pressure was high over the Atlantic and low over Scandinavia so that the British Isles came under the influence of polar air and wintry conditions spread even to south England by the 31st. Snow and sleet occurred generally in Scotland on the 30th and in England as well on the 31st, while rainfall was heavy locally on the 29th and 30th ; 1·64 in. was measured at Ilderton (Northumberland) on the 30th. Widespread fog occurred in south-east England on the morning of the 31st and temperature did not reach 40° F. in most parts on that day. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	71	− 8	Liverpool ...	64	−29
Aberdeen ...	112	+16	Ross-on-Wye ...	84	−16
Dublin	94	− 3	Falmouth ...	91	−22
Birr Castle ...	84	− 7	Gorleston ...	99	−18
Valentia... ...	64	−28	Kew	80	−13

Miscellaneous notes on weather abroad culled from various sources.

A sudden drop in temperature occurred in Switzerland on the 15th and snow fell over most of the country, to the level of Berne, and reached a depth of 1 ft. at the 3,000 ft. level; a temperature of 11° F. was recorded at 4,000 ft. A hurricane swept across Cyprus on the 17th, killing 3 children and doing much damage to buildings. A severe storm passed across western Greece about the 18th, 2 people were killed at Agrinion and nearly all the houses in Astako were wrecked. (*The Times*, October 17th–19th.)

Sixty people were killed in typhoons which swept the coast of Indo-China on two successive days about the 5th. It was reported from India that the monsoon had withdrawn by the 10th. A typhoon struck Manila (Philippines) at 1 a.m. on the 16th, 4 people were killed and much damage done to property; the main street was submerged by 3 ft. of water and several ships were driven ashore. Gales were were still raging between Manila and Hong Kong on the 17th. A typhoon was encountered on the 23rd 900 miles east of the Philippines and a typhoon also swept the district (186 miles in length) between Vinh and Bonge in Indo-China during the last week of the month—250 people were reported killed and 5,000 houses wrecked. (*The Times*, October 6th–November 3rd.)

A hurricane struck the Wairarapa district of New Zealand on the 1st, doing much material damage. Light to moderate rains fell in parts of Victoria and New South Wales early in the month, followed by good general rains before the 17th. An unexpected frost in north-eastern Victoria and the south Riverina in New South Wales about the 7th destroyed about £500,000 worth of fruit. Five years' drought in the northern part of central Australia was broken about the 10th and there were heavy falls of rain of over an inch in some places. Towards the end of the month further heavy rains occurred in Victoria and New South Wales, causing floods and the washing away of the railway line in places, and excellent rains also relieved the serious position in South Australia. (*The Times*, October 2nd–27th.)

After the snow at the beginning of the month high temperatures were experienced in Manitoba, Saskatchewan, Ontario and southern Quebec about the 13th, but east of Quebec City a winter snowstorm was raging on that day. Temperature was above normal in the

Western and Middle States for the first three weeks and variable in the north and east, while the rainfall was irregular in distribution but mainly deficient. A violent thunderstorm occurred in southern California on the 17th, accompanied by torrential rain, hail and a waterspout; 6 people were killed and many injured or rendered homeless. An earth tremor occurred at the same time. (*The Times*, October 13th–19th, and *Washington D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletins.*)

Daily Readings at Kew Observatory, October, 1934

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp.		Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
			Min.	Max.				
	mb.		°F.	°F.	%	in.	hrs.	
1	1014·4	SW.4	56	66	63	0·02	0·4	r 8h. 25m.–50m. [22h.
2	1007·4	NW.2	54	58	81	0·17	0·0	r_0r 5h.–17h., d 21h.–
3	997·7	SSW.4	49	61	73	0·05	0·3	pr_0 10h. rr_0 17h.–18h.
4	985·4	SW.5	51	61	64	0·06	6·4	r_0r 4h.–6h. & 17h.
5	1005·2	WSW.3	46	59	56	trace	5·0	pr_0 8h. & 16h. pr 18h.
6	1023·9	SSW.3	44	57	78	0·15	0·2	r_0r 12h. 30m.–20h.
7	1025·9	SW.4	54	65	87	0·03	0·1	r_0r 19h.–24h.
8	1029·2	NNE.2	56	61	64	0·12	1·7	rr_0 0h.–5h. r_0 7h.20m.
9	1025·7	NNW.3	43	58	51	—	4·7	
10	1029·0	WSW.3	48	63	67	trace	3·8	r_0 20h. & 21h. 15m.–
11	1029·7	W.3	56	64	64	—	7·0	[30m.
12	1028·1	WSW.3	47	61	64	—	5·1	f till 9h.
13	1029·3	WSW.2	52	63	73	trace	0·1	$r_0$7h., 18h. 30m. & 20h.
14	1016·1	W.4	56	61	51	trace	0·2	r_0 22h., 23h. & 24h.
15	1005·6	NW.4	44	49	52	0·01	4·6	r 2h.15m.–25m.
16	1021·6	NNW.5	37	51	60	trace	4·1	pr_0 7h., 15h. & 17h.
17	1014·4	WNW.3	41	50	86	0·12	0·0	rr_0 3h.–9h. & 15h.–17h.
18	1017·3	W.2	45	57	77	trace	0·1	d_0d 1h. 40m.–5h. 35m.
19	1019·1	NNW.2	51	59	60	—	3·2	
20	1018·1	SW.3	53	59	85	0·02	0·0	r_0r 6h. 25m.–8h.
21	1015·2	SSW.4	53	59	75	trace	0·3	d_0 9h. & 10h.–12h.
22	1008·5	WSW.4	56	60	48	trace	5·3	d 6h. 20m.
23	1012·7	W.2	45	57	58	—	7·5	z 18h.
24	1014·4	SSW.4	42	60	65	—	2·0	
25	1006·6	S.4	52	64	73	0·03	1·7	r_0r 18h.–19h. 45m.
26	1016·7	WSW.4	49	58	57	—	5·5	
27	1012·5	SW.5	49	57	65	trace	1·0	d_0 20h.
28	1012·2	W.4	51	55	54	trace	1·9	pr_0 7h. & 9h. 30m.
29	1012·1	WNW.3	38	51	53	—	7·2	x early.
30	1005·6	SW.2	34	47	73	trace	0·4	x m early, r_0 18h. [19h.
31	1007·2	NW.3	29	40	83	0·07	0·0	x F m ; d_0rs_0 13h.–
*	1015·1		48	58	66	0·85	2·6	* Means or totals.

General Rainfall for October, 1934

England and Wales ...	79	per cent of the average 1881–1915.
Scotland	155	
Ireland	127	
British Isles	107	

Rainfall : October, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square..........	1·09	41	*Leics* .	Thornton Reservoir ...	1·81	64
Sur .	Reigate, Wray Pk. Rd..	2·46	74	,, .	Belvoir Castle............	1·07	40
Kent .	Tenterden, Ashenden...	2·32	66	*Rut* .	Ridlington	1·27	45
,, .	Folkestone, Boro. San.	1·86	...	*Lincs* .	Boston, Skirbeck.........	1·17	43
,, .	Eden'bdg., Falconhurst	2·64	73	,, .	Cranwell Aerodrome...	·98	34
,, .	Sevenoaks, Speldhurst.	1·74	...	,, .	Skegness, Marine Gdns.	1·18	43
Sus .	Compton, Compton Ho.	2·34	51	,, .	Louth, Westgate.........	1·36	42
,, .	Patching Farm..........	2·16	55	,, .	Brigg, Wrawby St.......	1·21	...
,, .	Eastbourne, Wil. Sq....	2·96	71	*Notts* .	Worksop, Hodsock......	1·28	49
,, .	Heathfield, Barklye....	2·34	56	*Derby*.	Derby, L. M. & S. Rly.	1·54	59
Hants.	Ventnor, Roy.Nat.Hos.	2·26	58	,, .	Buxton, Terr. Slopes...	5·89	120
,, .	Fordingbridge, Oaklnds	1·81	44	*Ches* .	Runcorn, Weston Pt....	3·89	113
,, .	Ovington Rectory.......	1·74	43	*Lancs*.	Manchester, Whit. Pk.	4·58	139
,, .	Sherborne St. John......	1·29	37	,, .	Stonyhurst College......	8·08	180
Herts .	Welwyn Garden City ...	1·42	51	,, .	Southport, Bedford Pk.	4·37	123
Bucks.	Slough, Upton............	1·58	56	,, .	Lancaster, Greg Obsy.	6·40	156
,, .	H. Wycombe, Flackwell	1·67	51	*Yorks*.	Wath-upon-Dearne......	1·45	52
Oxf .	Oxford, Mag. College...	1·36	49	,, .	Wakefield,Clarence Pk.	1·62	56
Nor .	Pitsford, Sedgebrook...	1·39	52	,, .	Oughtershaw Hall.......	10·96	...
,, .	Oundle	·81	...	,, .	Wetherby, Ribston H..	2·07	69
Beds .	Woburn, Exptl. Farm...	1·67	63	,, .	Hull, Pearson Park......	1·56	52
Cam .	Cambridge, Bot. Gdns.	1·78	75	,, .	Holme-on-Spalding......	1·80	60
Essex .	Chelmsford, County Lab	1·41	68	,, .	West Witton, Ivy Ho.	4·88	131
,, .	Lexden Hill House......	2·01	...	,, .	Felixkirk, Mt. St. John.	2·77	96
Suff .	Haughley House.........	1·08	...	,, .	York, Museum Gdns....	1·35	50
,, .	Campsea Ashe...........	1·39	53	,, .	Pickering, Hungate......	2·12	70
,, .	Lowestoft Sec. School...	1·49	53	,, .	Scarborough..............	2·29	73
,, .	Bury St. Ed., WestleyH.	1·39	51	,, .	Middlesbrough...........	2·65	88
Norf. .	Wells, Holkham Hall...	1·51	54	,, .	Baldersdale, Hury Res.	5·89	148
Wilts .	Calne, Castleway.........	2·08	65	*Durh* .	Ushaw College...........	3·50	102
,, .	Porton, W.D. Exp'l. Stn	1·17	37	*Nor* .	Newcastle, Town Moor.	3·39	106
Dor .	Evershot, Melbury Ho.	3·01	65	,, .	Bellingham, Highgreen	5·98	153
,, .	Weymouth, Westham.	1·85	51	,, .	Lilburn Tower Gdns....	5·31	143
,, .	Shaftesbury,Abbey Ho.	1·81	46	*Cumb*.	Carlisle, Scaleby Hall...	4·65	139
Devon.	Plymouth, The Hoe....	3·02	76	,, .	Borrowdale, Seathwaite	21·00	184
,, .	Holne, Church Pk. Cott.	6·60	100	,, .	Borrowdale, Moraine...	16·94	187
,, .	Teignmouth, Den Gdns.	2·41	63	,, .	Keswick, High Hill......	8·66	155
,, .	Cullompton	2·93	71	*West* .	Appleby, Castle Bank...	6·00	172
,, .	Sidmouth, U.D.C.........	2·32	...	*Mon* .	Abergavenny, Larchf'd	2·90	69
,, .	Barnstaple, N. Dev.Ath	3·77	83	*Glam* .	Ystalyfera, Wern Ho....	6·65	97
,, .	Dartm'r,Cranmere Pool	8·40	...	,, .	Cardiff, Ely P. Stn.......	3·30	69
,, .	Okehampton, Uplands.	5·73	95	,, .	Treherbert, Tynywaun.	10·19	...
Corn .	Redruth, Trewirgie......	3·91	74	*Carm* .	Carmarthen, Priory St..	5·01	88
,, .	Penzance, Morrab Gdn.	3·08	60	*Pemb* .	Haverfordwest, School.	...	...
,, .	St. Austell, Trevarna...	4·76	90	*Card* .	Aberystwyth	4·72	...
Soms .	Chewton Mendip.........	3·37	70	*Rad* .	BirmW.W.Tyrmynydd	6·64	100
,, .	Long Ashton............	2·21	58	*Mont* .	Lake Vyrnwy	7·35	129
,, .	Street, Millfield..........	2·42	74	*Flint* .	Sealand Aerodrome......	2·82	93
Glos .	Blockley	1·35	...	*Mer* .	Dolgelley, Bontddu......	10·92	180
,, .	Cirencester, Gwynfa....	2·05	62	*Carn* .	Llandudno	3·94	117
Here .	Ross, Birchlea............	1·34	41	,, .	Snowdon, L. Llydaw 9..	25·73	...
Salop .	Church Stretton.........	2·96	82	*Ang* .	Holyhead, Salt Island...	4·79	120
,, .	Shifnal, Hatton Grange	2·51	89	,, .	Lligwy	5·84	...
Staffs .	Market Drayt'n, Old Sp.	3·04	99	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	1·06	40		Douglas, Boro' Cem....	6·00	130
War .	Alcester, Ragley Hall...	1·21	44	*Guernsey*			
,, .	Birminghm, Edgbaston	1·65	59		St. PeterP't.Grange Rd.	3·31	74

Rainfall: October, 1934: Scotland and Ireland

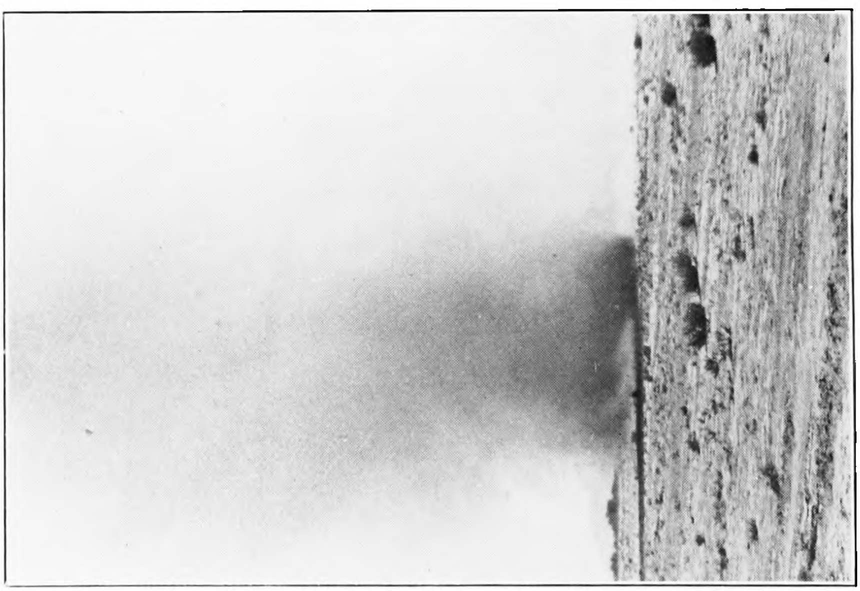
Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig	Pt. William, Monreith.	6·01	152	*Suth*	Melvich	7·38	201
,,	New Luce School	8·05	172	,,	Loch More, Achfary	17·52	225
Kirk	Dalry, Glendarroch	7·93	151	*Caith*	Wick	4·89	165
,,	Carsphairn, Shiel	12·81	181	*Ork*	Deerness	5·90	156
Dumf.	Dumfries, Crichton, R.I.	4·87	131	*Shet*	Lerwick	6·03	153
,,	Eskdalemuir Obs.	9·76	181	*Cork*	Caheragh Rectory	5·36	...
Roxb	Branxholm	6·11	188	,,	Dunmanway Rectory	6·22	104
Selk	Ettrick Manse	9·15	166	,,	Cork, University Coll.	3·50	90
Peeb	West Linton	6·50	...	,,	Ballinacurra	2·76	68
Berw	Marchmont House	4·22	110	,,	Mallow, Longueville	4·26	118
E.Lot	North Berwick Res.	2·46	83	*Kerry*	Valentia Obsy.	7·03	126
Midl	Edinburgh, Roy. Obs.	3·27	119	,,	Gearhameen	12·10	133
Lan	Auchtyfardle	6·72	...	,,	Darrynane Abbey	4·50	89
Ayr	Kilmarnock, Kay Pk.	6·95	...	*Wat*	Waterford, Gortmore	3·29	84
,,	Girvan, Pinmore	6·54	131	*Tip*	Nenagh, Cas. Lough	4·68	138
Renf	Glasgow, Queen's Pk.	6·35	195	,,	Roscrea, Timoney Park	3·60	...
,,	Greenock, Prospect H.	9·23	172	,,	Cashel, Ballinamona	3·27	91
Bute	Rothesay, Ardencraig	9·66	...	*Lim*	Foynes, Coolnanes	4·05	109
,,	Dougarie Lodge	8·05	...	,,	Castleconnel Rec.	4·16	...
Arg	Ardgour House	16·77	...	*Clare*	Inagh, Mount Callan	8·35	...
,,	Glen Etive	18·62	230	,,	Broadford, Hurdlest'n.	3·70	...
,,	Oban	9·40	...	*Wexf*	Gorey, Courtown Ho.	4·19	118
,,	Poltalloch	10·73	217	*Wick*	Rathnew, Clonmannon.	3·28	...
,,	Inveraray Castle	13·59	193	*Carl*	Hacketstown Rectory	3·16	83
,,	Islay, Eallabus	9·88	207	*Leix*	Blandsfort House	3·29	93
,,	Mull, Benmore	...	...	,,	Mountmellick	3·79	...
,,	Tiree	...	...	*Offaly*	Birr Castle	3·47	119
Kinr	Loch Leven Sluice	4·17	121	*Dublin*	Dublin, FitzWm. Sq.	1·87	70
Perth	Loch Dhu	13·40	187	,,	Balbriggan, Ardgillan	2·77	103
,,	Balquhidder, Stronvar.	8·45	...	*Meath*	Beauparc, St. Cloud	2·74	...
,,	Crieff, Strathearn Hyd.	5·40	137	,,	Kells, Headfort	3·39	101
,,	Blair Castle Gardens	5·63	182	*W.M*	Moate, Coolatore	4·49	...
Angus	Kettins School	3·21	101	,,	Mullingar, Belvedere	4·48	144
,,	Pearsie House	4·17	...	*Long*	Castle Forbes Gdns.	5·30	163
,,	Montrose, Sunnyside	3·16	114	*Gal*	Galway, Grammar Sch.	4·81	...
Aber	Braemar, Bank	4·41	117	,,	Ballynahinch Castle	9·16	153
,,	Logie Coldstone Sch.	3·33	103	,,	Ahascragh, Clonbrock.	5·29	145
,,	Aberdeen, King's Coll.	3·48	116	*Mayo*	Blacksod Point	7·87	158
,,	Fyvie Castle	4·18	109	,,	Mallaranny	9·66	...
Moray	Gordon Castle	3·92	124	,,	Westport House	7·51	167
,,	Grantown-on-Spey	4·80	162	,,	Delphi Lodge	15·93	168
Nairn	Nairn	2·52	107	*Sligo*	Markree Obsy.	6·22	153
Inv's	Ben Alder Lodge	7·13	...	*Cavan*	Crossdoney, Kevit Cas.	5·09	...
,,	Kingussie, The Birches.	5·03	...	*Ferm*	Enniskillen, Portora	4·63	...
,,	Inverness, Culduthel R.	3·28	...	*Arm*	Armagh Obsy.	4·50	165
,,	Loch Quoich, Loan	...	...	*Down*	Fofanny Reservoir	9·25	...
,,	Glenquoich	20·63	206	,,	Seaforde	5·32	149
,,	Arisaig, Faire-na-Sguir.	7·81	...	,,	Donaghadee, C. Stn.	4·31	149
,,	Fort William, Glasdrum	11·89	...	,,	Banbridge, Milltown	3·74	135
,,	Skye, Dunvegan	8·88	...	*Antr*	Belfast, Cavehill Rd.	4·92	...
,,	Barra, Skallary	6·61	...	,,	Aldergrove Aerodrome.	3·93	131
R&C	Alness, Ardross Castle.	6·16	160	,,	Ballymena, Harryville.	5·53	150
,,	Ullapool	8·37	173	*Lon*	Garvagh, Moneydig	5·74	...
,,	Achnashellach	13·72	171	,,	Londonderry, Creggan.	7·53	204
,,	Stornoway	6·65	128	*Tyr*	Omagh, Edenfel	5·73	156
Suth	Lairg	7·70	206	*Don*	Malin Head	6·61	...
,,	Tongue	6·30	150	,,	Killybegs, Rockmount.	...	...

Climatological Table for the British Empire, May, 1934

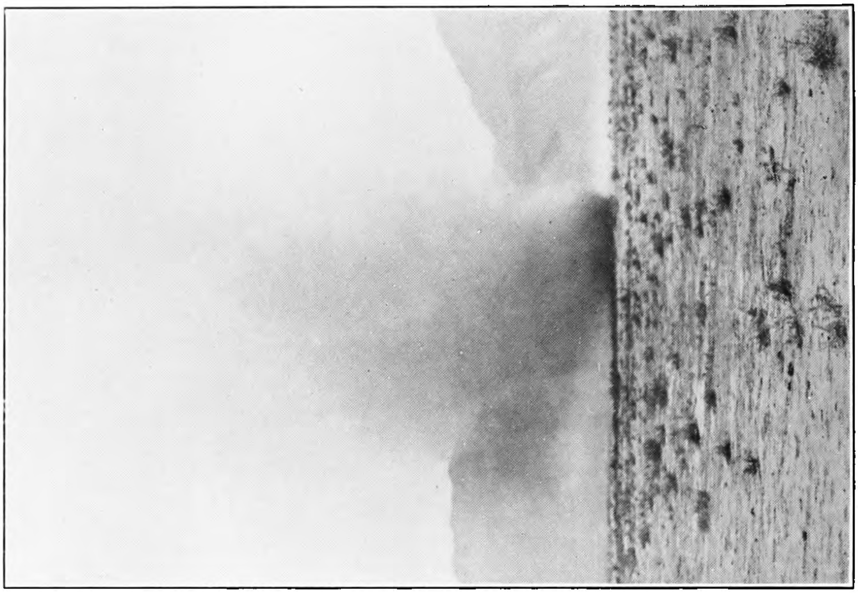
STATIONS.	PRESSURE. Mean of Day M.S.L. (mb.)	PRESSURE. Diff. from Normal. (mb.)	TEMPERATURE. Absolute. Max. (°F.)	TEMPERATURE. Absolute. Min. (°F.)	TEMPERATURE. Mean Values. Max. (°F.)	TEMPERATURE. Mean Values. Min. (°F.)	TEMPERATURE. Mean Values. ½ Max. and Min. (°F.)	TEMPERATURE. Mean Values. Diff. from Normal. (°F.)	TEMPERATURE. Mean. Wet Bulb. (°F.)	Relative Humidity. (%)	Mean Cloud Am'nt (0–10)	PRECIPITATION. Am'nt. (in.)	PRECIPITATION. Diff. from Normal. (in.)	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
London, Kew Obsy	1019·3	+ 3·4	79	37	63·9	46·2	55·1	+ 1·7	47·6	76	7·0	0·44	− 1·28	8	6·49	42
Gibraltar	1016·4	+ 0·3	83	50	73·1	58·2	65·7	+ 0·2	56·7	79	4·0	0·13	− 1·44	3	...	...
Malta	1015·0	+ 0·5	80	57	71·9	61·4	66·7	+ 0·8	61·3	74	4·6	0·47	+ 0·06	4	9·68	69
St. Helena	1013·2	+ 0·1	72	57	66·7	60·0	63·3	+ 0·2	60·5	91	8·8	2·19	...	14	...	...
Freetown, Sierra Leone	1012·3	+ 1·1	91	63	88·3	69·8	79·1	− 2·4	79·0	87	7·7	2·64	− 8·83	3	...	...
Lagos, Nigeria	1010·3	− 0·3	92	71	86·6	76·1	81·3	− 0·5	76·9	84	7·3	5·38	− 5·37	15	6·2	50
Kaduna, Nigeria	1006·3	...	98	68	90·8	72·0	81·4	+ 2·0	73·2	79	8·6	6·26	+ 0·56	14	6·4	51
Zomba, Nyasaland	1014·7	− 0·4	81	51	78·3	57·7	68·0	+ 2·2	64·2	72	4·6	0·09	− 0·95	3	...	...
Salisbury, Rhodesia	1016·6	− 0·8	81	45	75·9	49·9	62·9	+ 2·3	55·6	58	1·5	0·09	− 0·39	3	8·7	77
Cape Town	1015·8	− 2·3	82	44	69·1	52·3	60·7	+ 1·8	54·5	93	6·4	4·40	+ 0·65	12	...	...
Johannesburg	1018·3	0·0	78	34	66·6	46·6	56·6	+ 2·2	47·6	61	2·8	1·94	+ 1·18	7	8·4	77
Mauritius	1017·6	+ 1·2	82	63	78·6	67·6	73·1	+ 0·5	70·3	80	7·0	11·65	+ 8·62	27	5·6	50
Calcutta, Alipore Obsy.	1003·2	− 0·3	105	69	96·9	79·6	88·3	+ 2·2	81·3	85	5·2	2·55	− 3·01	4*	...	...
Bombay	1008·3	+ 0·9	93	77	91·6	79·5	85·5	− 0·3	77·3	73	2·7	0·00	− 0·55	0*	...	...
Madras	1005·6	+ 0·2	110	77	97·8	81·7	89·7	− 0·1	78·6	65	5·2	0·00	− 1·84	0*	...	...
Colombo, Ceylon	1010·0	+ 1·6	88	71	86·4	77·9	82·1	− 0·7	78·6	79	6·6	8·61	− 2·33	18	7·9	64
Singapore	1009·0	+ 0·3	90	71	87·9	75·9	81·9	− 0·1	78·3	80	8·1	12·12	+ 5·48	14	7·4	61
Hongkong	1008·8	− 0·3	90	66	81·3	73·8	77·5	+ 0·1	72·7	78	8·5	8·73	− 3·34	12	4·5	34
Sandakan	1010·1	...	92	74	90·0	75·2	82·6	+ 0·1	77·9	82	5·2	3·98	− 2·35	11	...	...
Sydney, N.S.W.	1023·9	+ 5·3	77	48	67·9	52·9	60·4	+ 1·6	55·3	82	5·0	5·11	− 0·07	15	5·8	56
Melbourne	1025·7	+ 6·5	76	37	65·0	46·2	55·6	+ 1·5	49·6	82	6·5	0·14	− 2·02	3	5·9	58
Adelaide	1025·0	+ 5·0	81	43	72·6	49·8	61·2	+ 3·3	52·1	52	5·0	0·10	− 2·68	3	6·6	65
Perth, W. Australia	1017·9	− 0·5	84	42	73·3	56·3	64·8	+ 4·1	57·0	67	4·7	4·88	− 0·09	13	5·9	57
Coolgardie	1018·7	− 0·7	83	41	76·0	51·6	63·8	+ 6·1	56·8	63	3·4	0·10	− 1·23	2	...	...
Brisbane	1021·1	− 2·5	78	48	72·3	56·0	64·1	− 0·5	58·7	74	5·0	2·39	− 0·42	13	6·1	57
Hobart, Tasmania	1022·8	+ 7·5	71	37	60·8	47·2	54·0	+ 3·5	48·0	70	5·9	0·28	− 1·62	7	4·6	47
Wellington, N.Z.	1018·5	+ 2·9	67	35	55·5	45·0	50·3	− 2·5	47·5	77	6·9	4·53	− 0·15	12	3·7	37
Suva, Fiji	1012·9	− 0·2	88	69	80·0	72·0	76·0	− 0·5	72·5	85	8·4	20·92	+ 10·85	25	2·3	20
Apia, Samoa	1010·8	− 0·3	87	73	84·8	74·7	79·7	+ 1·3	76·4	81	6·7	6·09	+ 0·02	17	...	...
Kingston, Jamaica	1012·9	− 0·2	87	69	86·1	72·5	79·3	− 0·4	72·9	77	7·9	1·93	− 2·46	4	7·0	54
Grenada, W.I.	1010·5	− 2·1	88	71	85	72	78·5	− 1·2	72·0	70	6	8·09	+ 3·90	21	...	...
Toronto	1015·6	+ 0·7	86	34	69·4	46·0	57·7	+ 3·9	48·6	54	3·4	0·47	− 2·32	4	10·3	70
Winnipeg	1012·6	− 1·2	99	18	69·6	42·9	56·3	+ 4·3	43·5	67	5·0	0·63	− 1·37	6	...	...
St. John, N.B.	1013·9	0·0	78	33	58·5	41·6	50·1	+ 2·4	45·6	73	6·1	2·16	− 1·55	12	6·4	43
Victoria, B.C.	1016·2	− 0·5	75	41	61·5	48·1	54·8	+ 1·8	51·0	79	5·6	1·22	+ 0·09	12	8·1	53

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(23246) Wt.25/32 1,000 11/34 Hw. G.377/6



DUST-DEVIL 14H. 40M., AUGUST 10TH, 1934 (*see* p. 268)



DUST-DEVIL 15H. 15M., SEPTEMBER 6TH, 1934 (*see* p. 268)

M.O. 371.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 69

Dec. 1934

No. 827

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120 GEORGE STREET, EDINBURGH 2; YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any Bookseller.

The Audibility of the Firing in the English Channel on September 27th, 1934

By F. J. W. WHIPPLE, Sc.D.

It is well known that the way in which the sound from explosions spreads is a phenomenon which is subject to great variations. These variations can be explained in part by changes in meteorological conditions, notably in the direction and strength of the wind, but the extent to which sounds are heard at very great distances is apparently related to characteristics of the upper atmosphere in regions far above those with which we are concerned in the study of the weather.

During recent years there have been two occasions when firing taking place during reviews of the fleet in the English Channel has been heard over a large part of England. On one of these occasions, November 1st, 1930, the sounds attracted general attention at places at considerable distances, 200 Km. and more to the north-east, though they were heard neither at places between 100 Km. and 160 Km. in the same direction nor at places to the westward. On the second occasion, on July 14th, 1932, the sounds were very well heard in the west (near Lands End) and north-west (in Wales). This antithesis is not a mere accident. There is a well marked oscillation according to the time of year. Air waves travel through the high atmosphere to the east in winter and to the west in summer. For this purpose the end of summer is in August or September as we know from experience during the War and from other evidence.

An opportunity for investigating the distribution of audibility in the transitional month September presented itself on September 27th, 1934, when, as was announced by the Admiralty, salvoes were to be fired by H.M.S. *Valiant.* Announcements of the approximate times of firing in the afternoon and in the evening appeared in the newspapers and were broadcast by the B.B.C. There was a generous response to the request that reports by observers who thought they had heard the firing should be sent to Kew Observatory. The reports numbered nearly 700. These have been used in the preparation of the maps (Figs. 1 and 2) showing where the sounds were heard in

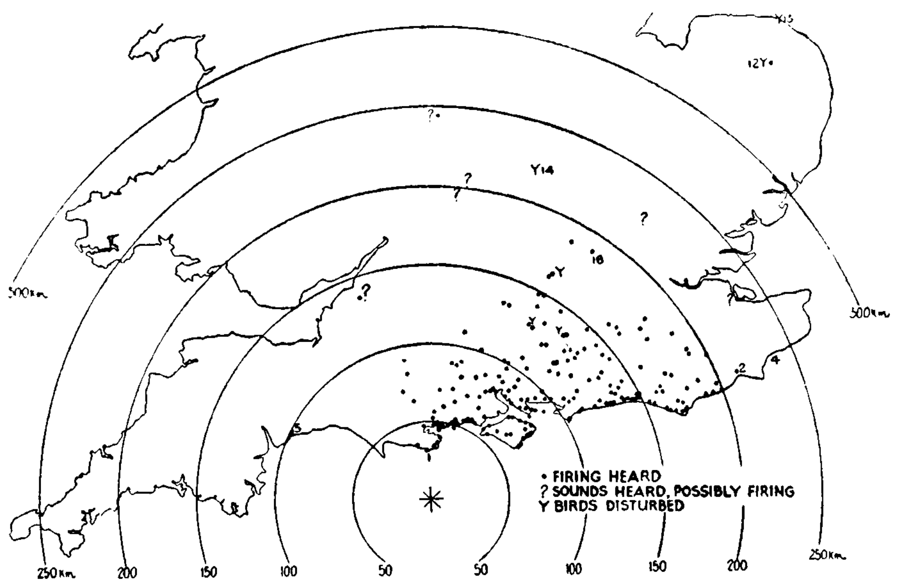


FIG. 1—AUDIBILITY OF FIRING, H.M.S. *Valiant,* SEPTEMBER 27th, 1934, AFTERNOON

the afternoon and in the evening. It will be seen that there is a considerable likeness between the maps. The firing points indicated by stars on the maps were not quite the same. In the afternoon the co-ordinates were 50° 18′ N. 2° 2′ W. and ten salvoes were fired in 5½ minutes between 15h. 22m. 23s. and 15h. 27m. 55s. B.S.T. In the evening the ship was a little further south and west, the co-ordinates being 50° 11′ N. 2° 17′ W. and fours alvoes were fired in the three minutes between 20h. 28m. 31s. and 20h. 31m. 32s. B.S.T.*

Both of the firing points were nearly due south of St. Albans Head[1]†. The firing was heard there and along the south coast to the east as far as Rye[2] in the afternoon and as far as Bexhill[3] in the evening. There were observers listening at Hythe[4] in the afternoon

* The centre in Fig. 2 is placed a little to the east of the correct position.

† These small numbers refer to figures on the maps.

who heard nothing, so the boundary of the zone of audibility must have cut the coast at a distance from the firing point between 220 and 250 Km.

To the west of St. Albans Head there was only one place on the coast, Sidmouth[5], where sounds were heard in the afternoon but in the evening the coastguards heard the firing as far west as Lyme Regis[6] and the airwaves rattled windows at Torquay[7]. Sounds were heard on the other side of the English Channel, in the Channel Islands in the afternoon and at Etretat near Havre in the evening. There might have been more observations in France if the request

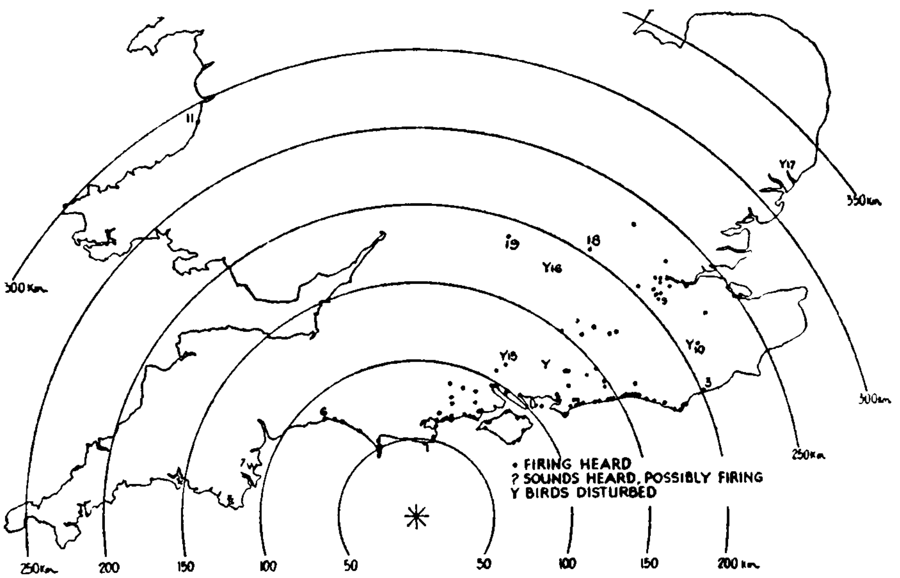


FIG. 2—AUDIBILITY OF FIRING, H.M.S. *Valiant*, SEPTEMBER 27th, 1934, EVENING

for information had reached the French newspapers. It is clear, however, that in Dorset the sounds which were heard on the coast did not penetrate inland. On the other hand, to the north-east of the guns the sounds travelled a long way past the coast line and were heard distinctly as far as the Weald just below the North Downs.

On such occasions there is usually much difficulty in deciding which of the observers at distant points correctly judged faint sounds which come to their ears as gunfire. On September 27th there were a good many observers not far from the south coast who reported ten salvoes in five minutes or four salvoes in three minutes and a few people gave the time to a second, leaving no doubt as to the reliability of their observations, but such detail could not be expected in the majority of the reports. Extraneous noises were troublesome in Essex where there were several detonations soon after 20h. and in Oxfordshire where sounds were reported about 15h. 20m.

It may be, however, that in Kent near Orpington[9] observers heard some of the salvoes twice. Four salvoes were fired. According to one report from Orpington bangs were "clearly heard indoors at 8.36, 8.37, 8.38, 8.39, 8.44," whilst another report runs: "listening in our garden we heard three distinct detonations of undoubted gunfire between 8.40 and 8.45. Two previous ones were heard between 8.35 and 8.40, but these were considerably less distinct. They appeared to come from due west not southwest."

The outer region of audibility in the evening in Kent included Goudhurst and Greenwich. There were observations apparently reliable as far to the north and west as Sarratt[18] in Hertfordshire and Iffley[19] near Oxford. In the absence of well timed observations it is impossible to say whether these regions were in a zone of "abnormal audibility" in the technical sense, i.e. a zone such that the time of passage of the sound waves was much in excess of the time required for sound to travel along the ground.

There are two noteworthy reports of audibility at very distant points. One of these was from Aberystwyth[11] at a range of 290 Km. "At approximately 8.50 p.m. I heard the booming of a distant gun. Several thundery roars could be heard in quick succession." This observer was able to hear sounds at 290 Km. to the north-west of the source. At this time of year it is not found possible to record at Birmingham airwaves from Woolwich on the same bearing. It may be that the waves pass over Birmingham and could be recorded at a greater distance. The other report is for a still greater range, 350 Km. The observer who was at Weston Longville[12], 10 miles north-west of Norwich, says that pheasants "began shouting" and he stopped and listened and could distinctly hear the salvoes. Unfortunately the time of this observation is given merely as "about 3.30." The air waves from H.M.S. *Valiant* could not have reached the observer before 3.40 and the margin of safety in the word "about" is hardly sufficient. There were other cases of the disturbance of pheasants. In the afternoon there was one close to Cromer[13] (the cock pheasants all began crowing at 3h. 40m.) and another at Towcester[14]. In the evening birds were disturbed near Winchester[15], at Goudhourst[10] in Kent, at Nettlebed in Oxfordshire and also at Woodbridge[17] in Suffolk, about 325 Km. from the firing point. Why pheasants are affected by airwaves which cannot be perceived by the human ear and are persumably infrasonic is not known. It is a nice problem for the physiologist.

It is unfortunate that no station with sound-ranging equipment obtained autographic records of the airwaves; in fact, no such records of salvoes fired an "abnormal" distance away have ever been made. Owing to the fact that the firing in the afternoon was later than was anticipated, none of the stations was in operation at appropriate times. Bristol, Birmingham and Nottingham were operating in the evening. It will be seen from the maps that these stations are in areas where the firing was not generally heard. This negative evidence makes it unlikely that the sounds heard and reported by observers, for example at Clifton and at Gloucester, were due to the firing.

Though it has to be remembered that on this occasion the salvoes were being fired by only one battleship instead of by a squadron it may fairly be concluded from the evidence that sound did not carry so well to the outer zone of audibility on this September day as on the days of the reviews which, as has been mentioned, took place in July and in December.

The large area with normal audibility to the north-east of the firing is associated, of course, with the distribution of wind in the lower atmosphere. In Fig. 3 the velocity of sound in still air is represented as a function of height by the graph AA. This curve depends on the observations of temperature made at Duxford at 12h. 15m. The component of wind velocity towards north-east is represented by the curve BB and the velocity of sound in the same direction by the curve CC. It will be seen that this velocity increased at any rate up to 1·8Km.

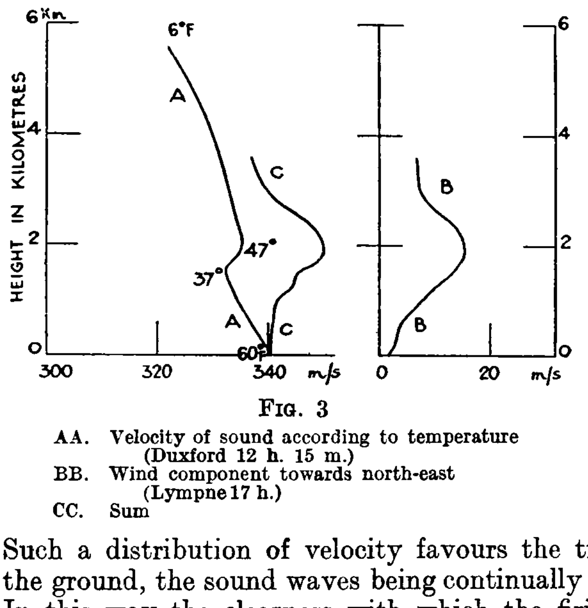


FIG. 3

AA. Velocity of sound according to temperature (Duxford 12 h. 15 m.)
BB. Wind component towards north-east (Lympne 17 h.)
CC. Sum

Such a distribution of velocity favours the travel of sound along the ground, the sound waves being continually refracted downwards. In this way the clearness with which the firing was heard in the Isle of Wight and other parts of the south coast can perhaps be explained.

The observations across the main wind current at Sidmouth and Etretat may be explained by conditions over the sea. The air was at practically the same temperature as the sea so that there would be a tendency for sound waves starting nearly horizontally across the wind to go straight on without being deflected upwards. That the firing was heard in the Channel Islands in the afternoon is more difficult to understand since in this case the sound travelled against the wind and moreover the distance is too short for passage through the high atmosphere to be likely.

In conclusion, I have to express my appreciation and thanks to the Admiralty for so courteously giving notice of the firing, to the

Board of Trade who provided most valuable observations by members of H.M. Coastguard, to the newspapers and the B.B.C. who circulated the request for observations, and to all the correspondents who were so good as to make observations and communicate their reports.

Discussions at the Meteorological Office

The subject for discussion for the next meeting is :—

January 14th, 1935. *Thermodynamics applied to air mass analysis.* By C. G. Rossby (Cambridge, Mass., Met. Pap. I No. 3, 1932). *Opener*—Prof. D. Brunt, M.A., B.Sc.

Royal Meteorological Society

The Buchan Prize of the Royal Meteorological Society for 1935 has been awarded to F. J. W. Whipple, M.A., Sc.D., F.Inst.P., for papers contributed to the *Quarterly Journal* of the Society during the years 1929–33.

The opening meeting of this Society for the present session was held on Wednesday, November 21st, at 49, Cromwell Road, South Kensington. Lieut-Col. E. Gold, D.S.O., F.R.S., President, in the Chair.

J. Edmund Clark, Ivan D. Margary, and C. J. P. Cave.—The Phenological Report, 1933.

1933 was warm, dry and sunny to an exceptional degree. Warmth was +2° F., rain 87 per cent. and sunshine 109 per cent. for the 12-month period, December to November. This was due chiefly to conditions in the summer and therefore phenologically most effective half year. Scotland, north and east, and England, north-east, were strikingly favoured. The difference in flowering period between England, south, and Scotland, north, was reduced from 20 to 10 days. The relative spacing of spring migrant isophenes tallied. Owing to the cold snap in the south at the end of April, they were decidedly close there, but broadened in the north, curiously giving a " normal " year for all districts. The most striking insect phenomenon was the excessive invasion of migrant butterflies. Noteworthy was the record of 30 of the huge American " Milkweed " butterfly, *Danaus plexippus*, treble any previous record.

E. E. Jessop, M.Sc.—A study of climate during abnormal summers in Europe and Asia.

The object was to investigate the climatic conditions prevailing over Europe, Asia and north Africa during periods of summer drought in England. By means of maps the percentage variation of rainfall from the normal over Europe, Asia and north Africa, for four British droughts, was shown, and also the pressure for the same area. From these it was possible to distinguish three types which were described and discussed in detail. In each of these types it appeared that the high pressure causing the drought in western Europe was accompanied by pressures below normal over northern Russia or northern Siberia, which caused heavy rainfall there. Pressure and rainfall graphs were plotted for a period of 30 years to test this. The influence of the position of the Indian low, and the effect of the pressure gradient to the north-west of India on monsoon rainfall was also briefly discussed.

Dugald S. Hancock.—General Sunshine Values: England and Wales, Scotland, Ireland and the British Isles, for the period 1909–1933.

The values were obtained from the "Bright Sunshine" maps of the *Monthly Weather Report.* They are grouped in four tables, which include quarterly and five-yearly means, together with the highest and lowest values for each month, with the year in which they occurred. The means for 1881–1915 are also given. Outstanding years viz. 1911, 1912 and 1933 are fully analysed. The author suggests a decrease in average insolation from 1916 onwards.

Correspondence

To the Editor, *Meteorological Magazine*

Winds Box the Compass

I experienced a very curious case of winds which veered in a short time through 360°, when I was sailing from Howth to Lambay Island and back on September 1st last.

In the morning the wind was light to moderate SW. At about 13h. 30m. B.S.T. this dropped to nothing as a heavy cloud came over from the west, and for a few minutes very heavy thunderstorm rain fell at about 14h. 15m. in a complete calm. After that a light easterly wind rose, veered in about 10 minutes to SE., S. and SW., increasing considerably until it was quite fresh. Then it got lighter again and was moderate to light veering very slowly to NW. and N., taking three-quarters of an hour to do so. Then it changed to NE., E., and another rain cloud was seen coming again from the west, well to the north of where I now was. The wind then veered to SE., S. and SW., rising to moderate strength, then slowly again to north of west.

I do not know if such small cyclonic winds are at all common anywhere in the British Isles, but I have sailed for a great many years and have never seen anything like such a perfect example.

Here off the east coast of Ireland it is quite common in the summer to get a westerly wind on the land and an easterly on the sea, and the calm between these two often moves about the water so that for a time one is in an easterly wind and a few minutes later in a westerly, but there is always a dead calm between these changes, and not a veering or backing wind.

Of course it is only when sailing on open waters that an ordinary observer can be sure that the wind has varied in direction continuously.

G. S. PHILLPOTTS.

Oakfield, Foxrock, Co. Dublin, September 24th, 1934.

[The synoptic situation on September 1st was as follows. Depressions were centred to the north-west of Ireland, and over Germany and south-west France. Dublin was just within the circulation of the depression to the north-west, but the gradient was very weak.

Conditions were favourable for thunderstorm development, and in fact a thunderstorm was reported at Aldergrove at 10h. G.M.T.

With such a pressure distribution small cyclonic disturbances would be liable to form and move slowly north-eastwards. Two such disturbances following one another at a short interval and passing just to the north-west of the observer would result in wind changes similar to those experienced by Mr. Phillpotts.—Ed. *M.M.*]

Brilliant Moon Pillar

On the evening of October 26th, 1934, at 19h. 15m. G.M.T. a brilliant moon pillar, white in colour, was observed rising from behind a cloud bank which hid the moon. Short segments of the 22° and 46° halos were visible immediately above the moon which made the pillar resemble the beam of a searchlight shining on end through a cloud sheet. Later, when the moon had risen above the cloud bank, the halo segments disappeared but the central portion of the halo increased in brilliance and the four beams of light, two horizontal and two vertical, radiating from the moon were extremely well defined. The two horizontal beams and the upper vertical beam decreased in intensity after 19h. 25m., but the lower vertical beam persisted until at least 19h. 35m.

WILLIAM D. FLOWER.

Royal Air Force, Sealand, November 11th, 1934.

Cloudiness and the State of the Sky

The usual method of expressing the state of the sky with regard to cloudiness is to give an estimate of the amount in tenths of sky covered by cloud, irrespective of type. This being so, the mean cloudiness of a place, although giving the average amount of cloud, does not convey to one the average state of the sky; because a sky totally covered with cirrus is treated numerically as being of the same cloudiness as a sky covered with, say, a dense sheet of stratus.

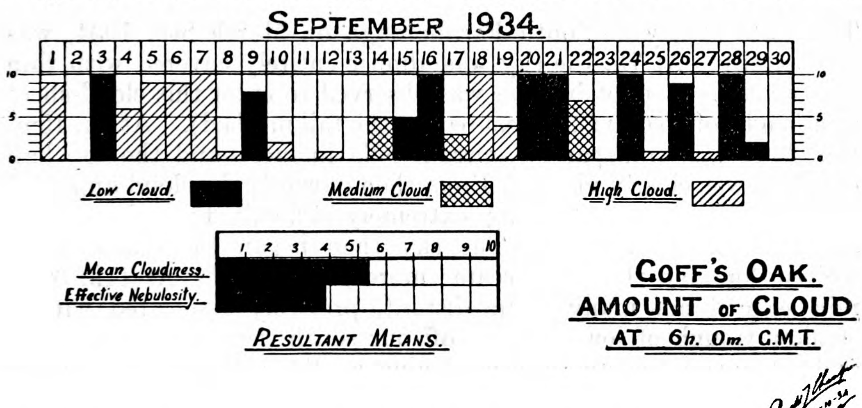
Having regard to sunshine and what is regarded as "fine" weather, maps shewing isonephs can be very misleading and something more is required than the mean area of the cloud sheet. For instance, in summer months a place having a preponderance of cirriform cloud would be classified with another whose sky is frequently overcast with heavy rain-clouds and certainly not enjoying " fine " weather. In this respect the mean cloudiness is not the same as the mean state of the sky. If, however, the density or opacity of clouds be considered as well as the area of cloud sheet, the resultant figures would give a measure of the "Effective Nebulosity."

At Goff's Oak, Hertfordshire, having found that the lower clouds are usually the more opaque, clouds have been first classified under the headings High, Medium and Low and then the Effective Nebulosity, C, estimated as follows :—

$$C = \frac{3a + 2b + c}{3n}$$

Where a = the sum of low cloud in tenths.
b = ,, ,, medium cloud in tenths.
c = ,, ,, high cloud in tenths.
n = number of observations taken.

During the month of September last, as will be seen in the attached diagram, there were 12 days on which the clouds at 6h. G.M.T.



were high cloud (mostly cirrus). Summarised, there were 84 tenths of low, 15 tenths of medium and 63 tenths of high cloud for the 30 days.

The mean cloudiness would be expressed as

$$\frac{84 + 15 + 63}{30} = 5{\cdot}4$$

Whereas the mean effective nebulosity would be expressed as

$$\frac{(3 \times 84) + (2 \times 15) + 63}{3 \times 30} = 3{\cdot}8.$$

The latter figure seems to be a fairer computation of the mean " State of the Sky " than is expressed by the mean cloudiness.

DONALD L. CHAMPION.

7, Robinson Avenue, Goff's Oak, Herts, October 12th, 1934.

[The point raised by Mr. Champion is frequently noted in the relation between nebulosity and duration of "bright sunshine." It is well known that in summer the percentage of cloud added to the duration of sunshine expressed as a percentage of "possible" amounts to more than 100, the inference being that a certain amount of cloud is so thin that the sun shining through it can still burn the card in the recorder. A calculation made some years ago* showed that in most parts of the world outside the tropics, the total amount of thin cloud (including that hidden by lower cloud) is about 60 per cent. of the total cloudiness. Mr. Champion's figure for total nebulosity is 5·4, and 60 per cent. of this gives 3·24 for total "thin" cloud, of which only 2·1 tenths would be visible. This agrees exactly with his estimated amount of 2·1 tenths of high cloud. It seems, therefore, that a more practical method of estimating "effective" nebulosity would simply be to omit high cloud.—C. E. P. BROOKS.]

Unusual Cloud Sequence and Persistent Solar Halo

The state of sky at South Farnborough on March 8th, 1934, was noteworthy. At 7h. the sky was almost entirely covered with thin alto-stratus. A pilot balloon was observed to enter this cloud-sheet at a height of 15,000 ft. (measured by the tail method). At 8h. 15m. the cloud was transparent—cirro-nebula in fact—and the top half of a halo was clearly visible. From then onwards the cloud appeared slowly to evanesce, it being extremely difficult to estimate the amount, until 10h. 30m. The sky then began to return to its whitish hue and the halo became more pronounced. At 11h. 30m. rain seemed not many hours distant, probably associated with a shallow trough of low pressure off our south-west and west coasts and advancing slowly (it was raining at Valentia at 7h.). Apart from a varying amount of detached cumulus which began to form at 9h. 55m. the sky's appearance remained unchanged until 14h. 30m.–15 h., when the whitish cloud layer became translucent, and at 16h. it appeared definitely to be thin alto-stratus (sun's place visible), but the halo could still be seen, produced perhaps by ice-crystals above the alto-stratus. Later in the afternoon a pilot reported that at 15h. 15m. the "thick haze" was very wet, base at 14,400 ft. and temperature at 14,700 ft. −18°C. (0°F.) (heights from altimeter, uncorrected). Although the sky was still covered at dusk, all stars brighter than those of 3·4 magnitude† and above an elevation of 25–30° were visible at 19h. 30m. It was thought that the cloud layer, which should have been down to about 10,000 ft. or less, was still present but invisible in the same way that the moon

---

* *London Meteor. Off., Prof. Notes* No. 53, 1929.

† (Faintest star in Ursa Major).

can often be seen through a cloud layer which was impervious until dusk. Similarly, pilots flying after dusk have, I understand, occasionally reported that the ground has been invisible from a height of, say, 2,000 ft. when the sky from the ground appeared to be cloudless. On this occasion a pilot climbed to a height of 10,000 ft. at 20h. and no cloud was encountered. At 23h. 30m. the sky was overcast, but it cleared again in the early hours and hoar frost and fog formed. The wind up to about 10,000 ft. was W. at 7h. 30m. and SW. from midday, 10–15 m.p.h.; from 10,000 ft. to 15,000 ft. it was NW. in the morning and W. from midday, 25–35 m.p.h.

Briefly the interesting facts are: a halo visible almost continuously for approximately eight hours—through clouds composed of water-drops during the afternoon. Alto-stratus, followed at 8h. 15m. by the normal cloud sequence (cirro-nebula to alto-stratus) to be expected in front of an advancing low-pressure system, then a clear sky, frost and fog. The low-pressure system was still advancing the following morning and Farnborough was enjoying summer-like weather with a midday temperature of 51°F.

J. S. Smith.

R.A.E., South Farnborough, Hants, March 9th, 1934.

Mr. C. K. M. Douglas comments on this observation as follows:—

"My experience was that alto-stratus clouds most frequently consist of ice crystals, and that the characteristic appearance of the sun "as through ground glass" is definitely caused by a layer of ice-crystals of great vertical extent. I noted a number of halo phenomena produced by clouds at 10,000 ft. or less including sun pillars and mock suns below the level at which I was flying. On one occasion when flying at 4,000 ft. the mock sun was estimated to be at 3,000 ft. The same thing has been seen at Ben Nevis Observatory, and its occasional occurrence down to ground level seems probable, even in our latitude. It is well known that this happens in high latitudes. I described my observations fully in *Edinburgh J. Scot. Meteor. Soc.* 18, pp. 83–6.

In the normal sequence of cirrostratus thickening to altostratus, the fading of the halo precedes the disappearance of the sun owing to its luminosity being much less. In the new "International Cloud Atlas," altostratus is defined as a cloud which does not give a halo. Thus a veil of cloud giving a halo is always cirrostratus, according to the new definitions. It may of course sometimes occur quite low. Height does not enter into the new definitions.

The fact that no rain followed the halo on March 8th may be explained in relation to the complex frontal situation as published in the *Daily Weather Report, International Section.* Since the high clouds came over from north-west they were associated with the occlusion off our north-west coasts, which faded out and was eventually caught up by a more active occlusion."

[If the temperature at 14,700 ft. was −18°C., that at 14,400 ft.

was probably well below freezing. If the cloud had been wet and had consisted of supercooled water drops rime should have been formed on the aeroplane. The pilot when asked whether this was the case stated that neither he nor his observer had examined the struts, etc., for rime formation as their time had been fully occupied on a special job. The impression of wetness had been produced by a film which formed on the wind screen and by the mistiness of the cloud. The observer, while agreeing that it was " very wet," preferred to call it " thick haze " rather than " cloud."—Ed. *M.M.*]

Rain in Advance of True "Warm-front" Rain

With reference to the note by Col. Gold in the November number of the *Meteorological Magazine* under the above title, I find that I noted the time the rain commenced here on October 6th, 1934. Slight rain began at 11h. 57m. G.M.T. A further observation made at 13h. shows continuous slight rain at that hour.

Is it possible that the cessation of the rain that Col. Gold comments upon may have been due to the diurnal variation of warm-front rainfall ? The existence of this variation is shown by Major Goldie in " Characteristics of rainfall distribution in homogeneous air currents and at surfaces of discontinuity " (*Geophys. Mem.*, No. 53). The curve there given for the diurnal variation of warm-front rainfall in winter (including October) at Kew, shows a secondary minimum between 14h. and 16h. G.M.T. This suggests that there is a tendency for warm-front rainfall to decrease in force at this period. The time of cessation given by Col. Gold, viz., 13h. 30m. until 15h. 30m., seems to be in fair agreement with this.

I have noticed a tendency here (Woodcote Valley) for warm-front cloud to thin or break during the early afternoon. The position here is approximately 1¾ miles south by west of the anemometer at Croydon Aerodrome.

C. Stuart Bailey.

Longtridge, 76 *Woodcote Valley Road, Purley, Surrey, November* 21*st*, 1934.

Thunderstorms and thick Snow in Cheshire

On November 1st, 1934, West Kirby, Cheshire, was visited by two early-morning thunderstorms which were so severe that they literally shook the foundations of the houses. The first occurred an hour or two after midnight, and the second at 6 a.m., the latter doing serious damage. At 9 a.m. there followed a remarkable hailstorm, the stones coming down in one continuous shower for a whole hour. There was no wind. Shortly before 11 a.m. snow began to fall, and of this there was no abatement until 6 p.m., when the ground away from the immediate sea-front had become covered to a general depth in places of over 4 inches, and on the higher ground the depth was estimated at 6 inches. The total measurement of the hail and snow, as "rain," during the 12 hours ending at 9 p.m. was 26·2 mm. at St. Andrew's Vicarage. The shade temperature at 9 a.m. was 40°, at 1 p.m. 34°, at 3 p.m. 33°, and it did not rise above 33° until 7 p.m., when a westerly breeze set in. The day altogether was a most unusual experience, and the snowfall almost unprecedented for so early in the year.

E. F. ROBSON.

West Kirby, Cheshire, December 4th, 1934.

Frontal Thunderstorm of October 23rd, 1934

During the evening of Tuesday, October 23rd, 1934, the coastal districts of north Wales and Lancashire were deluged by heavy rain with thunder at many places, the storm being particularly severe at Morecambe, where a house was struck by lightning which tore a large hole in the roof and split in two an iron bedstead. Floods occurred for a time owing to the inability of the drains to cope with the heavy rainfall. Lightning discharges were observed to the south of Liverpool, so that the places affected lay on a line at least 70 miles long. Possibly all the Lancashire coast area was affected by the same storm moving in a north-easterly direction since Manchester was practically immune. I observed a flash about 20h. 30m. G.M.T. which appeared to emanate from a north-westerly direction, and it was so intense that I doubted whether it could be anything but lightning, yet I could not feel certain it was such.

This outbreak of thunder can hardly be ascribed to anything but a front, having due regard to the time of occurrence and the general weather preceding it. An apparently feeble discontinuity was discernable on a line Blacksod–Valentia at 7h. G.M.T., October 23rd, which moved north-east at 20 to 25 m.p.h. and at 18h. had reached a line roughly Dalwhinnie–Eskdalemuir–Llandudno, the limit of its southern extremity being difficult to define. During the night of the 23rd Morecambe had 23mm. of rain, Blackpool 17mm., Southport 14mm., Colwyn Bay 12mm., and Douglas 10mm. Probably the great bulk of the rainfall was associated with the thundery conditions. The occurrence of the thunder is all the more remarkable since at 18h. it was evident that a new disturbance was approaching our south-west coasts which, subsequently moving north-north-east during the night, existed at 7h. on the 24th as a warm occlusion on a line Cork–Holyhead–Catterick. Only a slight shower at 21h. 40m. was recorded at Manchester before midnight, presumably being due to the front which caused the thunder, but 3mm. fell from the warm occlusion. From this, it appears possible that the rainfall at Morecambe due to the thunderstorm was of the order of 20mm.

Upper winds in the vicinity were south-westerly up to 15,000 feet with no substantial veer but considerable increase in velocity above 8,000 feet. The upper air ascents at Duxford do not assist in this particular case. The 13h. G.M.T. ascent showed that air forced to ascend from about 3,000 feet would meet with a very stable layer at 7,500 feet, and these conditions would prevent the growth of large cumulus clouds.

The fact that no trace of the passage of the front can be found in the records at this station, except for the shower at 21h. 40m. supports the view that the discontinuity passed to the north and that its southern extremity was ill-defined and in process of dispersal. It is likely that thunder occurred also further to the north and east although the reports available do not confirm this.

At any rate, the outbreak of thunder can be directly associated with the cold front referred to, and is all the more remarkable since relatively warmer air was already nearing our south-west coasts. A similar case occurred on July 24th, 1934, when with warm air already up to the west coast of Ireland, cold front thunderstorms were widespread in south-east England.

C. W. G. Daking.

Barton Airport, Manchester, October 31*st,* 1934.

Rain in Stationary Depressions

Readers of the *Meteorological Magazine* must be grateful to you and to Colonel Gold for the detailed review of the new Abercromby's "Weather" as revised by Major Goldie, which appeared in your July number. Their thanks are due in part for the critic's spotlight which was turned on to some places which should have received attention at this spring-cleaning of 1934.

The sub-title of the book is "The Nature of Weather Changes from Day to Day" and therefore the statement on p. 24 that "suppose the cyclone stood still for a week, then the observer would see a watery sky for a week, without any rain falling" attains importance. But this statement, which was in the original book and is retained in the new book, is so wrong that its correction seems beyond the scope of a *caveat lector* as suggested by the reviewer, and it might have been deleted without any qualms to the reviser on the score of being called an iconoclast.

Let us suppose a cyclone stands still for a week off Valentia: we shall then find that, practically irrespective of the pressure gradient, rain recurs in the neighbourhood of London at intervals of about 24 hours. In other words, at some 500 miles from the centre of a nearly stationary depression rain occurs with a daily rhythm. In actual experience, the rain bands are generally alternately light and heavy; in seasons of a dry character the lighter rain bands may only be represented by an increase of cloud or by "mackerel sky." The rain bands are separated by fine or fair intervals. Generally the passage of the rain is indicated by a fall of the barometer followed by a rise : but examples have been noted where the barograph trace has not shown the passage of several of a series of 24-hour " rain stripes," as it is convenient to call them. One example of this type occurred from June 23rd–25th, 1922, and the Director of the Meteorological Office then suggested that the reason for the daily rain and cloudless nights should be a subject for research.

Another interesting example of this type occurred in August, 1927, and lasted from the 6th to 25th; in this spell of 20 days the average period of the rain cycle at Kew, taken from the *Hourly Values* at Kew Observatory, which show the rhythm at a glance, was 25·3 hours. The average distance of the depression or depressions was 560 miles ; several centres were concerned.

Consider now the case of a depression remaining stationary near Iceland : then rain recurs in London at intervals of 48 hours, giving that rather common type of weather when alternate days are wet and fine.

One cannot establish a dogma on isolated examples but for interest it is convenient to quote the recent case when a 48 hour series of rain bands lasted for a week and the new Cunarder " Queen Mary " was launched on one of the wet days, with the alternate days brilliantly fine. In this example, as in many others, the synoptic charts on the odd days are alike, and those on the even days are also alike. The " fronts " were rather unusual in this September 22nd–29th series, and the interest is increased because they were almost exactly repeated on alternate days.

The two positions I have mentioned, off Valentia and near Iceland, are two places where we know depressions are wont to halt, perhaps for a week. With depressions in these positions, we in London get daily or bi-daily recurrences of rain, 7 in the first case, $3\frac{1}{2}$ in the second, separated by fine or fair intervals. Has anyone seen " a watery sky for a week without any rain falling " ?

R. M. Poulter.

October 1st, 1934.

The remark in question, like two others to which Col. Gold called attention, occurs in the early part of the book in a section reproduced from Abercromby's original version. At this stage the reader has not been introduced to questions of detail which receive attention in later chapters. The point at issue here indeed is the " failure " of the common prognostic if there is not a normal travel of a normal depression. It is fairly evident that the hypothetical remark, with its mild hyperbole, should not be divorced from its context or read without regard to information given elsewhere in the book and also that a digression into the features of quasi-stationary depressions was scarcely appropriate to this section.

It is also fairly certain that Abercromby was by no means ignorant of the weather features of the southern parts of quasi-stationary low pressures ; as to the northern and north-eastern sectors, he probably kept an open mind. I agree, however, that a footnote or perhaps a reference to later sections might usefully have been inserted at this point to remove cause for misunderstanding.

A. H. R. GOLDIE.

NOTES AND QUERIES

Dust-Devils

Some months ago the writer was asked by the Librarian of the United States Weather Bureau to send him, if available, some prints of dust-devils, and was surprised to discover that this phenomenon had apparently never been successfully photographed in India.

The personnel of the R.A.F. photographic sections at Quetta (in north Baluchistan) and Peshawar (in the North West Frontier Provinces) were therefore asked to take photographs of dust-devils whenever a suitable opportunity occurred. As a result, some excellent prints have been obtained by Sgt. Heaps of No. 5 (A.C.) Squadron, R.A.F., Quetta. Two of these are reproduced as the frontispiece of this number of the magazine.

The first was taken near Quetta (1·66 Km. above sea-level) at 14h. 40m. (Indian Standard time) on August 10th, 1934. On this day the 8h. (local time) chart showed a low pressure area over north Baluchistan with a moderate barometric gradient. The sky at Quetta was covered with high cloud at first but cleared rapidly in the early morning. During the forenoon cumulus cloud appeared over the surrounding hills. This cloud gradually developed into cumulo-nimbus, and by 17h. (I.S.T.) the sky was half covered—clearing subsequently at night. The surface winds were mainly calm during the morning and early afternoon but strengthened to a gentle breeze from W. by 17h. (I.S.T.). The upper winds at 7h. (I.S.T.) were 3 m/s from 150° at 2 Km. and 9 m/s from 320° at 3 Km. ; the upper winds at 15h. (I.S.T.) were 5 m/s from 260° at 2 Km. and 7 m/s from 250° at 3 Km. Upper air temperature observations made by the R.A.F. at 11h. (I.S.T.) were as follows :—

Height above ground (ft.)	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Dry bulb °F. ...	87	84	77	75	71	66	61	55	52	45	42

The dust-devil, which rotated anti-clockwise, was only a few metres in diameter but extended upwards to an estimated height of 100 metres. Its movement was every erratic.

The second photograph was taken at 15h. 15m. (I.S.T.) on September 6th, 1934. On this occasion the 8h. (local time) chart showed a low pressure area extending over north Baluchistan, the North West Frontier Provinces, and Punjab with a moderate barometric gradient. Except for a little high cloud in the early morning, the sky was clear all day. The surface winds were light and variable at first, but in the afternoon there was a gentle breeze from the west. The upper winds at 7h. (I.S.T.) were 1 m/s from 210° at 2 Km. and 8 m/s from 300° at 3 Km.; the upper winds at 15h. (I.S.T.) were 10 m/s from 260° at 2 Km. and 6 m/s from 260° at 3 Km. Upper air temperature observations made by the R.A.F. at 11h. were as follows:—

Height above ground (ft.)	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Dry bulb °F. ...	76	71	68	65	61	57	52	47	41	37	33

This dust-devil which also rotated anti-clockwise, was a little smaller in diameter than that on August 10th but extended to a greater height—estimated at 150 metres. It moved in the same direction as the surface wind.

Dust-devils occur very frequently on the barren plains and plateaux of the North West Frontier Provinces and north Baluchistan—especially in the afternoons during the hot weather if the sky has previously been mainly clear. They sometimes extend up to several thousands of feet; and aircraft flying over or through them have occasionally experienced severe "bumps." It is hoped in the near future to obtain a large number of observations and photographs of dust-devils in order to study the development of this phenomenon in detail.

R. G. VERYARD.

Agricultural-Meteorological Conference, 1934

The annual Conference of workers in Agricultural Meteorology for 1934 was held at the Meteorological Office, South Kensington, on Friday, October 5th, 1934. Sir W. Napier Shaw, F.R.S., was in the Chair.

The following papers were read and discussed:—

1. "Further Development of the Growers' Year," by Sir Napier Shaw, F.R.S.
2. "Why Things Grow," by Sir A. D. Hall, K.C.B., F.R.S., Director, John Innes Horticultural Institute and Chief Scientific Adviser to the Ministry of Agriculture and Fisheries.
3. "Evaporation—A Review of Methods and Results," by Mr. E. G. Bilham, B.Sc..(Meteorological Office).

Mr. Bilham's paper was followed by a demonstration of evaporimeters recently designed by Dr. J. S. Owens and by E. Ashby and T. A. Oxley of the Imperial College of Science.

About 40 persons attended the Conference and a few observers under the Crop-weather scheme of the Ministry of Agriculture attended a short instructional course given by Mr. E. V. Newnham of the Meteorological Office, before the Conference began.

OBITUARY

The Hon. Lady Peek.—We regret to record the death on November 3rd, 1934, of The Hon. Lady Peek who maintained a climatological station at Rousdon, Devonshire from 1886 to 1921. The data, which form a substantial contribution to the climatology of Devonshire were published successively in the *Meteorological Record* of the Royal Meteorological Society, *Daily Readings from Stations of the Second Order* and the *Monthly Weather Report.*

We regret to learn of the death, at Vilno, on October 21st, 1934, of Professor Colonel Stefan Hlasek-Hlasko, late Director of the Polish National Meteorological Institute and formerly, Director of the Observatory of Pavlovsk, Director of the Observatory of Terrestrial Magnetism at Tiflis and Commanding Officer of the Meteorological section of the Army.

We regret to learn of the death, on December 4th, 1934, at the age of 85, of Sir Horace Lamb, F.R.S., Professor of Mathematics at the University of Manchester from 1885–1920.

NEWS IN BRIEF

A Royal Medal has been awarded by the Royal Society to Prof. S. Chapman for his researches in kinetic theory of gases, in terrestrial magnetism and in the phenomena of the upper atmosphere.

Professor W. Meinardus of Göttingen will retire on April 1st, 1935 in order to carry on scientific research.

Erratum

November, 1934, title under the diagram facing p. 239 *should* read " Luminous night clouds, July 2nd, 1934."

The Weather of November, 1934

Pressure was above normal over Mexico, eastern Canada, eastern United States and across Bermuda and the North Atlantic to Iceland, southern Scandinavia, France, central and southern Europe, central and southern Russia and western Siberia, the greatest excesses being 10.4 mb. at Ekaterinburg, and 8.4 mb. at 50° N, 70° W. Pressure was below normal in western Canada, western and central United States, the Azores, Spain, north coast of Africa, Spitsbergen, northern Scandinavia and northern Russia, the greatest deficits being 4.3 mb. at Spitsbergen and 4.1 mb. at Pt. Barrow (Alaska). Temperature and rainfall were generally above normal in Spitsbergen and Scandinavia but below normal in central and south-west Europe. In Götaland (Sweden) rainfall was however deficient.

The chief features of the weather of November over the British Isles were the wintry conditions prevailing early in the month, the general deficiency of sun except in north Scotland, the deficiency of rain and the widespread fog. From the 1st to 8th the British Isles was under the influence of a complex low pressure system and unsettled conditions prevailed generally. Showers of snow, sleet or hail occurred in many places on the 1st, 2nd and 3rd with severe frost at night, —13° F. was the grass minimum at S. Farnborough on the 1st, at Dumfries on the 2nd and 11° F. at Dalwhinnie on the 3rd—but there were many long bright intervals. From the 4th to 8th however the weather became mainly dull with cold northerly winds and some rain in the south and local wintry showers in the north. The mist or fog prevailing in the northern Midlands early in the month became general in the south as well after about the 4th. On the 8th a depression advanced from the North Atlantic and remained centred over south England for the next 2 or 3 days. Heavy rain occurred generally in the south; 2·25 in. fell at Appledore (Kent) and Heathfield (Sussex) on the 8th and 1·22 in. at Banstead (Surrey) on the 9th, but in the north and west the falls were slight. Strong winds reaching gale force locally were experienced at times at exposed places. On the 12th–14th another depression moved across Ireland and south-west England giving slight to moderate rain locally in Ireland and England while mist or fog was experienced generally in England and south Scotland. At Renfrew fog persisted for 4 days from the 12th–15th being densest on the 12th and 15th, when the temperature did not rise above 31° F. all day. From the 14th to 17th pressure was low over France and a ridge of high pressure extended across Scotland connecting the anticyclones over the North Atlantic and Russia. Weather was mainly cloudy or dull with some rain locally and much mist or fog except in north Scotland and parts of Ireland where it was mainly fair. There was little diurnal variation of temperature in the south at this time, only 1° F. at Croydon on the 16th, though frost occurred in the north and west. After the 17th the high pressure area gradually moved south and from the 19th to 27th pressure was high to the south and low to the north of the British Isles. Much mist or fog prevailed in England especially the London area from the 19th to 22nd with temperature well below normal in the foggy districts, but elsewhere the weather was mild and cloudy with some rain and bright intervals. Weymouth had 7·9 hours bright sunshine on the 19th and Ross-on-Wye 7·4 hours on the 22nd. From then until the 27th the weather was mainly mild and dull with local mist and fog though there were a few bright intervals especially in northern England. Gales occurred frequently in the extreme north of Scotland from the 24th to 28th but ceased as the high pressure area extended northwards to Iceland on the 28th to 30th. On the 30th a depression was approaching from the Atlantic giving S to SW winds strong to a gale in the western districts in the evening. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	52	+ 7	Liverpool ...	43	−20
Aberdeen ...	66	+ 6	Ross-on-Wye ...	26	−40
Dublin	44	−26	Falmouth ...	56	−23
Birr Castle ...	41	−20	Gorleston ...	51	−19
Valentia... ...	53	−11	Kew	38	−15

Miscellaneous notes on weather abroad culled from various sources.

Snow fell in abundance on the Alps about the 8th and the majority of the passes were closed to vehicles. Following the recent gales and heavy rain unusually high tides flooded the square of St. Mark at Venice and the lower quarters of the city where temporary bridges have been erected (*The Times*, November 9th–10th).

During a storm in the Kwango region of the Belgian Congo a herd of buffaloes was struck by lightning 30 of them being killed. Sixty-six Africans who were crowded in a hut were killed by lightning on the 17th at Clarkesbury, Cape Province (*The Times*, November 8th–19th).

Seven hundred fishermen of Korea were reported to be missing following a storm which struck them while fishing off Kanyo about the 11th. A typhoon which passed across the Philippines about the 14th or 15th resulted in many deaths and much destruction of property. Mauban was buried under 9 ft. of water. Another typhoon struck the Philippines on the 29th cutting off communications between 7 of the central islands and Manila. In Leyte the wind is said to have reached 125 m.p.h. Eighteen people were killed and much material damage was done. The storm was far to the south of Manila (*The Times*, November 12th–December 3rd).

The heavy rain and floods in South Australia on the 5th helped diminish the grasshopper plague there. A tornado swept across the western half of Victoria on the 7th, damaging houses, crops and orchards in some parts and causing disastrous floods, but elsewhere the rain ensured plenty of summer feed. Thirty-six lives were lost by lightning and drowning and £100,000 worth of damage done to railways, bridges and crops etc. by the gales and floods near Melbourne and in Gippsland (Victoria) at the end of the month. Rains measuring $\frac{1}{4}$ to $1\frac{3}{4}$ in. fell in many districts of New South Wales near the end of the month (*The Times*, November 6th–December 4th).

A severe gale occurred in the Gulf of St. Lawrence at the beginning of the month. Fourteen people were killed owing to the flooding of the streets of San Francisco and Los Angeles by a storm passing along the Pacific coast about the 19th. Temperature was above normal in the western and central United States but variable in the eastern States early in the month becoming above normal later while the rainfall was irregular (*The Times*, November 3rd–20th and *Washington D.C., U.S. Dept. Agric. Weekly Weather and Crop Bulletin*).

Daily Readings at Kew Observatory, November, 1934

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
	mb.		°F.	°F.	%	in.	hrs.	
1	1016·8	W.3	29	45	60	0·01	6·3	x early, r_0 18h.–19h.
2	1016·8	W.3	35	45	56	trace	4·8	r_0 9h., m 18h.
3	1017·0	SSW.4	38	54	56	—	7·2	
4	1005·1	E.2	43	44	87	0·06	0·0	fr_0r 11h.–19h.
5	1003·3	N.2	39	46	79	trace	0·0	r_0 20h.–22h.
6	1001·8	NNE.4	43	47	73	0·02	0·0	r_0 5h.–9h. & 15h.
7	1008·8	N.2	36	45	71	—	1·8	x 21h.
8	1008·0	SW.3	31	47	86	0·12	0·0	r_0r 11h.–24h.
9	989·3	SSE.3	45	51	93	0·56	0·0	r_0r 0h.–8h. & 19h.–24h.
10	987·5	SE.3	45	48	87	0·57	0·1	r_0r 0h.–9h.& 14h.–19h.
11	1002·7	NNE.3	44	50	79	trace	0·4	m 9h.–12h., pr_0 15h.
12	1001·6	NW.2	41	49	70	—	2·3	f early, F night.
13	993·7	ESE.2	32	48	77	0·01	2·9	F till 9h., r_0 3h. & 8h.
14	1001·6	NNE.3	40	47	89	0·22	0·0	rr_0 17h.–21h., f or m.
15	1009·1	E.3	45	50	76	0·07	0·3	rr_0 3h.–6h. & 23h.–24h.
16	1013·5	E.2	45	47	85	0·04	0·0	rr_0 0h.–9h., f or m.
17	1016·2	N.3	45	47	83	trace	0·0	d_0 15h.
18	1025·9	NNE.3	44	49	80	0·01	0·0	r_0 3h.–5h., f 21h.
19	1028·2	SW.1	36	40	98	trace	0·0	F all day.
20	1028·7	WSW.1	34	43	93	trace	0·0	F or f all day.
21	1032·6	WSW.1	33	41	95	trace	0·0	F all day.
22	1033·4	SW.2	41	51	71	—	3·7	f till 10h. 30m.
23	1030·5	WSW.2	36	49	87	trace	0·9	r_0 3h.–8h., f 7h.
24	1034·5	SW.1	47	51	99	0·01	0·0	r_0 9h.–12h., f 7h.–18h.
25	1038·0	S.2	48	50	89	—	0·0	f till 12h.
26	1032·5	W.3	48	52	66	—	3·1	
27	1034·0	W.2	48	56	70	—	4·2	f about 9h.
28	1033·7	N.1	50	52	82	0·02	0·0	fd_0, 15h.–24h.
29	1033·3	S.1	48	49	92	0·03	0·0	fm all day, r_0 0h.–9h.
30	1032·3	SE.3	47	49	68	—	0·0	f till 8h.
*	1017·0		41	48	80	1·76	1·3	* Means or totals.

General Rainfall for November, 1934

England and Wales ...	75	per cent of the average 1881–1915.
Scotland	49	
Ireland	46	
British Isles	62	

Rainfall : November, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square..........	1·85	78	*Leics* .	Thornton Reservoir ...	2·44	108
Sur .	Reigate, Wray Pk. Rd..	3·17	102	,, .	Belvoir Castle...........	2·09	94
Kent .	Tenterden, Ashenden...	2·73	90	*Rut* .	Ridlington	2·19	95
,, .	Folkestone, Boro. San.	2·30	...	*Lincs* .	Boston, Skirbeck.........	1·97	99
,, .	Eden'bdg., Falconhurst	4·07	115	,, .	Cranwell Aerodrome...	1·73	93
,, .	Sevenoaks, Speldhurst.	2·72	...	,, .	Skegness, Marine Gdns.	1·48	69
Sus .	Compton, Compton Ho.	3·66	96	,, .	Louth, Westgate.........	2·33	90
,, .	Patching Farm..........	5·10	143	,, .	Brigg, Wrawby St.......	2·03	...
,, .	Eastbourne, Wil. Sq....	4·47	128	*Notts* .	Worksop, Hodsock......	2·18	111
,, .	Heathfield, Barklye....	4·67	126	*Derby*.	Derby, L. M. & S. Rly.	2·03	94
Hants.	Ventnor, Roy.Nat.Hos.	4·44	138	,, .	Buxton, Terr. Slopes...	2·00	43
,, .	Fordingbridge, Oaklnds	2·42	71	*Ches* .	Runcorn, Weston Pt....	1·98	71
,, .	Ovington Rectory.......	...	...	*Lancs*.	Manchester, Whit. Pk.	1·39	53
,, .	Sherborne St. John......	1·88	66	,, .	Stonyhurst College......	2·25	50
Herts .	Welwyn Garden City ...	2·03	85	,, .	Southport, Bedford Pk.	2·60	83
Bucks.	Slough, Upton............	2·08	94	,, .	Lancaster, Greg Obsy.	1·46	37
,, .	H. Wycombe, Flackwell	1·85	72	*Yorks*.	Wath-upon-Dearne......	1·91	94
Oxf .	Oxford, Mag. College...	1·57	71	,, .	Wakefield,Clarence Pk.	2·12	100
Nor .	Pitsford, Sedgebrook...	1·74	79	,, .	Oughtershaw Hall.......	2·99	...
,, .	Oundle	1·47	...	,, .	Wetherby, Ribston H..	2·25	96
Beds .	Woburn, Exptl. Farm...	1·94	87	,, .	Hull, Pearson Park......	2·04	93
Cam .	Cambridge, Bot. Gdns.	2·06	107	,, .	Holme-on-Spalding......	1·80	83
Essex.	Chelmsford, County Lab	1·52	68	,, .	West Witton, Ivy Ho.	2·17	63
,, .	Lexden Hill House......	1·52	...	,, .	Felixkirk, Mt. St. John.	2·18	89
Suff .	Haughley House.........	1·56	...	,, .	York, Museum Gdns....	1·68	80
,, .	Campsea Ashe............	1·75	79	,, .	Pickering, Hungate......	1·96	79
,, .	Lowestoft Sec. School...	1·45	62	,, .	Scarborough..............	2·91	118
,, .	Bury St. Ed., WestleyH.	1·20	52	,, .	Middlesbrough...........	2·05	97
Norf. .	Wells, Holkham Hall...	1·73	80	,, .	Baldersdale, Hury Res.	1·80	49
Wilts .	Calne, Castleway.........	1·58	58	*Durh* .	Ushaw College...........	2·98	117
,, .	Porton, W.D. Exp'l. Stn	1·67	64	*Nor* .	Newcastle, Town Moor.	2·97	123
Dor .	Evershot, Melbury Ho.	2·22	52	,, .	Bellingham, Highgreen	2·08	61
,, .	Weymouth, Westham.	2·14	69	,, .	Lilburn Tower Gdns....	4·09	122
,, .	Shaftesbury,Abbey Ho.	2·05	63	*Cumb*.	Carlisle, Scaleby Hall...	·50	17
Devon.	Plymouth, The Hoe....	1·46	40	,, .	Borrowdale, Seathwaite	5·00	39
,, .	Holne, Church Pk. Cott.	3·23	50	,, .	Borrowdale, Moraine...	2·40	23
,, .	Teignmouth, Den Gdns.	2·24	72	,, .	Keswick, High Hill......	1·38	24
,, .	Cullompton	1·47	43	*West* .	Appleby, Castle Bank...	·74	22
,, .	Sidmouth, U.D.C.........	1·43	...	*Mon* .	Abergavenny, Larchf'd	2·04	53
,, .	Barnstaple, N. Dev.Ath	2·80	71	*Glam* .	Ystalyfera, Wern Ho....	2·13	32
,, .	Dartm'r,Cranmere Pool	3·30	...	,, .	Cardiff, Ely P. Stn.......	1·72	41
,, .	Okehampton, Uplands.	2·54	48	,, .	Treherbert, Tynywaun.	3·77	...
Corn .	Redruth, Trewirgie......	2·67	55	*Carm* .	Carmarthen, Priory St..	...	...
,, .	Penzance, Morrab Gdn.	2·91	64	*Pemb* .	Haverfordwest, School.	...	...
,, .	St. Austell, Trevarna...	2·08	42	*Card* .	Aberystwyth	1·87	...
Soms .	Chewton Mendip.........	1·92	45	*Rad* .	BirmW.W.Tyrmynydd	2·39	36
,, .	Long Ashton.............	1·32	42	*Mont* .	Lake Vyrnwy	2·74	49
,, .	Street, Millfield..........	1·16	42	*Flint* .	Sealand Aerodrome......	2·55	107
Glos .	Blockley	1·93	...	*Mer* .	Dolgelley, Bontddu......	2·11	34
,, .	Cirencester, Gwynfa....	1·51	51	*Carn* .	Llandudno	1·65	57
Here .	Ross, Birchlea...........	2·13	84	,, .	Snowdon, L. Llydaw 9..	5·57	...
Salop.	Church Stretton.........	2·75	93	*Ang* .	Holyhead, Salt Island...	2·75	66
,, .	Shifnal, Hatton Grange	2·33	97	,, .	Lligwy	2·72	...
Staffs.	Market Drayt'n, Old Sp.	2·31	88	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	1·42	62		Douglas, Boro' Cem....	2·83	59
War .	Alcester, Ragley Hall...	1·82	79	*Guernsey*			
,, .	Birminghm, Edgbaston	2·07	87		St. PeterP't.Grange Rd.	5·34	127

Rainfall: November, 1934: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	2·00	46	*Suth* .	Melvich	2·59	65
,, .	New Luce School	2·19	43	,, .	Loch More, Achfary	5·79	68
Kirk .	Dalry, Glendarroch	1·19	20	*Caith* .	Wick	2·01	64
,, .	Carsphairn, Shiel	2·02	26	*Ork* .	Deerness	2·66	68
Dumf.	Dumfries, Crichton, R.I.	·59	17	*Shet* .	Lerwick	3·03	71
,, .	Eskdalemuir Obs	2·26	39	*Cork* .	Caheragh Rectory	3·62	...
Roxb .	Branxholm	1·76	48	,, .	Dunmanway Rectory	3·00	48
Selk .	Ettrick Manse	2·38	44	,, .	Cork, University Coll	1·33	33
Peeb .	West Linton	2·66	...	,, .	Ballinacurra	1·26	31
Berw .	Marchmont House	2·91	97	,, .	Mallow, Longueville	1·87	50
E.Lot.	North Berwick Res	2·07	92	*Kerry*.	Valentia Obsy	3·76	69
Midl .	Edinburgh, Roy. Obs.	·93	42	,, .	Gearhameen	4·90	51
Lan .	Auchtyfardle	1·21	...	,, .	Darrynane Abbey	3·76	74
Ayr .	Kilmarnock, Kay Pk	1·13	...	*Wat* .	Waterford, Gortmore	1·24	34
,, .	Girvan, Pinmore	1·36	26	*Tip* .	Nenagh, Cas. Lough	1·79	45
Renf .	Glasgow, Queen's Pk	1·05	28	,, .	Roscrea, Timoney Park	1·36	...
,, .	Greenock, Prospect H.	2·70	42	,, .	Cashel, Ballinamona	1·04	30
Bute .	Rothesay, Ardencraig	2·09	...	*Lim* .	Foynes, Coolnanes	2·17	54
,, .	Dougarie Lodge	1·79	...	,, .	Castleconnel Rec	2·70	...
Arg .	Ardgour House	4·65	...	*Clare* .	Inagh, Mount Callan	4·01	...
,, .	Glen Etive	...	...	,, .	Broadford, Hurdlest'n.	1·93	...
,, .	Oban	1·98	...	*Wexf* .	Gorey, Courtown Ho	2·17	62
,, .	Poltalloch	2·13	38	*Wick* .	Rathnew, Clonmannon.	4·90	...
,, .	Inveraray Castle	3·20	38	*Carl* .	Hacketstown Rectory	1·96	50
,, .	Islay, Eallabus	2·57	48	*Leix* .	Blandsfort House	1·41	42
,, .	Mull, Benmore	...	...	,, .	Mountmellick	1·30	...
,, .	Tiree	1·67	35	*Offaly*.	Birr Castle	1·34	43
Kinr .	Loch Leven Sluice	...	...	*Dublin*	Dublin, FitzWm. Sq	1·90	71
Perth .	Loch Dhu	1·75	20	,, .	Balbriggan, Ardgillan	1·76	61
,, .	Balquhidder, Stronvar.	2·10	...	*Meath*.	Beauparc, St. Cloud	1·23	...
,, .	Crieff, Strathearn Hyd.	·74	17	,, .	Kells, Headfort	1·21	36
,, .	Blair Castle Gardens	·29	8	*W.M* .	Moate, Coolatore	1·60	...
Angus.	Kettins School	·71	23	,, .	Mullingar, Belvedere	1·45	43
,, .	Pearsie House	·82	...	*Long* .	Castle Forbes Gdns	1·55	43
,, .	Montrose, Sunnyside	1·23	46	*Gal* .	Galway, Grammar Sch.	·88	...
Aber .	Braemar, Bank	1·52	40	,, .	Ballynahinch Castle	4·01	67
,, .	Logie Coldstone Sch	2·33	76	,, .	Ahascragh, Clonbrock.	1·61	40
,, .	Aberdeen, King's Coll.	2·42	82	*Mayo*.	Blacksod Point	3·54	68
,, .	Fyvie Castle	3·29	95	,, .	Mallaranny	4·02	...
Moray	Gordon Castle	1·73	60	,, .	Westport House	2·32	47
,, .	Grantown-on-Spey	...	...	,, .	Delphi Lodge	6·39	61
Nairn.	Nairn	·76	32	*Sligo* .	Markree Obsy	1·82	43
Inv's .	Ben Alder Lodge	·62	...	*Cavan*.	Crossdoney, Kevit Cas.	1·34	...
,, .	Kingussie, The Birches.	1·13	...	*Ferm* .	Enniskillen, Portora	·91	...
,, .	Inverness, Culduthel R.	1·13	...	*Arm* .	Armagh Obsy	·69	24
,, .	Loch Quoich, Loan	...	...	*Down*.	Fofanny Reservoir	2·66	...
,, .	Glenquoich	6·42	53	,, .	Seaforde	1·82	48
,, .	Arisaig, Faire-na-Sguir.	2·65	...	,, .	Donaghadee, C. Stn.	·98	32
,, .	Fort William, Glasdrum	2·88	...	,, .	Banbridge, Milltown	·85	31
,, .	Skye, Dunvegan	5·86	...	*Antr* .	Belfast, Cavehill Rd	1·30	...
,, .	Barra, Skallary	2·76	...	,, .	Aldergrove Aerodrome.	·70	22
R&C .	Alness, Ardross Castle.	1·79	45	,, .	Ballymena, Harryville.	1·64	40
,, .	Ullapool	3·21	60	*Lon* .	Garvagh, Moneydig	1·39	...
,, .	Achnashellach	4·67	51	,, .	Londonderry, Creggan.	1·51	37
,, .	Stornoway	2·35	40	*Tyr* .	Omagh, Edenfel	1·45	38
Suth .	Lairg	1·72	43	*Don* .	Malin Head	1·51	...
,, .	Tongue	2·89	63	,, .	Killybegs, Rockmount.	2·64	...

Climatological Table for the British Empire, June, 1934

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	Absolute. Min.	Mean Values. Max.	Mean Values. Min.	Mean Values. ½ Max. and Min.	Mean Values. Diff. from Normal.	Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt.	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1017·7	+ 1·0	84	46	70·5	52·3	61·4	+ 2·2	53·2	76	7·2	1·00	− 1·15	8	6·83	41
Gibraltar	1015·8	− 1·5	91	57	81·1	63·1	72·1	+ 1·6	62·0	80	3·8	0·00	− 0·54	0	...	...
Malta	1015·0	− 0·2	94	65	79·5	68·4	73·9	+ 1·2	67·1	71	4·0	0·02	− 0·07	1	10·92	75
St. Helena	1014·5	− 0·4	69	55	64·6	58·3	61·5	+ 1·0	59·2	94	7·5	2·39	...	13	...	...
Freetown, Sierra Leone	1012·7	+ 0·7	89	64	86·7	72·3	79·5	− 0·8	77·1	90	8·2	17·95	− 2·09	26	...	...
Lagos, Nigeria	1012·1	− 0·3	89	72	85·7	75·4	80·5	+ 1·0	76·0	87	8·4	15·68	− 2·80	19	5·1	41
Kaduna, Nigeria	1008·6	...	91	66	87·3	68·8	78·1	+ 1·6	72·5	83	6·8	8·70	+ 1·61	14	7·5	59
Zomba, Nyasaland	1014·6	− 2·9	79	50	72·2	57·0	64·6	+ 1·7	60·5	81	7·2	1·14	+ 0·66	10	...	...
Salisbury, Rhodesia	1021·3	0·0	76	40	69·0	47·2	58·1	+ 1·2	51·5	67	4·1	0·28	+ 0·23	8	6·5	59
Cape Town	1020·8	+ 0·7	85	41	70·3	50·5	60·4	+ 4·7	50·8	87	3·8	1·79	− 2·71	5	...	...
Johannesburg	1024·7	+ 2·4	65	36	60·7	42·0	51·3	+ 0·6	43·2	63	1·5	0·14	0·00	1	8·2	78
Mauritius	1019·4	+ 0·4	77	58	74·7	63·3	69·0	− 0·4	65·5	73	4·7	3·09	+ 0·29	23	7·6	70
Calcutta, Alipore Obsy.	1000·9	+ 1·2	101	73	92·1	79·5	85·8	+ 0·7	80·7	87	7·8	7·69	− 4·22	9*	...	...
Bombay	1003·8	− 0·2	93	75	88·9	78·1	83·5	− 0·5	78·5	84	7·7	28·45	+ 8·58	20*	...	...
Madras	1003·9	+ 0·1	108	73	97·4	80·3	88·9	− 1·1	76·1	65	8·0	1·76	− 0·21	5*	...	...
Colombo, Ceylon	1009·4	+ 0·8	87	73	84·5	76·4	80·5	− 1·1	77·2	83	8·5	18·22	+ 10·90	21	3·4	27
Singapore†	1009·0	+ 0·1	89	71	86·3	75·6	80·9	− 0·6	78·0	82	8·1	8·39	+ 1·52	13	6·2	51
Hongkong	1008·2	+ 2·4	91	74	86·0	77·1	81·5	+ 0·1	78·1	82	8·6	25·11	+ 9·41	26	4·7	35
Sandakan	1009·8	...	92	71	88·6	74·4	81·5	− 0·2	77·0	86	7·0	8·59	+ 1·09	22	...	...
Sydney, N.S.W.	1020·3	+ 2·4	67	43	61·6	47·4	54·5	− 0·2	48·8	81	6·2	4·12	− 0·62	14	5·2	53
Melbourne	1022·0	+ 3·5	65	33	56·2	39·8	48·0	− 2·4	43·5	86	6·1	1·73	− 0·33	13	4·2	44
Adelaide	1021·0	+ 1·9	69	39	63·3	47·2	55·3	+ 1·8	48·7	68	6·6	1·03	− 2·07	11	4·1	42
Perth, W. Australia	1019·1	+ 1·1	73	41	63·9	48·9	56·4	− 0·4	50·6	73	5·3	11·41	+ 4·47	15	5·2	52
Coolgardie	1019·3	+ 0·4	71	37	60·8	44·2	52·5	− 0·3	48·4	76	5·8	1·19	− 0·07	9	...	...
Brisbane	1019·7	+ 1·4	76	40	68·6	47·6	58·1	− 2·1	51·8	70	2·8	0·76	− 2·03	4	7·6	73
Hobart, Tasmania	1022·0	+ 7·7	55	31	51·1	39·0	45·1	− 1·9	40·1	79	6·8	1·04	− 1·19	12	4·0	44
Wellington, N.Z.	1015·7	+ 0·8	57	35	51·7	42·6	47·1	− 2·4	45·1	85	6·9	4·81	+ 0·04	20	3·3	36
Suva, Fiji	1014·2	+ 0·6	88	64	79·9	70·7	75·3	+ 0·6	71·8	85	7·7	3·20	− 3·51	19	3·3	30
Apia, Samoa	1011·3	− 0·3	88	69	85·4	73·0	79·2	+ 1·4	75·6	79	4·1	1·64	− 3·71	8	...	...
Kingston, Jamaica	1013·6	− 0·2	92	69	88·1	74·1	81·1	− 0·2	72·6	73	5·1	0·61	− 3·49	6	6·5	49
Grenada, W.I.	1010·1	− 3·2	88	70	85	72	78·5	− 0·5	73·0	74	7	11·98	+ 3·73	23	...	...
Toronto	1011·3	− 3·4	94	49	78·9	56·8	67·9	+ 4·1	59·2	67	4·1	2·75	+ 0·09	7	9·8	64
Winnipeg	1011·6	− 0·2	90	38	71·5	50·7	61·1	− 1·2	51·9	80	6·2	4·15	+ 1·04	14	7·6	47
St. John, N.B.	1011·3	− 2·2	78	39	64·3	47·8	56·1	− 0·4	51·4	78	7·3	4·57	+ 1·30	15	6·5	42
Victoria, B.C.	1016·2	− 0·6	72	47	65·6	50·1	57·9	− 0·9	53·8	75	3·7	0·21	− 0·63	4	12·0	75

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(23666) Wt. 25/32 1,000 12/34 Hw. G 377/6

M.O. 371.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 69

Jan. 1935

No. 828

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses
ADASTRAL HOUSE, KINGSWAY, LONDON, W.C.2; 120 GEORGE STREET, EDINBURGH 2
YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any Bookseller.

Temperature of the Surface Water of Loch Maree July, 1932–September, 1934

In 1932 Mr. Malcolm MacLennan, of Letterewe, Ross-shire, offered to take daily readings of the temperature of the water of Loch Maree if a suitable thermometer could be loaned. (Mr. MacLennan also keeps a rainfall record.) A thermometer was issued—an ordinary Mark I mercury thermometer with Sea Protector—and observations commenced in July, 1932. The readings are taken daily at about 9 a.m. G.M.T. at the side of the Loch, near Letterewe, the thermometer, case and all being plunged over a foot under water and kept there for three minutes before a reading is taken. The temperatures are taken 3 feet from the bank in a place where the water is at least 8 feet in depth. Opposite this point, which is roughly midway along the length of the Loch, there is deep water, the 40-fathom line being ¼ mile out.

Loch Maree is a long narrow loch 13½ miles long and generally more than ½ mile wide, with a superficial area of 11 square miles, a maximum depth of 367 feet and a mean depth of 125 feet. Its estimated volume of water is 38,539 million cubic feet and it is sixth in volume amongst the fresh-water lochs of Scotland.

There is a considerable amount of information available about the temperature conditions and the temperature changes of Scottish freshwater lochs, both in space and time. Most of this information was collected in the years 1897–1909 by Sir John Murray, Mr. Laurence Pullar, Professor E. M. Wedderburn and their associates;

the physical problems arising were very fully discussed in numerous papers by Professor Wedderburn, whose work on seiches is well known. A summary of the information and many references to papers are to be found in Sir John Murray's " Bathymetrical Survey of the Scottish freshwater Lochs ", issued by the Challenger Office, Edinburgh, in 1910.

TABLE I.—MONTHLY MEAN TEMPERATURES OF THE SURFACE WATER AT LOCH MAREE (NEAR LETTEREWE) AND OF THE AIR AT ACHNASHELLACH

	1932		1933		1934		Means	
	Water	Air	Water	Air	Water	Air	Water	Air
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
January	—	—	42·3	35·9	42·8	40·7	42·5	38·3
February ...	—	—	41·5	37·7	42·6	42·1	42·1	39·9
March	—	—	41·5	44·3	42·0	38·6	41·7	41·5
April	—	—	44·0	46·4	43·1	41·0	43·5	43·7
May	—	—	49·4	51·7	45·8	47·6	47·6	49·7
June	—	—	58·3	58·9	54·4	57·0	56·3	57·9
July	58·3	57·7	62·7	60·1	61·5	60·1	60·8	59·3
August	59·0	56·1	60·8	57·1	59·3	56·3	59·7	56·5
September ...	55·6	51·0	58·7	55·8	56·9	54·7	57·1	53·8
October	50·6	45·1	53·9	47·7	—	—	52·3	46·4
November ...	47·6	42·4	46·6	40·3	—	—	47·1	41·3
December ...	44·2	40·9	43·7	37·5	—	—	43·9	39·2
Year	—	—	—	—	—	—	49·5	47·3

In the Loch Maree series, made since 1932, surface observations only have been possible, but they have been made daily for two years and three months. The monthly mean water temperatures are given in Table I together with the mean air temperatures of the same months at Achnashellach, some 14 miles distant. The object has been chiefly to obtain information as to the nature and extent of the temperature changes of the surface of such a sheet of water and the nature of the annual variation. The most nearly comparable series of regular surface observations is that made by the Scottish Lake Survey at Loch Ness* from July, 1903, to April, 1905. The Loch Ness observations, however, were on a much more elaborate scale and included observations at various depths down to 200 feet. For the most part, they were made from a small decked yacht anchored off Fort Augustus in 250 feet of water. The time of

* E. M. WEDDERBURN—*Edinburgh, Trans. R. Soc. XLV, Pt. II, No.* 16, 1907.

observation varied; in cases where more than one series had been taken in one day, the earliest only was used in computing mean temperature. Loch Ness resembles Loch Maree in so far that it is also a long narrow loch, but its length and its superficial area are each approximately twice those of Loch Maree, its maximum depth is 754 feet and its mean depth 433 feet. The volume of water contained is indeed approximately seven times as great as that of Loch Maree.

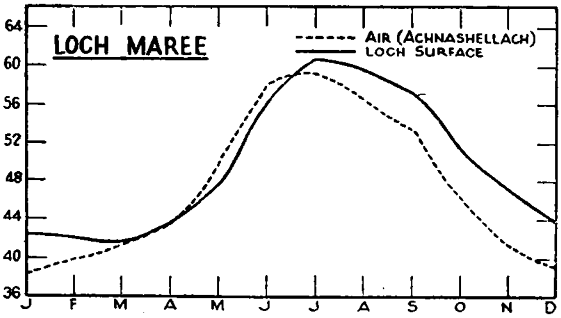


Fig. 1

In Fig. 1 are set out the mean surface water temperatures at Loch Maree as derived from the 27 months' observations in 1932–4 and also the mean air temperatures as derived from the observations of the same months at Achnashellach.

In Fig. 2, for purposes of comparison, are set out the mean temperatures at the surface and at a depth of 200 feet in Loch Ness as derived from 22 months' observations in 1903–5, and also the mean air temperatures as derived from the observations of the same months at Fort Augustus. It is notable in both cases that for the year as a whole the mean surface water temperature exceeds the mean air temperature—by 2·2° F. in the case of Loch Maree and by 0·8° F. in the case of Loch Ness. If instead of Achnashellach air temperatures we take those of Stornoway for comparison with Loch Maree the difference is reduced from 2·2° to 1·5°, but it is still positive.

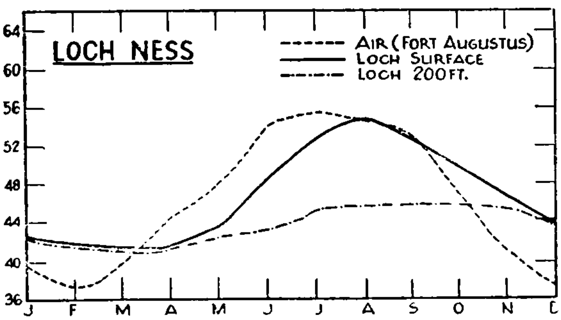


Fig. 2

The curves of annual variation show that the higher mean temperature of the surface water of the lochs comes from the feature that in the winter months the loch temperature is not appreciably depressed but remains sensibly constant as compared with the variation of the air temperature. The Loch Ness observations showed that the temperature at 200 feet was always less than or at most equal to that at the surface, that its annual variation had a range of only 4·8° F., and that it never fell below the temperature of maximum density. Loss of heat from surface water thus tends always to set up convection (quite apart from any mixing set up by disturbance due to strong winds). In fact, in each month from December to March the mean temperatures obtained in Loch Ness were almost identical from the surface down to 200 feet.

As might be expected in view of the smaller depth of water, especially where the temperatures were taken, Loch Maree observations show a steeper rise of temperature in summer than those at Loch Ness and attain their maximum about a month earlier, i.e., they follow up the air temperature much more closely. The greatest excess of loch temperature over air temperature occurs at Loch Maree in October and November (5·9° and 5·8°) and at Loch Ness in November and December (5·5° and 6·5°). The high difference at Loch Ness in December arises mainly, however, from the unusually low mean air temperature of 35·7° F. at Fort Augustus in December, 1903, when mean air temperature was 8·4° below loch temperature.

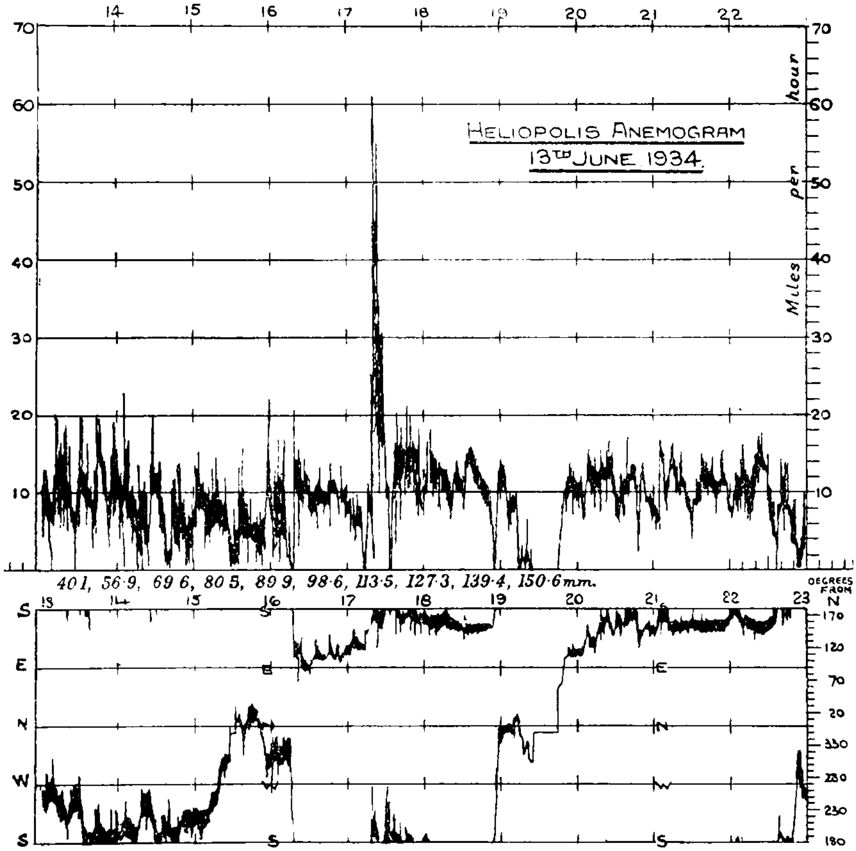
The annual range of the surface water temperature at Loch Maree is 91 per cent. of that of the air temperature; at Loch Ness the surface water had an annual range equal to 72 per cent. of that of the air temperature and at 200 feet a range equal to only 26 per cent. of that of the air temperature. The interdiurnal change of temperature at Loch Maree was usually slow. The largest variations found within a calendar month were 9° F. in May and in October, 1933. In the former case between May 15th and May 29th there occurred a rise of 9° F., about half of which may be regarded as the contribution from the normal annual variation. In October, 1933, the fall of 9° was a practically continuous change throughout the month at about twice the rate shown in October, 1932.

The observations cover the summer period, July to September, of three years. Of these 1933 was the warmest—in the mean 3·1° warmer than 1932, which was the coldest. The highest temperature attained by the loch surface was 65° F. on two days in July, 1933, and two days in July, 1934; the lowest was 39° F. on four days in February, 1933. The loch is said never to freeze.

A. H. R. GOLDIE.

Minor Haboob at Heliopolis, Egypt

A very severe sandstorm (or minor "haboob") was experienced in the Cairo Area on June 13th, 1934. The day had been extremely hot and almost calm throughout. Towards dusk unusually heavy conditions prevailed, and at 17h. 10m. G.M.T. a heavy mass of sand was observed approaching Heliopolis from south-south-west or south-west. The height of rising sand was estimated to be about 1,500 ft. to 2,000 ft., and it did not appear to extend along a long front, but owing to buildings obstructing the view the full extent could not be gauged. At 17h. 20m. G.M.T. a squall of 61 m.p.h. was recorded at the Meteorological Office, Heliopolis aerodrome (about ¼ mile to the south of the town), and immediately afterwards the visibility deteriorated to less than 50 yards. After about 10 minutes the sandstorm had passed, but its effect was felt for a considerable time afterwards as sand particles were held in suspension over Heliopolis up to a very late hour. A member of the staff of this office who lives about 1 mile to the north-west of Heliopolis, reported later that no gust occurred, and even in western Heliopolis itself the wind

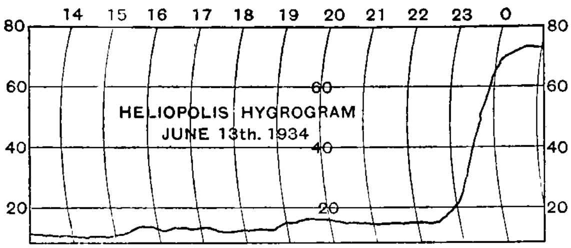


is estimated not to have exceeded 20–25 m.p.h. It appears probable therefore that the storm was of very limited extent and may not have been more than 3 miles wide. Its track after passing Heliopolis seems to have been over the open desert.

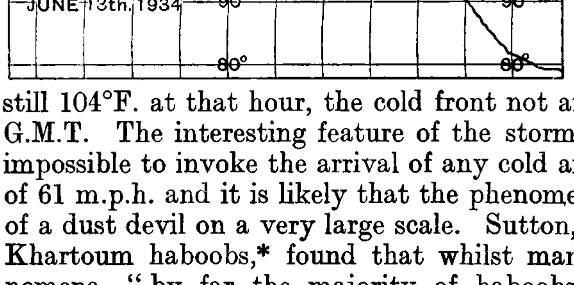
According to press reports serious damage was caused by the storm in Cairo. Trees and hoardings were blown down, pleasure boats on the Nile were blown about as if made of paper and some were capsized. Four swimmers in the Nile about a mile south of Cairo lost their lives by being caught in whirlpools set up by the violence of the squall.

It is worthy of note that the squall of 61 m.p.h. is the highest recorded at Heliopolis during the past 10 years at least; in fact gusts exceeding 50 m.p.h. have been recorded previously on six occasions only.

Normally in Lower Egypt sandstorms are caused either by the action of a sufficiently strong surface wind, or the actual "scooping up" of sand which occurs with the arrival of a cold front. In the first case the visibility may be reduced to 1,000 to 2,000 yards for hours on end; in the latter, the visibility is often reduced to less than 100 yards temporarily, but conditions improve quickly. The storm of June 13th was more similar in character to the haboobs experienced in the Sudan than to either of the types usually experienced in Egypt.



The synoptic chart for the morning of June 13th showed the existence of a desert depression of only moderate intensity west-south-west of the Nile Delta and the centre moved east-north-east between Cairo and Aboukir during the ensuing 12 hours. In front of the on-coming "low" very high temperatures were reached, the maximum at Heliopolis being 113°F., or only 5° less than the record for this station, which happens to have occurred on exactly the same date in 1933. On June 13th, 1933, however, by 18h. G.M.T. the temperature had fallen to 85°F., whereas in the present case it was still 104°F. at that hour, the cold front not arriving until 22h. 50m. G.M.T. The interesting feature of the storm is the fact that it is impossible to invoke the arrival of any cold air to explain the squall of 61 m.p.h. and it is likely that the phenomenon was of the nature of a dust devil on a very large scale. Sutton, in his investigation of Khartoum haboobs,* found that whilst many are cold front phenomena, "by far the majority of haboobs probably have their origin in the diurnal variation of temperature and pressure in the northern Sudan and adjacent regions." The 12h. G.M.T. temperature at Aboukir was 83°F., whilst at Heliopolis it was 112°F., representing an average horizontal temperature gradient of 29°F. per 100 miles, which is almost certainly equal to or more than gradients



* See *London, Q.J.R. Meteor. Soc.*, **57**, 1931, p. 155.

occurring in the Sudan. It should be remarked, however, that most stations in the Delta recorded temperatures over 105°F., so that the very steep gradient was confined to a relatively narrow strip of country near the coast.

Autographic records of wind, temperature and humidity are shown in the accompanying diagrams. The similarity of the squall with one which occurred at Amman on March 4th, 1934, is noteworthy.

Another minor haboob was experienced in Cairo at 20h. 15m. G.M.T. on June 13th, but did not affect Heliopolis. The Director, Meteorological Service, Physical Department, Cairo, reports that neither of the storms were experienced at Helwan Observatory (20 miles to south of Heliopolis); in fact, autographic records from that place show no gust stronger than 17 m.p.h. until the arrival of the cold front at 0h. 35m. on June 14th.

C. V. OCKENDEN.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are :—

January 28th, 1935.—*The branching of lightning and the polarity of thunderclouds.* By J. C. Jensen. (Philadelphia, J. Franklin Inst. 216, 1933, pp. 707–48.) *Opener:* Mr. R. E. Watson, Ph.D.

February 11th, 1935.—*Practical weather analysis.* By G. Schinze. (Hamburg, Aus. d. Arch. dtsch. Seew. 52, No. 1, 1932) (in German). *Opener:* Mr. W. A. Harwood, D.Sc.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, December 19th, at 49, Cromwell Road, South Kensington, Lieut.-Col. E. Gold, D.S.O., F.R.S., President, in the chair.

The following papers were read and discussed :—

C. K. M. Douglas, B. A.—Some Facts and Theories about the Upper Atmosphere.

The first part of the paper consists mainly of detail and the latter part of a discussion of general principles, dealing more especially with the structure of depressions and anticyclones. The paper is in five sections :—

1. It is shown that the changes of temperature of a given moving air mass at fixed levels between 2 and 5 Km. are often slow, but that subsidence of initially cold air may cause a rise of temperature of the order of 10° F. in 24 hours in certain cases.

2. It is shown that the ascending air over a rain area is normally warmer than the adjacent air at the 4 Km. level. Some details are given.

3. The variations of the height of the tropopause are discussed.

It is thought that the air masses just below and above the tropopause move (slowly) up or down together.

4. The rotary aspects of depressions and anticyclones are considered in relation to convergence and divergence in the horizontal motion. The high-level systems appear first behind the low-level centres and are sheared over them. It is thought that a high-level depression is partly advective in character, but also develops over the subsiding cold air, while a high-level anticyclone (or wedge) develops over rising warm air.

5. It is considered that the troposphere is normally the primary theatre of action, but that air movements in the stratosphere play a necessary part in the development of depressions and anticyclones. There is some discussion of surges and of the movements of air from one system to another.

H. L. Wright, M. A.— Visibility and Atmospheric Suspensoids at Kew Observatory.

At Kew Observatory, in the afternoon, the distance of vision if above 2 Km. depends so little on nuclei and humidity that their effect may be neglected. The distance of vision varies inversely as the number of particles raised to a power apparently a little greater than unity. It also depends on some other quantity which is subject to annual variation and it is suggested that this quantity may be the size of the particles.

Conditions of mist and fog in the afternoon are associated with high humidity and with high concentrations of particles and nuclei. As each one of these quantities increases so does the density of the fog. The order of importance of these three quantities cannot be assigned at present with any certainty.

C. S. Durst, B. A.—Dust in the Atmosphere.

A picture is formed of a dusty atmosphere in which each particle of dust is surrounded by a pocket of air of different temperature and humidity to those of the general air mass. This picture is shown to be corroborated by the rising of haze tops, the air temperature over the Arabian Sea during the south-west monsoon and the diurnal variation of wind in that region. Some consequences are pointed out, one of which is that there may be a layer of dust high up in the atmosphere.

Correspondence

To the Editor, *Meteorological Magazine*

Frostless December Weather

Possibly the number of days this December with maxima over 50° F. has hardly been equalled here since at least 1870 ; nor only one rainless day. But even more striking is the entire absence of even a ground frost. So far this winter, I have only recorded three frosts off the ground and one other on, namely, 30°, October 30th ;

27½°, November 1st; 31°, November 20th; the ground frost, November 13th. In a cottage garden plot near by scarlet geraniums are quite gay and many other summer flowers have lingered.

J. EDMUND CLARK.

Portway, Street, Somerset, January 1st, 1935.

Heavy Rain on December 26th at Waltham Cross

A remarkable shower was experienced at Waltham Cross, Herts, on the evening of December 26th.

The day had been dull, overcast and rainless, with a feeble S. wind which, slowly veering SW., occasionally fell to a dead calm. At 19h. 35m. G.M.T., without any indication of its approach, a very heavy shower of rain commenced. The air at the time was quite calm, but the rainfall was of the intensity usually associated with a line-squall or summer thunderstorm, the splashing on the tarmacadam roadway appearing as a level stratum of mist. At 19h. 41m. the rain ceased almost as suddenly as it had commenced and was followed by a light wind from SSW. force 2. The 5-inch rain-gauge registered a fall of 0·12 in. in the six minutes. This is the heaviest fall I have experienced in so short a period without any appreciable wind or other squall phenomena, there being no apparent change in temperature or wind direction and force associated with the shower. It would be interesting to know what forces were acting to produce so sharp a shower in what was otherwise dull, inactive weather.

Further moderate rain set in at 20h. 30m., which lasted until about 21h. 10m., after which the sky cleared, to be followed by a night of bright moonlight and ground fog.

DONALD L. CHAMPION.

7, *Robinson Avenue, Goff's Oak, Waltham Cross, Herts., December 28th,* 1934.

December Thunderstorms in Southern England

Thunderstorms have developed on at least four days during the present month in the southern counties of England from Essex to Dorset, and on the evening of December 27th a heavy squall accompanied by vivid lightning and a few loud peals of thunder broke over the northern and north-western suburbs of London. As always happens when the metropolis experiences anything a little out of the ordinary in the way of weather phenomena, this visitation attracted a disproportionate amount of attention in the Press. " An Air Ministry official " was cited as authority for the following statements :—" Most unusual, but not impossible " (*Daily Mirror*) ; " A thunderstorm at this time of year is a very unusual occurrence . . . . I personally cannot recall a thunderstorm in December " (*Daily Mail*). Such notions, like short memories, are misleading and should be combated.

So far from being rare, thunder during a wet, rough and mild December is quite typical in southern England. The month now ending has produced several instances. In the very rainy and boisterous December of 1929 a large number of the stations contributing returns to the *Monthly Weather Report* had two or three days with thunderstorms or thunder alone (Kew and Kensington two each); at Ascot and Grayshott there were four such days, while in north-west Devon, Arlington, near Barnstaple, reported seven and Woolacombe eight. Observers' remarks published on page 199 of Vol. 3 of this magazine reveal the incidence of thunder in the southern counties on no fewer than eleven dates from the 7th to the 28th in the excessively wet and mild December of 1868; Selborne noted the occurrence on four days. Corresponding records in Vol. I, page 107, show that the somewhat similar December of 1866 gave Calne (Wilts) an actual thunderstorm on three successive days, and thunder or lightning in southern England on seven dates from the 6th to the 17th. Again, in December, 1886, another blustering and rainy month, the *Meteorological Record*, Vol. 6, No. 24, of the Royal Meteorological Society lists the 8th, 9th, 14th, 15th, 20th and 28th, as having brought thunderstorms or one of the associated manifestations to places in the same part of Great Britain. Finally, in the *Book of Normals* (Section 4) it is recorded that Dungeness had four days of December thunder in 1909, and Kew two in 1919 (as in 1929). Such a month as this December of 1934 would probably have greater claims to distinction if it were to pass without distributing its quota of thunderstorms south of a line from Harwich to Haverfordwest.

E. L. HAWKE.

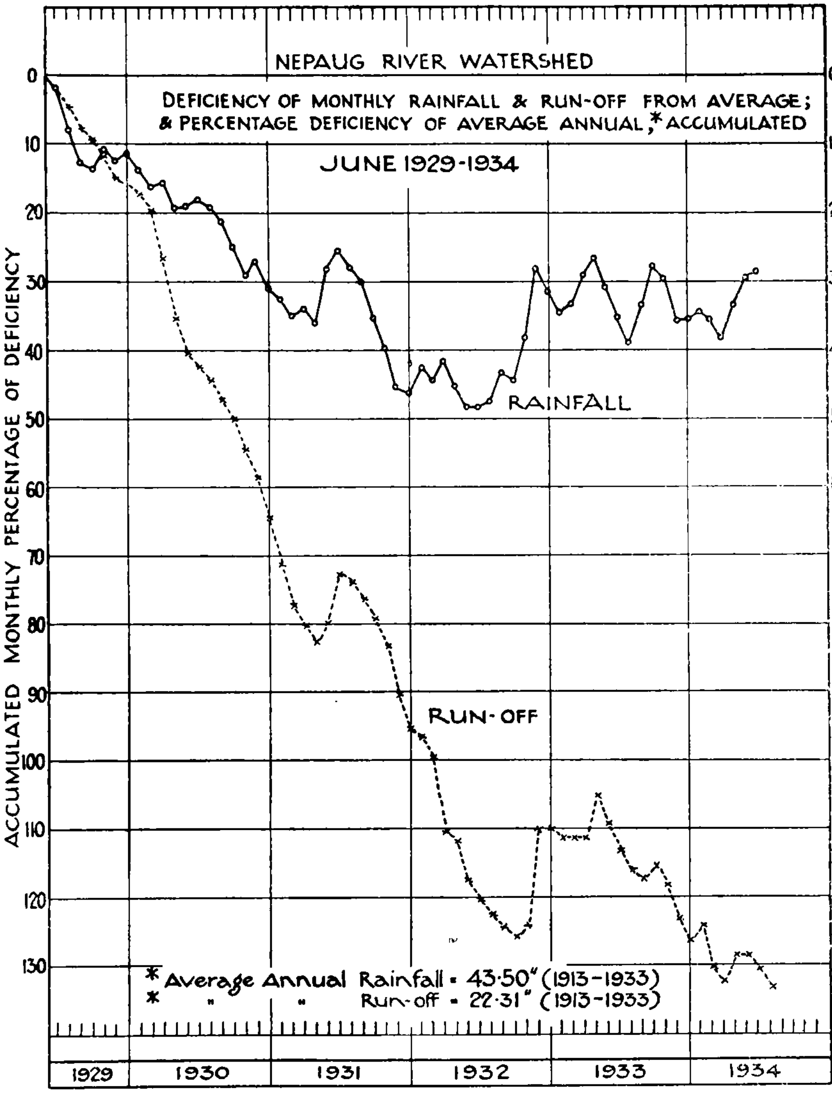
Caenwood, Rickmansworth, Herts, December 30th, 1934.

The Deficiency of Rainfall at Hartford, Connecticut

Following out the method of portraying the deficiency of monthly rainfall which appeared in the July issue of the *Meteorological Magazine*, perhaps you will be interested in a plot which we made here after having read that article.

We have added, also, run-off from the Nepaug River watershed for the same period. This has, as you will note, produced most interesting results; that is to say, for the five years, 1929–34, while the deficiency in rainfall has been about 28 or 29 per cent., that for run-off has been about 133 per cent., i.e., while we are short during this period about four months of average rainfall, during the same period, we are short about one year and four months in run-off. This, I presume, means that of the three principal dispositions of rainfall, vegetation demands, ground water reserve and surface run-off, surface run-off, which is the residual, has fared rather badly, being a bad third to the requirements of the other two, indicating that Nature will see that her requirements are met, regardless of human needs.

You will note that we started the beginning of our plot about the middle of 1929, which antedates your drought by a few years. Our



period was taken at this time because the effect of our drought was first felt then in our big storage reservoir. It is interesting also to note that, with the beginning of your drought in 1932, our rainfall began to increase.

CALEB MILLS SAVILLE.

The Water Bureau, Hartford, Connecticut, U.S.A. August 14th, 1934.

Cloudiness and the State of the Sky

I am much obliged to Dr. Brooks for the very interesting remarks following my note on the above in the December issue of this magazine.

It is true that, in estimating nebulosity, the simple method of ignoring high cloud gives a measure of " effective " nebulosity with regard to bright sunshine, but since cirriform cloud at times does occur in considerable quantities, it certainly has effect on the " state " of the sky, apart from its meteorological significance.

This being so, it appears that it should be considered in the mean state of the sky but not treated as being heavy cloud as it is in mean cloudiness. The fact that it is ineffective in reducing the duration of bright sunshine will be apparent in maps showing the distribution of that element expressed as a percentage of the " possible ".

The point I wished to stress was not the effect of high cloud on bright sunshine, but the fact that the terms " Cloudiness " and " State of the Sky " are not always synonymous, because the latter is often considerably fairer in appearance than is denoted by the former; hence, my suggestion of an alternative method of summarising the latter.

DONALD L. CHAMPION.

7, *Robinson Avenue, Goff's Oak, Herts, December 27th,* 1934.

NOTES AND QUERIES

Atmospheric Refraction and the Moon's Globularity

Under this heading Mr. Bonacina contributes an interesting note in the November number of the *Meteorological Magazine.* I think, however, that the problem he sets is capable of an explanation which has no reference to atmospheric refraction.

The full moon appears flat because it is evenly illuminated and also because such markings as are visible are irregular. Furthermore, these dark markings are, broadly speaking, grouped about the centre of the disc, leaving a very luminous bright external ring round the limb. If the conditions were reversed, with a bright central region and a darkening towards the limb, the full moon would tend to appear as a globe. This is shown by low-power observation of the sun in the telescope or by a good photograph of the whole sun. The absorption of light from regions near the limb of the sun by the solar atmosphere causes a gradual slight darkening towards the limb and the effect is definitely globular. It is not within ordinary experience to see spheres so illuminated that the central part of the visible side is darkest and hence any psychological tendency to see the moon as a globe would be neutralised by its presentation of the external bright ring.

The full moon cannot be seen in daylight, except perhaps at the moment of sunset. At any phase, not very near the full, the terminator mainly passes through the darker areas of the surface. To the eye, therefore, one of the apparent edges of the moon is relatively dark, while the light increases towards the bright ring of the opposite limb. Conditions for assuming globularity are thus favourable, but the globular effect will not usually be seen at night since the intensity of moonlight, even at the quarter phase, is too great to allow the eye to discriminate fully between the illumination of the limb and that of the terminator region. Under conditions of lesser general intensity of illumination, when the moon is seen in daylight, and perhaps even in early twilight, the difference will be very noticeable and hence the globular effect will be observed. It follows that such conditions are also the best for seeing detail on the lunar surface without instrumental aid and by actual observation I have found this to be true.

Since the above remarks were written two letters on this subject have been received. Mr. J. C. M. Kruisinga, of Vriezenveen, Overyssel, Holland, is of the opinion that a globe representing the full moon with its irregular markings, if hung against a black background, would not appear as a globe even if it were illuminated somewhat from the side. Mr. Kruisinga also notes the fact, stated above, that the moon as seen in daylight has " a sharp edge on one side and an elliptical shadow-line on the other " and he considers that the capability of ascribing some definite shape to such an object is assisted by the fact that it is seen in association with familiar daylit objects such as clouds, hills, etc. With regard to this, he says :—" By mitigation of the nocturnal contrast between black and white it (the moon) has ceased to be ' extra-terrestrial,' and we now see, or subconsciously note, that it is lit by the same sunlight as the distant cumulus or mountain-side. We are able to guess its real shape because it now fits nicely into our general scheme of deducting the shape of things from their terrestrial appearance in sunlight. The human eye has probably not been developed to discern shapes on the astronomical level, but to see corners, edges, points and curves within the distance considered vitally important to the observer. Apart from scientific interest, no human being has until now had any use for speculations concerning the real shape of heavenly bodies, and therefore the moon has to be drawn down, as it were, to a practical level, and to be looked at amidst terrestrial surroundings during the daytime, when it will be found to look like a globe—simply by conforming to the impressions we associate with sunlit curvatures of familiar objects."

Miss Cicely M. Botley points out that the moon has been seen as a black globe just before the total phase of a solar eclipse. At this stage there would still be a very narrow but bright solar crescent on one side of the moon. I find it difficult to suggest an explanation here. Perhaps the complete blackness of the moon allows fuller play to the psychological element, which may also be enhanced by the fact that the movement of the moon across the sun in an eclipse is rapid enough to be visible after a short time-interval.

E. W. BARLOW.

Snow cover and Ski-ing in the Black Forest

The latest issue of the Baden meteorological yearbook* contains under the above title a detailed analysis by Dr. A. Peppler of snow records in the Black Forest with special reference to ski-ing. He writes not only as a meteorologist but as an experienced skier, the founder and president of the ski-club in Giessen. He is thus well aware of the insufficiency from the skier's point of view of snow data as normally included in official meteorological publications.

In this paper he deals with records mostly covering over thirty winters from 35 stations in the Black Forest including the Königstuhl and adds by way of comparison a briefer treatment of conditions at 25 stations in other mountainous parts of Germany. Tables are given showing the average number of days each winter month with snow lying to depths of or exceeding 10, 20, 30 and 40 cm. which he describes respectively as possible, good, very good and excellent for ski-ing. Many skiers would doubtless disagree with this classification but as Dr. Peppler points out, the requisite depth depends largely upon contours, etc. and is in consequence considerably less in the Black Forest than on steeper, more rugged ranges. In any case the numerical values are clearly stated in the tables and diagrams so that the qualitative equivalents are more or less immaterial.

The western, windward side with its plentiful precipitation naturally receives larger amounts of snow in winter than the drier, eastern slopes and to show the relation between height and snow conditions the author found it necessary to exclude stations on the leeward side unless they were sufficiently near the crests to have high precipitation figures. The snow reliability diagrams and tables (which thus apply only to the windward sides and crests) indicate that in the four months December to March on an average 10 cm. at least of snow is measured on 50 per cent. of the days at a height of about 780 m., on 75 per cent. at 950 m. and on over 90 per cent. above 1,200 m. In the average season 40 cm. is to be obtained on 50 per cent. of the days somewhat above 1,000 m., whereas on the Feldberg it may be expected on over 80 per cent. February is the best month while March is rather better than January at the higher levels and on the Feldberg itself even the April average is 20 days with 40 cm.

In the latter part of the paper the snow conditions in the Black

---

* *Karlsruhe, Deutsches Meteorologisches Jahrbuch für* 1933, *Baden*, **65**, pp. 92—108.

Forest are shown to compare favourably with those on the Brocken, Schneekoppe and Fichtelberg while even in a poor snow season such as 1911–2 it is stated that 30 cm. were measured on over 90 per cent. of the days at about 1,300 m.

There is something more the potential visitor might like to know. How frequent and prolonged are the intervals when the snow (or rain) is actually falling ? An average of 622 mm. in the four months December to March somehow suggests that the weather might often detract from the pleasure of sport on the Feldberg.

The Rainfall of 1934

Although 1934 will be remembered for the acute and prolonged lack of adequate water supplies in many localities, the total rainfall for the year, over the British Isles as a whole, actually exceeded the average. The difficulties experienced were mainly due to the deficiency inherited from 1933, since November and December of that year together gave less rain than that of any similar period since before 1870, but they were aggravated by the incidence of the rainfall during the year. December was by far the wettest month of the year, so that while 1934 opened with the ground drier than usual and many reservoirs short of capacity, it ended with rivers in spate and underground storage in some measure replenished.

Provisional estimates of the general rainfall for 1934 are given below, both in actual inches and as percentages of the average, together with similar values for 1933 and the average rainfall in inches.

	1934.		1933.		Average.
	in.	%	in.	%	*in.*
England and Wales...	33·7	96	28·6	81	35·2
Scotland	55·0	109	40·3	80	50·3
Ireland	45·9	106	33·5	77	43·3
British Isles	42·0	102	33·3	80	41·4

Over each country 1934 was therefore appreciably wetter than 1933. The year 1934 gave more than the average rainfall in both Scotland and Ireland, as well as over the British Isles as a whole. Over England and Wales the deficiency was small, being only 1·5 in. Owing to the recent run of wet years the rainfall over England and Wales during 1934 was less than that of any year back to 1911, with the exceptions only of 1921 and 1933. Over Scotland, 1934 was wetter than any of the three preceding years and over Ireland than either 1933 or 1932.

General values for each month are set out in the table below, both as percentages of the average for the period 1881 to 1915 and in actual inches of rainfall.

It will be seen that over the country generally the rainfall of December appreciably exceeded that of the three months May, June and July, and was as much as ten times that of February. Over England and Wales only one of the seven months May to

November gave more than the average amount. Over Scotland there were four consecutive months July to October and over Ireland three months August to October with more than the average. Over the British Isles as a whole only two Februaries since before 1870 were drier than that of 1934, *viz.*, those of 1891 and 1932. The rainfall of December, 1934, was exceeded only by those of 1876, 1914 and 1929 with 189, 183 and 180 per cent. respectively. Over England and Wales only the Decembers of 1914 and 1876 were wetter and over Ireland only those of 1876, 1914 and 1872. At Chilgrove near Chichester, where the record commenced in 1834, the total of 11·90 in. for December, 1934, was more than an inch in excess of that of any other month and as much as 33 per cent. of the total for the whole year.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	%	%	%	%	%	%	%	%	%	%	%	%
England and Wales ..	105	22	110	137	71	71	56	95	109	79	75	190
Scotland	117	42	97	182	120	79	108	122	134	155	49	122
Ireland	124	11	114	107	103	72	68	113	208	127	46	164
British Isles	112	24	108	142	89	74	70	106	134	107	62	170
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
England and Wales ..	3·1	0·6	2·9	2·9	1·7	1·7	1·6	3·2	2·8	3·1	2·6	7·5
Scotland	5·7	1·8	3·9	5·4	3·6	2·2	4·1	5·5	5·4	7·6	2·6	7·2
Ireland	5·0	0·4	3·8	2·9	2·8	2·0	2·3	4·8	6·5	5·2	2·0	8·2
British Isles	4·2	0·8	3·5	3·6	2·3	1·9	2·3	4·1	4·1	4·6	2·6	8·0

The incidence of the rainfall during 1934 can be considered in four periods:—(1) January to April gave only ·7 in. short of the average, over the British Isles as a whole, in spite of a very dry February, (2) May, June and July were each moderately dry, giving an accumulated deficiency of 2·0 in., (3) the period August to November gave precisely the average amount and (4) December was unusually wet with an excess amounting to 3·3 in.

The totals for practically every station for 1934 were between 70 and 120 per cent. of the respective averages for the standard period 1881 to 1915. There was less than 90 per cent. over most of England lying between London to Bristol in the south and Liverpool to Hull in the north, with less than 80 per cent. between Cambridge and Great Yarmouth and also in the neighbourhood of Barnsley. In both the extreme south and north of England many stations recorded more than 110 per cent., with as much as 120 per cent. in parts of Dartmoor and in the Cheviots. Over Wales the rainfall closely approximated to the average. In Scotland there was less than the average amount only over a small area around Lossiemouth and in the Outer Hebrides. In the Southern Uplands and to the north of the Central Plain falls exceeding 110 per cent. were widespread, while as much as 120 per cent. occurred at Balmoral and in parts of Ross and Cromarty. In Ireland the range was from rather less than 90 per cent. near Dublin to over 110 per cent. in certain localities in the west.

J. GLASSPOOLE.

An Unusual Honour to Professor W. Köppen

We learn from the *Annalen der Hydrographie und Maritimen Meteorologie* that the Senate of Hamburg, at the request of the Deutsche Seewarte, has renamed "Violastrasse" the "Köppen-strasse". Professor W. Köppen lived from 1903 to 1924 at 7, Violastrasse, near the Kite station of the Deutsche Seewarte, which he established in Grossborstel, and which developed into the meteorological research station at Fuhlsbüttel. The new street sign contains the inscription "Köppenstrasse. Professor Wladimir Köppen von 1875–1919 Meteorologe und Abteilungsleiter der Deutschen Seewarte in Hamburg deren Drachenstation er 1903 in Gross Borstel errichtet hat".

Official Course of Training for Meteorological Observers

A course of training for meteorological observers was held at the Meteorological Office, South Kensington, on November 27th and 28th, 1934. Among the 22 observers who attended were two from Scotland and one from Ireland. As in previous years, the greater part of the course was occupied with a description of the instruments in general use at climatological stations and their management where this presents any difficulty, and with those points in the observation of weather and visibility that experience has shown are often a source of trouble to inexperienced observers.

BOOKS RECEIVED

Royal Alfred Observatory, Mauritius. Results of magnetical and meteorological observations for September to December and year 1932; and January to September, 1933. Port Louis, 1933.

Report on rainfall registration in Mysore for 1932 and 1933. By C. Seshachar, M.A., Bangalore, 1933 and 1934.

Meteorology in Mysore for 1932 and 1933, being the results of observations at Bangalore, Mysore, Hassan, Chitaldrug, Balehonnur and Jogimatti. Fortieth Annual Report, Bangalore, 1933 and 1934.

OBITUARY

R. P. Berloty.—We regret to learn of the death of R. P. Berloty on October 10th, 1934. M. Berloty was born at Lyons on March 25th, 1856. He entered the order of the Jesuits and devoted his life to science, becoming Docteur dès Sciences de la Faculté de Paris in 1886, and Professor aux Facultés libres d'Angers et de Lyon. After working for some years on solar phenomena and seismology at Stonyhurst, England, and at Tortosa, Spain, he was sent to Syria in 1907, where he founded the Astronomical and Geophysical Observatory of Ksara. This observatory gradually developed into a first order meteorological station and work was also done on magnetism and seismology. During the war, however, it was totally destroyed when the Jesuits were expelled from Syria. In 1920 Berloty returned to Syria, re-established the Observatory of Ksara, and founded secondary meteorological stations in the Levant.

Adrien de Gerlache de Gomery.—We regret to learn of the death of Baron de Gerlache in his 69th year on December 4th, 1934. While still a young lieutenant in the Belgian Navy he started to organise an expedition to explore the Antarctic regions, but it was not until August, 1897, that he set sail for Graham Land in the *Belgica* with Professor H. Arctowski as geologist, Dr. F. A. Cook as surgeon, and Roald Amundsen as first officer. During that summer he explored and charted the coasts near Graham Land, but in endeavouring to reach a high latitude early in March the ship was frozen in and Gerlache was committed to the first wintering in the Antarctic regions, the *Belgica* drifting in all directions with the pack. Before this drift nothing was known of winter conditions in the Antarctic and the meteorological observations were thus very important. It was largely due to the courage and tenacity of Gerlache that the party emerged with all its collections in good condition. Gerlache commanded the *Belgica* in the Duke of Orlean's scientific expedition to the East Greenland Sea in 1905 and he promoted the building of an ice-protected ship which he transferred to Sir Ernest Shackleton in 1914 as the *Endurance.*

NEWS IN BRIEF

Dr. Paul Raethjen of Königsberg has been appointed Professor of Meteorology at the University of Hamburg in place of the late Professor A. Wigand.*

Professor R. Samoilowitsch and Professor W. Wiese have been appointed to the newly established Chair of Polar Science of the University of Leningrad.

Erratum

December, 1934, photographs facing p. 253. The dates given under the two photographs should be interchanged.

The Weather of December, 1934

Pressure was below normal over the whole of the North Atlantic, western, central and southern Europe, Iceland, south Greenland and the east coast of North America and also in north Alaska, the greatest deficit being 17·4 mb. at 50° N., 30° W. Pressure was above normal over Spitsbergen, northern and eastern Europe and most of North America, the greatest excess being 9·2 mb. at Moscow and 7·1 mb. at 50° N., 120° W. Temperature was above normal over the whole of the western half of Europe, being as much as 16·6° F.

* See *Meteorological Magazine* 67, 1932–3, p. 294.

above normal at Spitsbergen, 12·5° F. at Särna (Svealand) and 9·3° F. at Zürich. Precipitation was deficient at Spitsbergen, Northern Scandinavia and central Europe, but in excess in central Scandinavia.

The outstanding features of the weather of December over the British Isles were, the general deficiency of sunshine, the abnormally high temperatures, the mean pressure readings markedly below normal and the large excess of rainfall except in the extreme north-west; the amounts of rain measured at Holyhead and Valentia were the highest ever recorded during December at these stations since records began in 1871 and 1870 respectively. Throughout the month deep depressions with associated secondaries approaching or crossing the country, maintained mild, rainy, cloudy conditions generally, though from the 4th to 5th the north of Scotland came under the influence of a high pressure area over Iceland, on the 17th the south of England was influenced by a wedge of high pressure and from the 20th–21st a wedge of high pressure passed across Ireland and England. Winds were generally between S. and W. becoming fresh or strong frequently, with gales locally in the south-west or north-west on the 1st, 2nd, 5th, 8th–12th and then from the 23rd to 28th there was a stormy period in the north with frequent gales at exposed places. Gales were again reported from Pembroke on the 30th. A gust of 90 m.p.h. was recorded at the Lizard on the 9th and of 75 m.p.h. at Kirkwall (Orkneys) on the 26th. Mist and fog were experienced locally early in the month becoming denser in the Midlands on the 6th and in south-east England on the 10th, and again between the 17th and 23rd being most severe in the same districts on the 22nd and 23rd. Christmas rail traffic was dislocated. Rain occurred on most days and at times was heavy locally; 3·74 in.
2·33/ were measured at Maesteg (Glamorgan) on the 1st, 3·26 in., 2·36 in.
3·26/ and 2·33 in. at Fofanny (Co. Down) on the 4th, 14th and 25th respectively and 2·32 in. at Brechfa (Carmarthen) on the 1st. At Holne (Devon) 10·23 in., at Maesteg (Glamorgan) 10·48 in. and at Tynywaun (Glamorgan) 10·77 in. were measured between the 1st and 8th inclusive. Mr. H. L. Davies, of 40, Salisbury Road, Maesteg, Glamorganshire, sends word that for the eight days ending at 17h. on the 9th, he measured 10·65 in. Snow occurred on the hills in Scotland on the 26th. Thunderstorms were experienced at Rothesay on the 8th, locally in Ireland on the 8th, 10th, 14th and 17th and in south England and south Ireland on the 27th. Temperature was above normal most of the month the minimum temperatures being especially high so that frequently the diurnal range was very small amounting only to 1° F. on some days. In the south maximum temperatures were mostly 50° F. or above. Sunshine values were generally very poor, almost the whole country being sunless on some days. The 31st was the day of most general sunshine, all parts of the country having some and Birmingham 5·3 hrs. Among isolated good records were 6·4 hrs. at Falmouth

on the 29th, 6·1 hrs. at Cullompton on the 12th and Worthing on the 21st and 6·0 hrs. at Phoenix Park, Dublin and Bournemouth on the 20th. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	18	− 4	Liverpool ...	25	−18
Aberdeen ...	15	−22	Ross-on-Wye ...	38	−10
Dublin	54	+ 8	Falmouth ...	39	−17
Birr Castle ...	39	− 4	Gorleston ...	20	−23
Valentia... ...	21	−17	Kew	26	−11

Miscellaneous notes on weather abroad culled from various sources.

The weather in Switzerland was so fine and mild during the first fortnight that the snow disappeared generally from the mountains up to a level of 5,500 ft., but heavy falls of snow were reported by the 18th and by the 21st a general drop of temperature had brought the snowline down to the 3,000 ft. level making ski-ing conditions good. Owing to heavy rains the Tiber overflowed its banks near Rome about the 16th, but no lives were lost though some families were driven from their homes. Floods occurred in Cyprus about the 20th and storms prevented the mails from being despatched : heavy rain continued until the 27th, when two of the largest reservoirs burst and flooded the neighbourhood. Torrential rain fell in Coimbra (Portugal) during Christmas night and many parts of the town were flooded. Five persons were drowned and much damage done by a storm followed by torrential rain in the district of Canea in Crete on the 26th. The first snow of the winter fell on the 26th in Vienna and the surrounding district. (*The Times*, December 13th–29th.)

Heavy rain occurred in the eastern Transvaal and many other parts of the Union during the first 10 days of the month and part of Ladysmith was flooded on the 10th when the Klip River burst its banks. (*The Times*, December 11th.)

A cold wave swept across Burma early in the month ending in a snowstorm at Tavoy which is a rare event. (*The Times*, December 12th.)

In the north-western district of Western Australia, in western Queensland, Carpentaria and north-west New South Wales the weather conditions were generally good during the month but in north-east New South Wales dry conditions prevailed. (*The Times*, December 27th.)

Temperature was above normal in the eastern United States at the beginning of the month, but the cold spell in the Mountain Region spread across the whole country to be followed by a warm spell which began in the west about the 11th–18th. This was followed by another cold spell from the north-west at the close of the month. Temperature on the Pacific coast was however above normal generally. Rainfall was mainly above normal at the beginning of the month becoming below normal later. The first severe blizzard of the winter swept across central Canada on the 19th. Twenty-two in. of rain in 24 hrs. about the 18th caused landslides between Sao Paulo and Santos in Brazil. (*The Times*, December 19th–21st and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Severe gales were experienced frequently on the North Atlantic and several lives were lost. (*The Times*, December 11th–28th.)

Daily Readings at Kew Observatory, December, 1934

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
	mb.		°F.	°F.	%	in.	hrs.	
1	1024·8	S.3	44	48	83	0·15	0·0	r 20h.–24h.
2	1003·3	SSW.4	47	55	94	0·46	0·0	rir_0 0h.–14h.
3	1006·8	SW.3	54	56	87	trace	0·0	pr_0 19h.
4	1003·3	SSW.3	54	54	94	0·31	0·0	r 9h.–13h., 20h.–24h.
5	990·0	SW.4	51	53	70	0·19	1·0	r 0h.–3h., 14h.–17h.
6	1006·4	SSW.3	45	54	96	0·59	0·0	irr_0 all day.
7	1009·0	SW.3	51	54	78	trace	3·1	ir_0 0h.–3h.
8	1008·4	SSW.4	49	57	82	0·13	1·0	r_0r 1h.–7h.
9	992·1	S.4	54	55	89	0·27	0·0	r_0r 9h.–17h.
10	1002·6	W.1	43	50	91	0·01	1·3	F–m all day.
11	999·5	S.3	42	50	82	0·05	0·1	r_0 3h., 18h., 19h.–20h.
12	987·1	SW.4	47	52	75	0·05	2·1	r_0r 7h.–9h.
13	989·0	S.4	45	51	76	0·11	1·9	pr_0pr all day.
14	984·4	SE.3	45	48	89	0·31	0·0	r_0r 10h.–24h.
15	974·3	SSW.4	48	51	88	0·41	0·0	irr_0 all day.
16	989·9	WNW.2	47	49	89	0·09	0·0	irr_0 0h.–9h.
17	1001·3	SW.2	40	47	89	0·01	2·4	f 1h.–11h., r_0 22h.
18	989·7	SW.5	45	53	82	0·19	1·0	r_0r 1h.–7h., 19h.–21h
19	988·8	S.3	48	51	90	0·13	0·8	r_0r 15h.–23h.
20	1005·4	NW.4	47	51	76	0·02	1·5	rr_0 10h.–11h.
21	1014·6	W.1	37	45	88	—	3·2	fF 8h.–24h.
22	1010·6	E.3	34	43	87	—	0·0	f 0h.–17h.
23	1006·7	SE.3	41	49	89	0·11	1·4	rr_0 7h.–11h., f 21h.
24	1012·6	E.3	37	43	86	0·01	0·0	r_0 3h., r 5h.–6h.
25	1014·4	ESE.2	36	41	92	0·01	0·0	rr_0 23h.–24h., f 10h.
26	1003·9	SSW.3	41	51	90	0·29	0·0	rr_0 0h.–4h., pr_0 20h.
27	1008·4	S.3	40	50	92	0·07	0·0	ir_0 12h.–15h.
28	1003·9	S.3	47	51	84	0·31	0·0	irr_0 7h.–22h.
29	1007·6	W.4	47	51	73	trace	1·3	r_0 9h. & 11h.
30	1019·5	SW.4	41	53	87	0·02	0·0	r_0 10h., 16h., 23h.
31	1015·9	WSW.3	52	53	74	0·14	3·8	r 1h.–2h., 6h.–8h.
*	1002·4	—	45	51	85	4·42	0·8	*Means or totals.

Rainfall 1934—General Distribution

	Dec.	Yr.	
England and Wales	190	96	per cent. of the average 1881–1915.
Scotland	122	109	
Ireland	164	106	
British Isles ...	170	102	

Rainfall : December, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square..........	4·80	200	*Leics* .	Thornton Reservoir ...	4·54	169
Sur .	Reigate, Wray Pk. Rd..	8·08	254	„ .	Belvoir Castle...........	3·98	162
Kent .	Tenterden, Ashenden...	7·58	243	*Rut* .	Ridlington	4·92	196
„ .	Folkestone, Boro. San.	6·12	...	*Lincs* .	Boston, Skirbeck.........	3·42	159
„ .	Eden'bdg., Falconhurst	7·44	225	„ .	Cranwell Aerodrome...	3·37	152
„ .	Sevenoaks, Speldhurst.	4·40	...	„ .	Skegness, Marine Gdns.	3·26	148
Sus .	Compton, Compton Ho.	11·72	280	„ .	Louth, Westgate.........	3·96	142
„ .	Patching Farm..........	9·42	280	„ .	Brigg, Wrawby St.......	3·64	...
„ .	Eastbourne, Wil. Sq....	8·55	245	*Notts* .	Worksop, Hodsock......	3·82	162
„ .	Heathfield, Barklye....	10·98	296	*Derby*.	Derby, L. M. & S. Rly.	4·35	167
Hants.	Ventnor, Roy.Nat.Hos.	9·27	281	„ .	Buxton, Terr. Slopes...	7·94	140
„ .	Fordingbridge, Oaklnds	11·02	280	*Ches* .	Runcorn, Weston Pt....	4·64	147
„ .	Ovington Rectory.......	12·14	306	*Lancs*.	Manchester, Whit. Pk.	4·83	149
„ .	Sherborne St. John......	8·56	260	„ .	Stonyhurst College......	5·97	123
Herts .	Welwyn Garden City ...	4·40	180	„ .	Southport, Bedford Pk.	4·32	134
Bucks.	Slough, Upton............	5·56	221	„ .	Lancaster, Greg Obsy.	5·15	118
„ .	H. Wycombe, Flackwell	6·91	228	*Yorks*.	Wath-upon-Dearne......	3·43	145
Oxf .	Oxford, Mag. College...	5·26	227	„ .	Wakefield,Clarence Pk.	4·10	169
Nor .	Pitsford, Sedgebrook...	4·47	185	„ .	Oughtershaw Hall.......	10·26	...
„ .	Oundle	2·96	...	„ .	Wetherby, Ribston H..	5·00	204
Beds .	Woburn, Exptl. Farm...	4·56	195	„ .	Hull, Pearson Park......	3·51	146
Cam .	Cambridge, Bot. Gdns.	3·31	172	„ .	Holme-on-Spalding......	4·13	168
Essex.	Chelmsford, County Lab	3·96	178	„ .	West Witton, Ivy Ho.	5·38	148
„ .	Lexden Hill House......	4·19	...	„ .	Felixkirk, Mt. St. John.	5·31	220
Suff .	Haughley House.........	3·35	...	„ .	York, Museum Gdns....	4·60	205
„ .	Campsea Ashe............	3·57	155	„ .	Pickering, Hungate......	3·69	146
„ .	Lowestoft Sec. School...	3·01	129	„ .	Scarborough..............	3·92	165
„ .	Bury St. Ed., WestleyH.	3·70	153	„ .	Middlesbrough............	3·27	169
Norf. .	Wells, Holkham Hall...	3·35	163	„ .	Baldersdale, Hury Res.	...	...
Wilts .	Calne, Castleway.........	7·10	228	*Durh* .	Ushaw College............	4·89	195
„ .	Porton, W.D. Exp'l. Stn	8·37	266	*Nor* .	Newcastle, Town Moor.	3·44	143
Dor .	Evershot, Melbury Ho.	13·87	268	„ .	Bellingham, Highgreen	4·47	123
„ .	Weymouth, Westham.	9·22	265	„ .	Lilburn Tower Gdns....	4·84	184
„ .	Shaftesbury,Abbey Ho.	5·83	181	*Cumb*.	Carlisle, Scaleby Hall...	4·32	134
Devon.	Plymouth, The Hoe....	12·55	255	„ .	Borrowdale, Seathwaite	21·50	140
„ .	Holne, Church Pk. Cott.	25·03	296	„ .	Borrowdale, Moraine...	18·52	151
„ .	Teignmouth, Den Gdns.	10·92	271	„ .	Keswick, High Hill......	9·26	138
„ .	Cullompton	12·47	284	*West* .	Appleby, Castle Bank...	5·44	137
„ .	Sidmouth, U.D.C........	9·85	...	*Mon* .	Abergavenny, Larchf'd	10·28	230
„ .	Barnstaple, N. Dev.Ath	8·37	189	*Glam* .	Ystalyfera, Wern Ho....	18·23	218
„ .	Dartm'r,Cranmere Pool	22·90	...	„ .	Cardiff, Ely P. Stn.......	11·16	218
„ .	Okehampton, Uplands.	15·87	225	„ .	Treherbert, Tynywaun.	23·36	...
Corn .	Redruth, Trewirgie......	12·60	201	*Carm* .	Carmarthen, Priory St..	12·75	222
„ .	Penzance, Morrab Gdn.	10·68	188	*Pemb* .	Haverfordwest, School.	...	...
„ .	St. Austell, Trevarna...	13·03	214	*Card* .	Aberystwyth	7·27	...
Soms .	Chewton Mendip.........	9·71	180	*Rad* .	BirmW.W.Tyrmynydd	14·69	179
„ .	Long Ashton............	7·13	185	*Mont* .	Lake Vyrnwy	10·76	157
„ .	Street, Millfield..........	5·73	168	*Flint* .	Sealand Aerodrome......	4·35	174
Glos .	Blockley	6·00	...	*Mer* .	Dolgelley, Bontddu......	9·36	137
„ .	Cirencester, Gwynfa....	6·61	197	*Carn* .	Llandudno	4·19	144
Here .	Ross, Birchlea............	6·07	204	„ .	Snowdon, L. Llydaw 9..	30·80	...
Salop .	Church Stretton.........	5·39	160	*Ang* .	Holyhead, Salt Island...	9·47	227
„ .	Shifnal, Hatton Grange	4·22	164	„ .	Lligwy	8·76	...
Staffs .	Market Drayt'n, Old Sp.	4·35	156	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	4·25	162		Douglas, Boro' Cem....	11·31	226
War .	Alcester, Ragley Hall...	4·72	192	*Guernsey*			
„	Birminghm, Edgbaston	4·59	170		St. PeterP't.Grange Rd.	9·91	243

Rainfall: December, 1934: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	9·60	211	*Suth* .	Melvich	3·16	74
,, .	New Luce School	10·27	185	,, .	Loch More, Achfary	3·48	34
Kirk .	Dalry, Glendarroch	11·28	159	*Caith* .	Wick	2·50	81
,, .	Carsphairn, Shiel	15·27	164	*Ork* .	Deerness	3·26	78
Dumf.	Dumfries, Crichton, R.I.	6·40	159	*Shet* .	Lerwick	3·54	74
,, .	Eskdalemuir Obs.	8·65	124	*Cork* .	Caheragh Rectory	10·31	...
Roxb .	Branxholm	4·46	122	,, .	Dunmanway Rectory	12·02	149
Selk .	Ettrick Manse	9·15	148	,, .	Cork, University Coll.	8·92	174
Peeb .	West Linton	4·12	...	,, .	Ballinacurra	8·42	164
Berw .	Marchmont House	4·08	145	,, .	Mallow, Longueville	8·33	170
E.Lot.	North Berwick Res.	3·28	153	*Kerry.*	Valentia Obsy.	13·60	205
Midl .	Edinburgh, Roy. Obs.	2·50	107	,, .	Gearhameen	18·80	150
Lan .	Auchtyfardle	4·23	...	,, .	Darrynane Abbey	9·38	159
Ayr .	Kilmarnock, Kay Pk.	5·18	...	*Wat* .	Waterford, Gortmore	8·59	187
,, .	Girvan, Pinmore	9·74	163	*Tip* .	Nenagh, Cas. Lough	7·04	152
Renf .	Glasgow, Queen's Pk.	4·59	108	,, .	Roscrea, Timoney Park	6·53	...
,, .	Greenock, Prospect H.	9·68	123	,, .	Cashel, Ballinamona	5·87	135
Bute .	Rothesay, Ardencraig	8·95	...	*Lim* .	Foynes, Coolnanes	5·86	124
,, .	Dougarie Lodge	9·57	...	,, .	Castleconnel Rec.	5·66	...
Arg .	Ardgour House	10·40	...	*Clare* .	Inagh, Mount Callan	9·55	...
,, .	Glen Etive	...	...	,, .	Broadford, Hurdlest'n.	5·15	...
,, .	Oban	6·13	...	*Wexf* .	Gorey, Courtown Ho.	9·18	240
,, .	Poltalloch	8·21	130	*Wick* .	Rathnew, Clonmannon.	8·54	...
,, .	Inveraray Castle	11·30	114	*Carl* .	Hacketstown Rectory	7·80	190
,, .	Islay, Eallabus	6·76	114	*Leix* .	Blandsfort House	7·40	201
,, .	Mull, Benmore	11·60	69	,, .	Mountmellick	6·89	...
,, .	Tiree	...	...	*Offaly.*	Birr Castle	5·14	156
Kinr .	Loch Leven Sluice	4·69	119	*Dublin*	Dublin, FitzWm. Sq.	4·50	181
Perth .	Loch Dhu	14·30	144	,, .	Balbriggan, Ardgillan	5·86	203
,, .	Balquhidder, Stronvar.	11·24	...	*Meath.*	Beauparc, St. Cloud	5·63	...
,, .	Crieff, Strathearn Hyd.	7·65	171	,, .	Kells, Headfort	5·75	151
,, .	Blair Castle Gardens	6·42	168	*W.M* .	Moate, Coolatore	4·51	...
Angus.	Kettins School	6·13	186	,, .	Mullingar, Belvedere	6·84	186
,, .	Pearsie House	8·28	...	*Long* .	Castle Forbes Gdns.	5·48	138
,, .	Montrose, Sunnyside	4·27	154	*Gal* .	Galway, Grammar Sch.	...	...
Aber .	Braemar, Bank	7·23	203	,, .	Ballynahinch Castle	9·94	133
,, .	Logie Coldstone Sch.	4·90	175	,, .	Ahascragh, Clonbrock.	6·48	138
,, .	Aberdeen, King's Coll.	4·18	130	*Mayo.*	Blacksod Point	8·82	144
,, .	Fyvie Castle	5·48	160	,, .	Mallaranny	8·51	...
Moray	Gordon Castle	2·10	78	,, .	Westport House	7·93	138
,, .	Grantown-on-Spey	...	...	,, .	Delphi Lodge	17·36	137
Nairn.	Nairn	2·01	91	*Sligo* .	Markree Obsy.	5·53	115
Inv's .	Ben Alder Lodge	...	...	*Cavan.*	Crossdoney, Kevit Cas.	6·32	...
,, .	Kingussie, The Birches.	2·94	...	*Ferm* .	Enniskillen, Portora	4·13	...
,, .	Inverness, Culduthel R.	2·69	...	*Arm* .	Armagh Obsy.	4·80	153
,, .	Loch Quoich, Loan	13·95	...	*Down.*	Fofanny Reservoir	22·18	...
,, .	Glenquoich	11·48	78	,, .	Seaforde	8·50	206
,, .	Arisaig, Faire-na-Sguir.	6·10	...	,, .	Donaghadee, C. Stn.	7·36	231
,, .	Fort William, Glasdrum	8·59	...	,, .	Banbridge, Milltown	4·31	149
,, .	Skye, Dunvegan	6·42	...	*Antr* .	Belfast, Cavehill Rd.	7·35	...
,, .	Barra, Skallary	4·89	...	,, .	Aldergrove Aerodrome.	5·19	151
R&C .	Alness, Ardross Castle.	3·56	86	,, .	Ballymena, Harryville.	5·80	131
,, .	Ullapool	3·17	50	*Lon* .	Garvagh, Moneydig	4·70	...
,, .	Achnashellach	7·80	78	,, .	Londonderry, Creggan.	3·95	90
,, .	Stornoway	3·49	56	*Tyr* .	Omagh, Edenfel	5·31	126
Suth .	Lairg	3·45	86	*Don* .	Malin Head	4·64	...
,, .	Tongue	2·95	60	,, .	Killybegs, Rockmount.	3·95	...

Climatological Table for the British Empire, July, 1934

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy....	1016·9	+ 1·1	83	53	76·8	57·7	67·3	+ 4·6	58·2	74	4·8	3·19	+ 1·02	8	9·1	56
Gibraltar..................	1015·2	− 1·6	89	63	83·5	68·0	75·7	+ 0·9	65·4	78	3·0	0·00	− 0·03	0	...	...
Malta.......................	1015·0	+ 0·3	97	67	86·2	72·3	79·3	+ 1·0	70·0	67	1·4	0·00	− 0·05	0	12·7	89
St. Helena	1015·2	− 0·4	72	54	63·3	56·3	59·8	+ 1·3	57·4	92	7·8	4·12	...	21	...	...
Freetown, Sierra Leone	1013·7	+ 1·0	88	68	83·8	72·8	78·3	− 0·3	75·4	91	8·7	53·38	+ 17·80	27	...	...
Lagos, Nigeria	1013·5	+ 0·3	89	71	83·9	74·8	79·3	+ 1·3	75·4	90	9·1	14·49	+ 3·99	20	3·9	31
Kaduna, Nigeria	1009·2	...	89	66	84·3	68·2	76·3	+ 2·7	71·7	88	8·6	5·70	− 4·92	21	5·5	44
Zomba, Nyasaland	1018·2	− 0·3	78	47	74·3	54·4	64·3	+ 2·3	59·7	77	5·2	0·43	+ 0·08	5	...	...
Salisbury, Rhodesia...	1020·1	− 1·2	78	37	71·2	45·8	58·5	+ 2·4	50·8	55	2·4	0·02	− 0·01	1	8·0	71
Cape Town	1022·5	+ 1·2	74	37	61·7	47·8	54·7	0·0	47·2	84	4·5	2·99	− 0·63	9	...	...
Johannesburg	1021·5	− 1·5	72	26	60·4	40·8	50·6	+ 0·2	40·3	52	2·3	0·84	+ 0·51	4	8·8	82
Mauritius	1020·3	− 0·1	76	57	74·3	61·9	68·1	− 0·2	65·1	74	5·5	1·25	− 1·24	28	7·2	66
Calcutta, Alipore Obsy.	998·7	− 0·5	93	76	90·1	79·5	84·8	+ 1·1	80·2	90	8·7	8·91	− 3·79	18*	...	...
Bombay	1003·9	0·0	89	73	85·6	77·0	81·3	− 0·1	77·5	87	9·2	21·37	− 2·90	24*	...	...
Madras	1003·8	− 0·7	101	73	95·2	78·9	87·1	− 0·5	75·9	69	8·4	2·07	− 1·77	6*	...	...
Colombo, Ceylon	1009·1	0·0	86	73	84·5	77·4	80·9	− 0·3	77·1	79	7·4	0·85	− 3·58	11	6·8	54
Singapore	1008·5	− 0·4	90	71	86·4	76·5	81·5	+ 0·2	78·0	82	8·2	10·19	+ 3·40	15	6·2	51
Hongkong................	1005·5	+ 0·8	93	73	87·0	78·7	82·9	+ 0·4	79·1	85	8·1	19·43	+ 5·01	25	5·9	44
Sandakan	1009·1	...	92	72	88·2	75·2	81·7	− 0·1	76·4	83	6·6	14·01	+ 7·29	14	...	...
Sydney, N.S.W..........	1018·4	+ 0·1	73	40	62·6	47·8	55·2	+ 2·5	50·0	79	4·7	9·04	+ 4·24	17	5·5	54
Melbourne	1018·8	− 0·1	69	34	58·0	44·3	51·1	+ 2·4	46·5	83	6·6	1·64	− 0·22	17	3·5	36
Adelaide	1019·3	− 1·0	74	38	63·0	47·1	55·1	+ 3·3	48·4	66	6·7	1·04	− 1·60	15	4·5	45
Perth, W. Australia ...	1019·9	+ 0·9	69	37	63·0	46·9	54·9	− 0·3	48·9	76	4·2	5·88	− 0·68	13	6·0	59
Coolgardie	1019·9	+ 0·1	73	35	60·3	39·9	50·1	− 1·1	47·2	73	4·8	0·92	+ 0·05	6	...	...
Brisbane..................	1019·0	+ 0·6	78	41	67·8	51·6	59·7	+ 1·2	53·1	71	5·8	5·11	+ 2·91	9	5·4	52
Hobart, Tasmania......	1016·4	+ 2·7	66	34	53·4	40·5	46·9	+ 1·2	42·8	81	6·1	2·11	− 0·07	17	4·5	48
Wellington, N.Z.	1014·3	+ 0·4	60	33	51·1	40·2	45·7	− 2·3	43·4	79	6·8	6·10	+ 0·47	20	3·6	38
Suva, Fiji	1014·0	0·0	82	63	78·1	69·1	73·6	+ 0·2	69·8	84	7·2	9·74	+ 4·81	22	3·9	35
Apia, Samoa	1011·1	− 0·8	87	70	84·3	73·6	78·9	+ 1·7	75·5	81	5·0	7·74	+ 4·76	18	...	...
Kingston, Jamaica	1014·5	− 0·2	93	70	89·2	73·0	81·1	− 0·6	72·2	77	3·1	0·85	− 0·77	8	5·6	43
Grenada, W.I.	1010·1	− 3·2	89	71	86	73	79·5	+ 0·3	73·0	74	6	8·59	− 0·84	25	...	...
Toronto..................	1014·0	− 0·4	93	54	81·5	61·4	71·5	+ 2·4	63·2	65	4·3	1·58	− 1·26	11	10·6	70
Winnipeg	1013·6	+ 1·3	92	40	78·9	53·2	66·1	− 0·3	55·4	81	3·8	1·77	− 1·33	10	11·2	70
St. John, N.B.	1012·9	− 0·7	80	41	71·1	53·8	62·5	+ 2·1	58·3	80	6·1	2·09	− 1·54	13	8·0	52
Victoria, B.C............	1017·2	− 0·1	81	49	67·0	51·7	59·3	− 0·8	56·2	87	6·2	0·25	− 0·17	5	10·0	64

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(24083) Wt. 25/32 1000 1/35 Hw. G.377/6