The Meteorological Magazine

Vol. 64

(Tenth of the New Series)

1929

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

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

INDEX

45

ERRATA

See pages 9, 99, 119, 147.

ILLUSTRATIONS

RIME AT SEALAND, NEAR CHESTER, 10H. 30M., DECEMBER 15th, 1928

M.O. 313.

The Meteorological Magazine

Vol. 64

Feb. 1929

No. 757

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

The Winter Weather of December, 1928, January and February, 1929

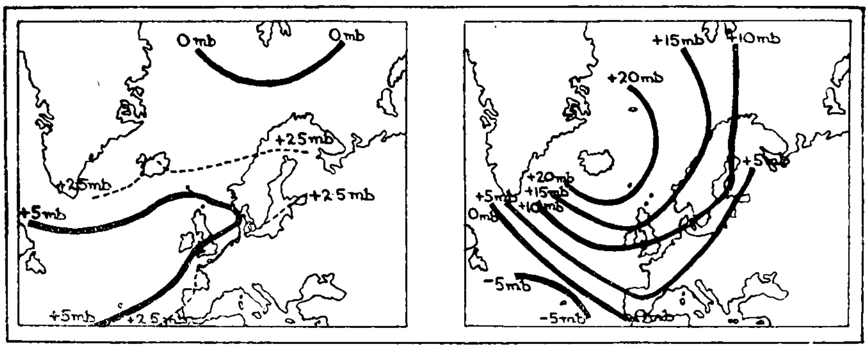
After a wet and stormy November fairly cold and dry weather set in early in December, as described in the *Meteorological Magazine* for January, 1929. Conditions were not by any means extreme however, for over the British Isles as a whole the average temperature was only 0.6°F. below the normal. The parts of the country where the greatest deficit of temperature occurred were the Midlands and southern England, where a number of stations recorded a mean temperature more than 2°F. below normal, but at none of the low-level stations did the average temperature fall below freezing point. The pressure distribution also was not outstanding. The deviations from normal are shown on the left hand side of figure 1, the characteristics being a belt in which pressure was more than 5mb. above normal, extending across the North Atlantic from New York and Newfoundland to the Azores and the British Isles, and a pressure slightly below normal over Spitsbergen.

January, 1929, has been much more remarkable. The month has been generally cold, and though full details are not yet available, it is safe to say that over the country as a whole it is the coldest month since 1917. The greatest deficit of temperature occurred in southeastern England where some stations recorded a mean temperature more than 3°F. below normal. At Kew Observatory the difference from normal was as much as −3.5°F.,

(82910) P.S. 1602/81. 1,000 2/29 M. & S. Gp. 303.

making it the coldest January there since 1895. The pressure distribution has been equally abnormal, this being one of the few winter months on record in which pressure over Iceland has exceeded that over the Azores. For the month as a whole, the mean pressure at Seydisfiord was 1022.0mb., or 23.2mb. above normal, while that at Horta was only 1008.7mb., 11.1mb. below normal. During the 35 years from 1894 to 1928 inclusive, pressure over Iceland exceeded that over the Azores twice in December, once only in January and five times in February, but the only occasions comparable with January, 1929, were the exceedingly cold February, 1895, when the difference amounted to 17.7mb., and January, 1918, with a difference of 9.7mb. A mean monthly pressure of 1015mb. or more is very rare in Iceland in winter, and the record for January, 1929, has been exceeded by only one January since 1846, namely, 1881, when it averaged over 1022mb. at Stykkisholm.

The deviations of pressure from normal over the eastern North Atlantic and western Europe during the first 28 days of



DECEMBER, 1928 JANUARY, 1929

FIG. 1

January, 1929, are shown on the right hand side of figure 1. Unfortunately the illustration had to be prepared before the end of the month, but the addition of the remaining three days makes little difference. The chart bears a certain resemblance to that for February, 1895, illustrated in the *Meteorological Magazine* for May, 1924, p.80, but the area with pressure above normal extends more definitely over the British Isles, and consequently the easterly winds were fortunately neither so strong nor so persistent as in 1895. By a curious coincidence, or perhaps it is more, the pressure map for December, 1928, is almost identical in all respects with that for December, 1894.

There is another aspect of the coldish winter of 1928-29 which is not without interest. A writer in *The Observer*, in the issue for January 20th, calls attention to an apparent 34 year periodicity, presumably a manifestation of the "Brückner Cycle," in these severe winters. January, 1895, was a cold month, and was succeeded in February by one of the greatest frosts of the nineteenth century. In December, 1860, and January, 1861, there was a very cold spell, the minimum temperature at Greenwich falling to 8°F. on Christmas Day and 10° on the 29th. In January, 1826 (a 35 year interval instead of 34) the Thames was frozen to such an extent that some of the bridges were completely blocked with ice. The periodicity is not so complete as it seems at first sight, however, for going back another cycle we find that neither 1791 nor 1792 were especially cold—not nearly so cold as 1795. Again, the coldest winter of the early nineteenth century in London was not 1826 but 1814, while 1838 was colder than either 1826 or 1861. In any case the winter through which we are passing, disagreeable though it may be, has so far not been outstanding compared with some of these giant frosts of the nineteenth century.

The cause of the abnormally high pressure over Iceland is at present a mystery. The northeast trade wind has been abnormally weak, a condition which contributes towards raising pressure over Iceland and depressing that over the Azores, but the northeast trade alone is not a very potent factor. It is more likely that something abnormal has been happening to the ice in the Arctic, but as to that we have no information.

At the beginning of February a large area of low pressure developed over the North Atlantic, and pressure over Iceland fell rapidly, but in the meanwhile an extraordinarily intense anticyclone had developed over northern Russia, pressure reaching nearly 1060mb. over the Urals on January 29th. The anticyclone continued to advance westwards, and has occupied northern Russia and the Baltic region during the first half of February. It is an offshoot of the great winter anticyclone of Siberia, with which it is connected by a ridge of high pressure in about 60°N. latitude, and on its southern side a great current of intensely cold air from Siberia drifted across Europe. The second week of February was accordingly intensely cold over central Europe, and at the time of writing the cold shows no signs of abating. Some of the minimum temperatures quoted in the press are: –67°F. at Ivanov-Voznesensk, northeast of Moscow (the previous lowest for this district being about –50°F.); –40° near Vilna in Poland; –31° in Silesia; –24° in Belgrade; and –15° in Berlin. In over a hundred years no temperature so low as this appears in the official records for Berlin, the previous records being –13°F. in January, 1850, and February, 1855. It must be pointed out however that the temperatures quoted above are not all official figures supplied by the various Weather Services, and some may refer to abnormal exposures. Various other facts however show that the cold is really abnormal. The western Baltic is freezing, and many ships are fast in the ice, and the Danube is frozen for 1,200 miles.

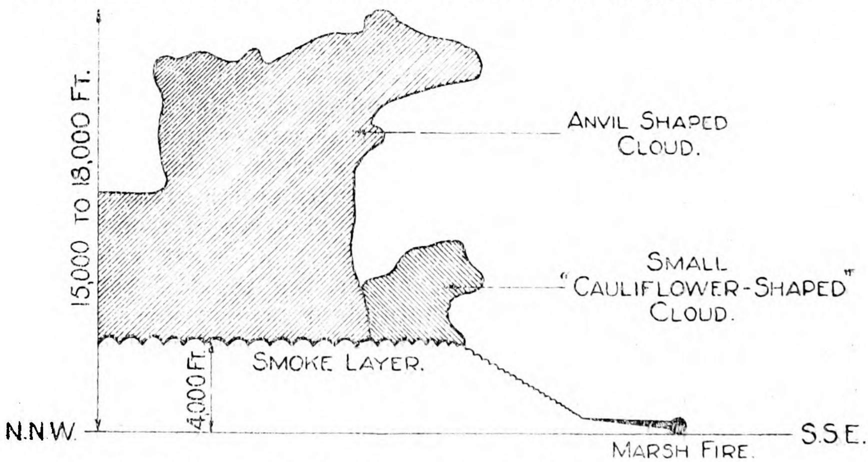
During the end of January and beginning of February a deep depression occupied the eastern Mediterranean, and was associated with several severe snowstorms over the Balkan Peninsula. The railway lines are blocked and three Simplon express trains have been snowed in for more than a week in Thrace, the abnormality of the heavy drifts being perhaps best shown by the fact that the railway authorities possess no snow ploughs.

C. E. P. Brooks.

Formation of a Cumulus or Cumulo-Nimbus Cloud near Basra on November 17th, 1928

The following account of the formation of an isolated cloud of great vertical extent within a few minutes over a marsh fire is based upon information supplied by Mr. F. D. Travers, Pilot of Messrs. Imperial Airways Ltd.

On November 17th, 1928, at 11h. 15m. (G.M.T.) during a flight from Basra to Baghdad a marsh fire was observed in Khor-Abu-Kelim (near Basra) the smoke from which reached a height of about 4,000 feet. On the upper surface of the smoky layer a small " Cauliflower shaped " cloud formed within a few seconds and this small cloud grew within two or three minutes into a large " anvil shaped " cloud whose top was at a height of 15,000-18,000 feet. A sketch of the cloud is given below.



The same thing had been observed to happen some minutes previously over another marsh fire at some distance from the route and apart from these two clouds the sky was cloudless from Basra to Shatt-el-hai (about 130 miles). Between Shatt-el-hai and Baghdadiyeh severe sandstorms and rain squalls were encountered.

Weather conditions in Egypt were very disturbed from November 14th, 1928 onwards due to the presence of a "low" near Greece. A cold front passed Ismailia at 23h. 45m. on the 14th—probably the same discontinuity as was encountered by a Flying Boat between Candia and Aboukir, the crew of which "were drenched with salt water at a height of 1,000 feet." The front was passed by an Imperial Airways Machine at 5h. 45m. (G.M.T.) on the 15th near El Arish, visibility being reduced to 50 yards owing to rising sand. At 10h. 20m. (G.M.T.) the squall reached Gaza and its further progress eastwards was (as is usually the case) held up by the Palestine Hills. The presence of the cold front was, however, responsible for heavy thunderstorms at Ramleh early on the 16th, 19mm. of rain falling within 15 minutes between 4h. and 5h. (G.M.T.). By Saturday, the 17th, cold air had passed Amman (Temp. fell 6°) and had probably penetrated well over southern 'Iraq. The rain squalls and dust storms between Shatt-el-hai and Baghdadiyeh were apparently due to a burst or bursts of cold air and a consequent bending of the "polar front" towards the east. The clouds observed over the marsh fire were formed in the southeast current drawn from the Persian Gulf region.

It would appear that above 4,000 feet the lapse-rate in the current up to a great height was at least equal to the saturated adiabatic rate and that a comparatively small disturbance was sufficient to cause very rapid condensation in a column of air extending from 4,000 to 15-18,000 feet. According to the above report a marsh fire affecting an area of about 40,000 square yards was sufficient.

J. DURWARD.

OFFICIAL PUBLICATIONS

The following publications have recently been issued:—

International Meteorological Organization, Commission for Synoptic Weather Information. Report of the seventh meeting, London, May, 1928. (M.O.309.)

The particulars of the various proposals which the Commission and its Sub-Commissions had under consideration at its 7th meeting in London in May, 1928, are given in appendices and furnish an excellent index of the activity of synoptic meteorology and of the efforts which the members of the Commission are making to bridge the gap between the relatively simple international arrangements of pre-war days and the world-wide organisation to which the present developments are leading.

One of the most important aspects considered at the meeting in London was that of the organisation of synoptic meteorology of the oceans. The Commission decided that a satisfactory organisation could be achieved only by having ships equipped with properly tested meteorological instruments and making reports at standard times in a uniform code. It was agreed that each nation should undertake to equip a number of ships, proportional to the tonnage of its sea-going mercantile marine, and that the standard hours of observation should be at midnight, 6 a.m., noon, and 6 p.m. (G.M.T.), and it was further agreed that details of the plan for the collection and distribution of observations at sea should be prepared for circulation to the different meteorological services interested.

The question of a universal code for meteorological reports in all countries and all climates is naturally one of great difficulty. The Commission gave provisional approval to a code and specifications designed for world-wide application and for meeting the requirements both of aviation and of general forecasting. Details of the code are included in the Report. Great difficulty has been caused in the past owing to the differences of the unit adopted for the expression of atmospheric pressure. The Commission agreed, practically unanimously, that for international purposes atmospheric pressure should be expressed in millibars, the unit proposed some 20 years ago by Professor V. Bjerknes.

Other resolutions of the Commission concerned the arrangements for the distribution of reports by wireless telegraphy in the European area; for the extension of meteorological stations in the polar regions; and for the arrangements for the exchange of meteorological reports between Europe and America.

GEOPHYSICAL MEMOIRS—

No. 44. The distribution of mean annual maxima and minima of temperature over the globe. By C. E. P. Brooks, D.Sc., and Miss G. L. Thorman, B.Sc. (M.O.307d).

The mean annual maximum of temperature at any place is the average of the highest shade temperatures reached at that place during each of a number of years. It gives approximately the temperature which is likely to be exceeded at that place once in two years. Similarly, the mean annual minimum gives the average of the lowest shade temperatures reached during each of a number of years. These figures, which are of great climatic interest, are given for a large number of places distributed over the world, and are also shown graphically on two world charts. It appears that the highest temperatures are found, not near the equator, but in latitudes 20-30°N. and S., the actual maximum being 125°F. in the Sahara. Mean annual minima are, however, highest near the equator, and on some equatorial islands they are above 70°F. In London the mean annual maximum is 89°F., and the mean annual minimum 20°F. The two maps are conveniently arranged for comparison, which brings out many interesting points.

Discussions at the Meteorological Office

December 10th.—*Measurement of variable velocity relative to air with pitot-static tube.* By K. Wada and S. Nisikawa. (Tokyo, Rep. Aeron. Research Inst. 2, 1927, No. 13, pp. 327-393.) *Opener*—Mr. A. C. Best, B.Sc. Mr. L. F. G. Simmons also spoke on " Recent research work on the Dines anemometer at the National Physical Laboratory."

This paper can be divided into four parts. In the first part the equation of a theoretical pitot-static tube is developed, taking the general form of Bernoulli's equation as basis. Then formulæ are obtained enabling the velocity of air to be calculated from the indications of a pitot-static tube when that velocity is variable. In the second part, the influence of friction in the pipe connecting the pitot-static tube to the indicating part of the apparatus is discussed. It is shown that, in the case of a simple harmonic variation of velocity, the friction reduces the amplitude of variation. A formula for this reduction is deduced. The authors used a diaphragm manometer as indicator. In the third part of the paper, they calculate the amount of the time lag resulting from the volume of the chambers of this manometer.

Finally, experiments are described in which the true velocity of the end of a pendulum, and the velocity indicated by a pitot-static tube attached to the end are compared. Comparisons are given both before and after corrections for the three effects described above, have been applied. It is shown that the corrections bring the true and indicated velocities into very close agreement.

Mr. L. F. G. Simmons, of the National Physical Laboratory, gave a brief account of recent research work in the Dines anemometer. Arising out of a paper by himself and Mr. Johansen on the transmission of air waves through pipes, Colonel E. Gold had suggested that an investigation be made to determine the effects of the length and diameter of the connecting piping on the record of a Dines anemometer, when the actual wind was varied in a known manner. It was soon found that in 50 feet lengths, one-inch piping was greatly superior to half-inch or smaller sizes. In consultation with the Meteorological Office, various other problems were tackled and the main results were as follows:—

(1) For anemometers in which the head and vane were of the order of 50 feet above the recorder, one-inch gas-piping should be used as the connecting tubes.

(2) The bends at the base of the head give rise to eddies which cause serious variations in the suction/pressure ratio according to the direction of the wind. These variations could be eliminated by enclosing the lower part of the head in a cylindrical

shield with conical top suggested by Mr. Giblett. By making the base angle of the cone 57° a fairly close approximation to the Dines factor could be obtained over the working range of velocities. There remained, however, a slight scale effect which was inherent in the design of the instrument.

(3) By staggering the suction holes, variations of the factor due to the distribution of holes and spaces could be rendered negligible.

(4) The question of the effect of the width of the annular space between the outer and inner tubes (near the suction holes) was examined. From the point of view of constancy of factor, no advantage would result from an alteration of the present dimensions of the inner tube, which would alter the annular space into which the suction holes lead. There is some evidence in favour of increasing the outer diameter, in order to secure a more uniform value of the factor over the normal working speed range; but it is anticipated that the experiments at present in progress will show that the same result can be effected by simply enlarging the suction holes, or by replacing the holes by suitably arranged slots.

(5) Leakage of air between the float rod and collar introduced an error which depended upon the size of the pressure and suction pipes. It would be desirable to eliminate this leakage by introducing a liquid seal.

(6) When displaced, the vane was found to execute several oscillations of rapidly diminishing amplitude before coming to rest in the air stream.

The modifications necessitated by the results of the investigation were illustrated by reference to a new anemograph which was on view. These included a shield, staggered suction holes and large unions to permit of the use of one-inch gas piping in place of the half-inch compo piping previously employed.

January 14th, 1929.—*On the formation of surface inversions of temperature with clear skies and land breezes.* By R. Steiner. (Rostock, Wiss, Abh. Luftwarte Univ., Heft 1, 1926.) (In German.) *Opener*—Mr. D. Brunt, M.A., B.Sc.

In his introduction the opener summarised briefly the physical causes of inversions at night. While the earth radiates approximately as a black body, giving radiation whose maximum intensity is at about 10μ, the water vapour in the atmosphere is transparent to a band of wave-lengths from 8μ to 11μ. Thus if at night the earth and the air above it initially had the same temperature, they could not remain in thermal equilibrium, and the earth would cool in virtue of its loss by radiation within the band 8μ to 11μ. The cooling extends gradually upward eventually giving an inversion, but the relative importance of turbulence and radiation in producing the inversion remains unsettled. The opener pointed out that the transfer of radiation can be approximately represented by an equation similar to that for conduction of heat in a solid, and that while radiation strives to produce an isothermal condition, turbulence strives to produce an adiabatic condition. That radiation must be of importance in the phenomena of the lower atmosphere is shown by the fact that in the morning the temperature at the top of the Eiffel Tower starts rising before the lapse rate has reached the dry adiabatic.

In the paper by Steiner the observations of temperature up to about 600 metres refer to occasions when the sky was clear, and the wind had come for long distances over land, mainly from the east. The lapse rate, after being in excess of the dry adiabatic, diminished steadily, giving isothermal conditions up to 600 metres at about sunset, the inversion not forming even at the ground until after sunset. These characteristics were shown by a number of ascents.

Mr. Heywood, of Leafield, showed some diagrams illustrating the formation of inversions ~~at the~~ ground some considerable time before sunset, in definite disagreement with Steiner's scheme of development.

In the course of the discussion it was pointed out that with recording instruments of the usual type ascents made every half-hour gave ample time to avoid errors due to the lag of the instrument. It was also pointed out that the average lapse rate is the same over the whole earth, and at all heights within the troposphere, and is approximately equal to the saturated adiabatic lapse rate, and approximately half-way between the isothermal and dry adiabatic conditions. The practical importance of determining the factors which are effective in producing night inversions, in regard to the forecasting of night frost, was also mentioned, special reference being made to the occurrence of ground frost in a polar current with a strong westerly gradient.

The subjects for discussion for the next two meetings will be:—

February 25th.—*Relations between changes of atmospheric pressure and temperature. A contribution to the question of the "seat" of pressure variations.* By Bernhard Haurwitz (Leipzig, Geophys. Inst. der. Univ. 2nd Series, Bd. 3, H. 5, 1927, pp. 267-336) (in German). *Opener*—Mr. L. Dods, B.Sc.

March 11th.—*Contributions on the mechanism of waterspouts and tornadoes.* By A. Wegener (Met. Zs. Bd. 45, H. 6, 1928) (in German). *Opener*—Mr. M. A. Giblett, M.Sc.

Erratum

January, 1929, page 290, line 34, *for* "1926" *read* "1928."

Royal Meteorological Society

The Annual General Meeting of this Society was held on Wednesday, January 16th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, in the Chair. The Report of the Council for 1928 was read and adopted, and the Council for 1929 duly elected, Sir Richard Gregory, LL.D., being re-elected President.

The meeting began with a pleasant surprise in the form of a short talk by Col. E. Gold on the blizzard and period of intense darkness which had visited London and the neighbouring districts that morning. This is a new departure which it is hoped will become a regular feature of future meetings, which will open with a "five-minute" talk on some recent happening of meteorological interest, or the exhibition of new lantern slides which have been added to the Society's collection.

In presenting the Buchan Prize to Dr. H. Jeffreys, Sir Richard Gregory gave an interesting summary of the development of our knowledge of the atmospheric circulation, beginning with the voyages of Dampier, the dynamical theories of Halley and Hadley and the physical experiments of Robert Boyle and Dalton. For long the thermal theory of cyclones held the field, until it was destroyed by W. H. Dines and sounding balloons. Later came the Bjerknes' conception of the cyclone, in which for the first time depressions of temperate latitudes were regarded as something more than accidental ripples on the general circulation. Finally, Dr. Jeffreys showed that not only were cyclones part of the circulation, but that owing to the presence of friction they were a necessary part. In his reply Dr. Jeffreys said that Dr. F. J. W. Whipple had also added an important step to the theory. He also remarked that there was still plenty to discover about cyclones.

Sir Richard Gregory then delivered an address on "Amateurs as Pioneers."

Though the word "amateur" is commonly used disparagingly to signify a superficial student or worker, its correct meaning is one who loves or is fond of anything, or cultivates a subject as a pastime, as distinguished from one who prosecutes it as a professional occupation. In this sense every scientific worker is an amateur in any field of activity in which he is interested outside that in which he is professionally engaged. Until relatively recent times all scientific societies were organisations of amateurs. At a later stage, when it is found that their inquiries have a practical value, professional institutions are established, and much of the work is taken over by industrial or national services. In the middle of last century James Glaisher formed an organisation of voluntary observers for meteorological records, and the Royal Meteorological Society maintained this service until it was taken over by the Meteorological Office in 1912. The systematic collection of rainfall records which was started by G. J. Symons in 1859 and now includes about 5,000 observers in Great Britain and Ireland, has similarly become part of the organised work of the Meteorological Office. The systematic study of upper air conditions, now carried on for practical purposes of aviation, had their origin in the work of such amateurs as W. H. Dines and C. J. P. Cave. It was an amateur, Benjamin Franklin, who established the identity between the discharge from an electric machine and lightning by his famous kite experiment in 1752. An amateur also, Oliver Heaviside, first showed that there was a conducting layer in the upper air, now called the Heaviside layer, which would reflect electro-magnetic waves; and it is through the action of the ionised layer as a reflector that radio communication around the world has become possible. It was amateurs who first established world communication with short waves, 300 metres or less in length, when such wave-lengths were regarded as useless for commercial purposes. In transport also, through the experiments of Wilbur and Orville Wright, the conquest of the air for the advancement of knowledge and the service of man has been due chiefly to the pioneer work of amateurs. Every encouragement should be given, therefore, to all such voluntary workers in scientific fields.

Correspondence

To the Editor, *The Meteorological Magazine*

Wet Bulb Temperatures as "Thaw Temperatures"

When the ground is frozen in winter the air temperature may rise 3 or 4 degrees (F.) above freezing point without any effective thawing even of the surface of the ground. The explanation of this appears to be that the frozen ground, so long as there is any moisture in it, acts as a wet-bulb thermometer and consequently does not thaw so long as the wet-bulb temperature is 32°F. or less. When there is no longer any moisture in the surface layer, it will no longer remain frozen if the dry bulb is above freezing point, but neither will it have the characteristics commonly associated with a "thaw"—it will be powdery and not muddy. Wet bulb temperatures are therefore of special interest when the dry bulb temperature is near the freezing point.

There is another aspect of this question which has some importance. Until evaporation from the surface layer of the ground is practically complete, the lowest layer of air (and of the surface with which it comes in contact) is being cooled by evaporation; afterwards cooling of this layer (and the surface) is effected practically only by radiation. The cooling by outward radiation from the earth's surface to a clear sky (at temperatures near the freezing point) is only about the same as the cooling due to the evaporation of 2 to 3 millimetres of water per day of 24 hours: (we may take outward radiation to a clear sky to be approximately 25 per cent. of black body radiation at the surface temperature.* Over relatively short periods of time (of the order of a day or less) evaporation may therefore be a more important cooling factor than radiation when the air is dry and there is some wind.

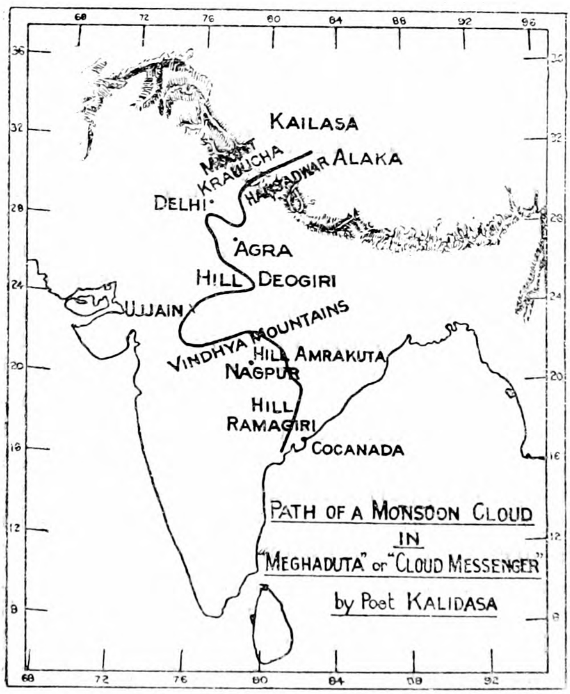
The existence of a snow layer is known to be very effective in reducing the temperature of the surface layers of air; the reason appears to be twofold: (1) it provides for continuous evaporation, and (2) it reflects a much great percentage of the incoming solar radiation than the uncovered surface of the ground. Even in mid-winter in this latitude the incoming solar radiation in the middle of the day more than counterbalances the outward radiation if it is mostly absorbed by the surface, but this may no longer be the case when a large proportion of the solar radiation is reflected.

E. GOLD.

January 7th, 1929.

Ancient Hindu Meteorology

It may be of interest to the modern meteorologist to know that Kalidasa, the celebrated Indian poet and dramatist, who flourished about the beginning of the Christian era, took pains in describing the path of the monsoon cloud in his famous work entitled "The Meghadutam" or "The Cloud Messenger." The chart below, which depicts the path of the monsoon cloud over India according to Kalidasa, has already been published by Krishnamachariar, a south India Sanskrit scholar. That circuitous path near Ujjain will not be



PATH OF A MONSOON CLOUD IN "MEGHADUTA" or "CLOUD MESSENGER" by Poet KALIDASA

---

* *See London, Q.J.R. Meteor. Soc.*, 39, (1913), *pp.* 258-60.

accepted appears to have been known to the poet; when addressing the monsoon cloud he says in the 27th verse, " though the path is circuitous for thee travelling to north do not miss Ujjain." It may be explained that Ujjain was the capital of the great kingdom of the Vikramas, Kalidasa being one of the nine gems of the court of a Vikrama. The cloud must therefore see this wonderful city and do homage to the king before proceeding north. The following remarks by the poet to the monsoon cloud are interesting:—

Verse 13. " Rest on mountain when thou art much exhausted."

Verse 19. " Rest for a while on Amrakuta hill, get light by the discharge of moisture and then speed on."

Verse 20. " The wind will not be able to move thee full of water."

Verse 22. " Thou wilt be delayed on every mountain."

Verse 56. (After Hardwar at the foot of the Himalayas) " give heavy showers of hail."

Verse 59. " Get compressed against the Himalayas and squeeze through Hansadwara pass near Mount Krauncha."

Verse 62. 63. " On the Kailasa mountain thy body will be congealed within thee and dreadful thunder will accompany thee."

Verse 120. The last verse in which the cloud is blessed by the poet thus, " Having carried my message of love to my beloved at Alaka near Kailasa you are free and mayest thou be never separated from your beloved the lightning in the same unfortunate way as I have been."

It is clear from the above statements that more or less accurate observations of cloud movements during the monsoon were made in India even two thousand years ago. This note may be interesting to students of past climates.

M. V. UNAKAR.

Poona, December 27th, 1928.

Pink Rainbows

The description of the pink rainbow on page 234 of the November issue appears to be similar to several I have noted here and upon one in particular, that on August 28th, 1924, I have made the following note:—

" Brilliant rainbow faded away at sunset and reappeared with secondary in the after-glow in colours such as an ordinary rainbow would have, if seen through orange coloured glasses."

These rainbows appear after sunset in the after-glow when the clouds are very high, and in the instance noted, both ends of the arc were cut off some distance from the horizon. For anyone who has not lived in the tropics it is difficult to realise the brilliance of these after-glows, which under certain conditions and at certain times of year, are fairly common. The blaze of colour that spreads and passes from east to west in the course of a few minutes can never be adequately expressed in words. I take it that the coloured brilliance is due to the sun shining directly on clouds of considerable altitude through a comparatively impure layer of air close to the surface of the earth, and that, if moisture is falling from these clouds, a rainbow naturally occurs, even though the sun may have set some minutes.

R. S. BRETON.

The Siam Commercial Bank, Ltd., Tung Song, S. Siam. *December* 19*th*, 1928.

Winter Fog and Relative Humidity at Three Selected Stations

Defining " Winter " as the months October to March (inclusive) and " fog " as a visibility of less than 1,100 yards, the table attached shows the occurrence of fog with regard to relative humidity during winter at the three stations—Birmingham, Cranwell and Gorleston. For Birmingham the period brought under review stretched from October 1st, 1923, to March 31st, 1927, and the hours of observation employed were those of 7h., 13h., and 18h., G.M.T.; whilst for Cranwell and Gorleston the period was from October 1st, 1922, to March 31st, 1927, and the hours of observation 1h., 7h., 13h., and 18h. The data used were extracted from the *Daily Weather Reports* issued by the Meteorological Office, London. It needs to be noted that in the construction of the table the first of the three relative humidity columns contains all readings below 95 per cent. and the second all readings below 90 per cent. The relative humidities were in every case measured by the use of wet and dry bulb thermometers, and the visibility observations at the sea station, Gorleston, are those taken looking landwards.

	No. of cases of fog	Percentage of such cases when relative humidity was less than		
		95 per cent.	90 per cent.	80 per cent.
Birmingham	220	57·3	30·5	6·4
Cranwell	279	5·1	2·2	0·7
Gorleston	138	21·0	6·5	0·0

The high percentages of fog at the town station—Birmingham —with air that is not saturated, or even approximately saturated, are probably significant from the view point of the effect of smoke when compared with Cranwell, a typically rural exposure. The figures for Gorleston—a seaside station—do not seem to admit of a ready explanation, though condensation upon salt particles is a possible one.

W. H. Pick
R. C. Sutcliffe.

NOTES AND QUERIES

Rime at Sealand on December 15th, 1928

The photograph of rime, which forms the frontispiece of this volume, was taken at Sealand Aerodrome, near Chester, on the morning of December 15th, 1928, at 10h. 30m.

The aerodrome stands on a stretch of low-lying sandy land that forms the northeastern corner of Flintshire, and which was formerly the ancient bed of the River Dee and, according to some, also that of the River Mersey. The site of the rain-gauge is only 16ft. above mean sea level. Being low-lying, fogs develop on clear quiet nights, but seldom persist after sunrise owing to the operation of a land breeze from the south-east to the adjacent Dee Estuary and the Irish Sea.

On December 14th the southwestern edge of a Scandinavian anticyclone was irregularly distributed over the British Isles, and except for the usual land breeze in the morning there was no wind for the rest of the day. The temperature at 16h. was 31.3°F. having fallen from 38.6°F. at 13h. and fog had formed before 16h. At 18h. the fog was thick, the visibility being less than 200yds. and the air temperature had dropped to 23°F. The fog continued during the night but was dissipated early the next morning by the land breeze from the southeast and at 7h. visibility was over 1,100yds. During the night the grass minimum fell to 12°F., a temperature shared with Worthy Down. The screen minimum fell to 18°F., which was the lowest screen temperature in the British Isles reported the following morning.

In the photograph the rime-laden foliage faces westnorthwest and lies in the lee of the morning breeze. The road in the foreground is the main Birkenhead-North Wales road, which crosses the railway line by a bridge to the left of the photograph. There is a considerable milk traffic on this road in the early morning, and consequently it shows no indication of frost or frosty precipitation, though the coating on the grass edge below the wooden fence is quite plain. The part of the fence to the right-hand side of the photograph was not so heavily coated as that to the left probably due to the fact that the wood on the left flanks open flat ground to the north and northeast and borders the railway. The trees on the right, as the photograph shows, have the wood behind them, and the small flat-topped tree lying almost on the fence had a thick covering of rime on the wood side, but was almost free from it on the road side. Thus the drift of the fog seems to have been from the northeast. This would be likely to occur as the lowest ground is to the southwest along the artificial banks of the present River Dee. The rime persisted all day, and finally disappeared in the slight sleet on the morning of December 16th.

The photograph was taken by one of the R.A.F. photographic staff at the aerodrome, through the courtesy of Group Captain A. D. Cunningham, C.B.E., Commanding No. 5 Flying Training School, Royal Air Force.

J. J. SOMERVILLE.

The Contrast in the rainfall of Januaries of 1928 and 1929

While the general rainfall over the British Isles as a whole was 202 per cent. of the average in January 1928, that of January 1929 was only 63 per cent. The former month was therefore more than three times as wet as the latter. For the country as a whole January 1928 was the wettest January since comparable statistics became available in 1870, while a smaller fall than that of 1929 has occurred only in the Januaries of 1880, 1881, 1896, 1907 and 1911, when the general falls were 37, 44, 53, 60 and 60 per cent. respectively.

This sharp contrast in the rainfall of two consecutive Januaries, although unprecedented in January, recalls that of the two consecutive months, November and December 1926, which were the wettest and driest months of those names respectively back to before 1870. The total rainfall of November and December 1926 was, however, quite close to the average. The deficiency of January 1929 was appreciably less than the excess of January 1928. Moreover, since 1918 the rainfall of each January, except one, has exceeded the average, the smallest amount being that for 1927 with 97 per cent. of the average. The rainfall of five Januaries during this period has reached or exceeded 140 per cent.

The outstanding feature of the distribution of the rainfall of January 1929, as a percentage of the average, was the gradient from east to west, associated with an unusual frequency of northerly and less frequent westerly winds. There was rather more than the average rainfall along the east coast of England and less than 50 per cent. over most of the western half of Great Britain and of Ireland, with only about 25 per cent. in the Western Highlands of Scotland and in the northwest of Ireland. The rainfall was most remarkable in Scotland where the month was the driest January since that of 1881. At Ardross Castle, in eastern Ross-shire, January 1929, with 0.99in., was the driest January since before 1870. Elsewhere over the

British Isles the Januaries of 1880 and 1881 were most often the driest on record. It is noteworthy that the driest January on record at individual stations has rarely given totals of less than half an inch.

In January 1928 the largest percentage values (of 280 per cent. or more) occurred in the northwest of England and in the Southern Uplands of Scotland. The month was the wettest January on record in these regions as well as in the northwest of Ireland, at Wick in Caithness and at Eallabus in Islay. The weather of the month, unlike that of January 1929, was mainly mild and the number of depressions which passed across or near these islands was unusually frequent.

J. GLASSPOOLE.

Meteorological Exhibits at the Exhibition of the Physical and Optical Societies

The nineteenth annual exhibition of the Physical Society and the Optical Society, held at the Imperial College from January 8th to 10th, 1929, was of more than ordinary interest to the meteorologist. In the Trade Section several new instruments were exhibited for the first time. Among these may be mentioned Messrs. Casella's anemometers, incorporating the "three cup" system designed by Mr. J. Patterson, of Toronto. The cups are 5in. in diameter and are carried on arms giving a centre-to-centre distance from the spindle of 6.3in. The system makes 640 rotations per mile of wind and the "factor" is, therefore, 2.5. One of the anemometers was fitted with a speed indicator, thus incorporating the essential features of the anemometer illustrated on p. 184 of the *Meteorological Magazine* for September, 1927.

Messrs. Negretti & Zambra showed several new instruments, including a new "recording float raingauge." This instrument, which is of imposing dimensions, employs a large float chamber capable of containing 12in. of rain. The float is suspended by a phosphor bronze chain wrapped several times round a brass drum connected to a ratchet wheel on the edge of which are twelve notches. Engaging the ratchet wheel is a pawl attached to the pen arm carriage. Ingenious mechanism is provided for disengaging the pawl when the pen reaches the top of the chart and returning it to the base line. The float chamber is emptied by means of a hand-operated pump and syphon device when nearly full.

The same firm showed a novel type of barograph. The recording pen is attached to a brass frame which carries a group of aneroid boxes connected by a spindle to a heavy brass weight. The frame is balanced on knife edges and its action depends on the change in the centre of gravity brought about by the movement of the weight in response to a change of pressure. The instrument is still in the experimental stage, but the idea seems worth pursuing.

In the Research and Experimental Section, the Meteorological Office exhibited a group of instruments recently developed for testing purposes or for special observational work. These included instruments for testing rainfall measuring glasses and Campbell-Stokes sunshine recorder spheres, a "sky-photometer" for measuring the total illumination of a horizontal surface, an "air-duct psychrometer" for humidity measurements on aeroplanes and a new electrically-operated wind direction recorder.

At the invitation of the Managers, the sky photometer and sunshine sphere testing apparatus were subsequently exhibited at a Conversazione of the Royal Institution on January 25th.

Defects in the Piping of Pressure-Tube Anemometers

Custodians of pressure-tube anemometers or anemobiagraphs for which the tubes connecting head and recorder are made of compo-piping are recommended to examine the piping very carefully for defects at frequent intervals. "Compo" is a soft alloy which will not withstand rough treatment, and cases have occurred where the piping has been pinched and even punctured by the metal straps which are often used to bind the piping to the anemometer mast which supports it. Such straps should be well lined with leather so that they do not bear directly on the compo-piping.

In a recent case an anemometer, which appeared to be working satisfactorily in all other respects, developed a mysterious fault on wet days. This resulted in the collection of sufficient water in the float chamber to raise the level of the water by as much as 1¼in. on some occasions. Although the compo-piping was carefully examined no defect could be detected until the piping was taken down, when it was found that defects had developed in both pipes at two soldered joints near the recorder. Not only did the defects vitiate the record because of the escape of air, but the break on the suction side in particular acted as a collector of rain-water which had trickled down the mast, and in consequence the water found its way into the float chamber in considerable quantity. In another case defective action was traced to the presence of a hole in the suction pipe, caused by chafing against one of the climbing steps on the mast.

It is not an easy matter to test compo-pipes for leaks when they are *in situ*. One method would be to disconnect the pipes top and bottom at the screwed joints where they are attached to the head and recorder, stop them securely at the top by rubber corks and apply pressure at the lower end of each pipe in succession by means of a suitable head of water or mercury in a glass U-tube connected to the lower end by a piece of rubber tube. This method would detect a leak but it would not detect a stoppage in the pipe due to a " pinch " or other cause.

In recent issues of anemometers the compo-piping is replaced by 1in. diameter iron-piping, which is much more durable and satisfactory than compo.

Reviews

Uber wärme Hochdruckgebiete und ihre Rolle im atmosphärischen Wärmehaushalt. By R. Mügge. Leipzig, Geophysikalisches Inst. der Universität. Veröff. 2 Band III, Heft 4, pp. 239-266.

In this paper Mügge first reviews briefly the correlation coefficients obtained between pressure, temperature, etc., in the upper air, and recalls the observed fact that the stratosphere is high and cold over high pressure, and low and warm over low pressure. The paper discusses the possibility of explaining the warm anticyclones which reach great heights as the effect of outbursts of cold air at high altitudes, from the tropics to higher latitudes. The international observations for two days of anticyclonic conditions, viz., May 7th, 1909, and May 19th, 1910, were taken, and vector-mean winds for three levels, 1-4 km., 4-8 km., and 8 km. to the tropopause, were evaluated, and represented graphically. For May 7th, 1909, three charts are reproduced showing the lines of flow in the three layers considered, and it is shown that at each level, there is a point of divergence which is displaced south-south-westward with increasing height. The isotherms for the lower stratosphere indicated an island of cold air slightly southward of the point of divergence in the higher level. The gradient of the isotherms opened out towards the southwest, indicating an outburst of cold air from somewhere westward of the centre of lowest temperature. Generally similar temperature distribution was found on the second occasion, May 19th, 1910.

Mügge regards the outflow of air as being compensated by the subsidence of the cold air from high levels. He computes the outflow across a cylinder of 1,000 km. diameter, and 4 km. high, and computes the downflow through the top of this cylinder as equivalent to a downward velocity of 2·8 cm./sec. over the whole of the top of the cylinder. The data reproduced in the paper do not make it possible to judge how stable or unstable the vertical conditions were over the region in question.

The question of radiative equilibrium, assuming the radiation to be entirely due to water vapour, and to be " grey " radiation, *i.e.*, proportional to the black body radiation for the same wave-lengths, is discussed in detail, and it is shown that the temperature in the stratosphere is determined partly by the incoming solar radiation, and partly by the heat brought into, or removed from, the region, by horizontal winds. Mügge applies this to the discussion of the conditions in the anticyclone of May 7th, 1910, where the mean temperature in the stratosphere was assumed to be — 60°C., in reasonable agreement with the observations. In the absence of any loss of heat by advection, the temperature of the stratosphere demanded by radiative equilibrium is — 45°C. Mügge shows that the loss could be accounted for if the air descending into the lowest 4 km. through each square cm., the top of the cylinder considered in the last paragraph, eventually carried away with it 0·1 calories, which would be equivalent to raising its potential temperature through 4°C. Since potential temperature normally increases with height, the air should not acquire the enhanced potential temperature necessary, in the course of its descent. Mügge suggests that the loss is due to evaporation of water, and shows that the mean rate of evaporation for the earth, if taken to apply to this case, would account for the loss of heat required. To the present reviewer the physical processes involved are not at all clear. It is regretted that the distribution of potential temperature with height was not discussed in greater detail, in view of the difficulty of accounting for the descent of air on a large scale.

Mügge also discusses the latitude variation of the temperature of the stratosphere, and arrives at the surprising result that the atmospheric radiation in polar regions is greater than in tropical regions, a result which is not readily explicable in terms of water-vapour radiation. This portion of the paper should be read in conjunction with Dr. Simpson's recent memoirs on the subject.*

D. Brunt.

Das Potentialgefälle der Luft in Wahnsdorf. By Hans Goldschmidt. Supplement to Deutsches Meteorologisches Jahrbuch für 1926. Freistaat Sachsen. Jahrgang XLIV, pp. A1—A20. Dresden, 1926.

The above supplement to the Free State of Saxony's Section of the German Year Book for 1926 discusses atmospheric electrical potential gradient records at the meteorological observatory at Wahnsdorf, a few miles north of Dresden, for the period July 1st, 1923, to December 31st, 1926.

The recording apparatus is described in detail, but consists essentially of a Benndorf electrograph connected to a radio-active collector. At first, registration was carried out in an isolated hut, but from May, 1926, a ground floor room of the main building was utilised. The records were standardised to give readings in volts per metre in the open by absolute observations

---

**London. Memoirs R. Meteor. Soc. Vol. II, No.* 16 *and Vol. III, No.* 21.

of the gradient between two wires carrying fuses, 1 metre and 2 metres respectively above the ground. The observations were taken 4—6 times a year on two open sites, one 100 metres to the north and the other 500 metres to the north-east of the observatory. A single exposure factor was used, but it would have been interesting to have results from both sites.

Mean hourly values were measured on the curves for two kinds of days, (1) quiet (q) days, that is days with cloudless or half-covered skies, with an absence of towering cumulus cloud, precipitation, mist, fog, electrified dust, thunder and lightning; and (ii), all (a) days, which included all days of complete record except those on which the insulation was faulty, or when there was charged precipitation. In some months there were only 2 or 3 " q " days and in others none at all, but no indication of the number of days used is given. Mean diurnal inequalities were abstracted for all the months, and for the mean months, seasons and years of the complete years 1924-26. The results are given in 11 pages of tables and graphs.

Generally speaking, the " quiet " day means are higher than the " all " day means, although in summer there is not much difference. The mean values for the three years, 1924, 1925 and 1926 are:—(q) 169, (a) 154; (q) 191, (a) 152; and (q) 174, (a) 141 volts per metre respectively, which are in accordance with places similarly situated to Wahnsdorf. The general variation of the monthly means from January to December is similar to that found elsewhere, being high in winter, (q) 243, (a) 207 volts per metre, and low in summer (q) 115, (a) 108 volts per metre. The mean daily variations for the individual months, however, are not in accord with those from other stations. As generally happens with potential gradient records from new stations, new types of daily variation seem to be supplied according to special local disturbances, and in the case of Wahnsdorf it is the summer variation which is outstanding.

The winter curve is the single wave type, with a minimum at 4h. and a maximum about 21h., such as is found universally over all the oceans and in high northern latitudes all the year round. The warm weather curves are also characterised by a single wave, but while the universal early morning minimum maintains its position, the evening maximum is almost obliterated (the maximum being in the forenoon), while the usual early afternoon minimum, supposed to be due to local effects in the lower layers of the atmosphere, does not appear at all.

The author feels that the exceptional type of summer daily variation at Wahnsdorf must be due to the peculiar position of the observatory, which is on a small plateau 250 metres high sloping away gradually to large tracts of field and forest land in the north; while to the south, about 500 metres distant, it drops down steeply into the Elbe valley. This runs southeast to northwest and is thickly studded with industrial towns. The suggestion is made (only to be rejected afterwards) that strong sunshine stirs up the highly polluted Elbe valley air, which rises up over the observatory and prevents the development of the afternoon minimum. Then in the evening the cooled air recedes, causing a decrease in potential gradient which obliterates the late evening maximum. This explanation is not supported either by solar radiation records or by wind frequency distribution. In summer especially, during the daytime when the gradient is high, clean winds from the north are predominant, while in winter polluted winds from the south are most frequent.

The harmonic analysis of the curves into the first three terms of the usual Fourier Series does not add to the information derived from the curves themselves.

From the summer of 1927 it is hoped to commence registration of the electrical conductivity of the air by the Schering method, and later on that of the radio-active emanation from the ground, in an attempt to explain the peculiar type of diurnal variation of potential gradient in summer. (It might be suggested that records of atmospheric pollution and the numbers of large ions in the air would throw some light on the phenomenon. With our increasing knowledge of atmospheric electricity, it is becoming more and more evident that a true picture of the electrical state of the atmosphere can only be obtained by the simultaneous observation of all the relevant factors.)

R. E. WATSON.

Obituary

Andrew Watt, M.A., F.R.S.E.—Andrew Watt was born in Edinburgh in 1869. He received his education first at Dumfries Academy and afterwards at Edinburgh University, where he took a high place in mathematics and graduated in 1889. After this, in consequence mainly of the state of his health, he made a voyage to Australia. There for some years he taught mathematics in the Scots College, Melbourne. Returning to this country in 1894, he continued in the same profession until 1900 when he joined the staff of the Scottish Meteorological Society as Assistant to the late Dr. Buchan. Shortly after the death of Miss Jessie Buchan in 1905, he became Assistant Meteorological Secretary and on Dr. Buchan's death in 1907, he was appointed as his successor. In the same year he was elected a Fellow of the Royal Society of Edinburgh. For some time prior to that the general work of the Meteorological Society had largely devolved on him. He edited the Society's Journal which maintained a high standard of usefulness until its discontinuance, and not a few of the articles which it contained were from his pen. His chief papers were on rainfall and climate. Occasionally he gave lectures under the auspices of the Society, on subjects of meteorological interest, and the success of these was to him ample reward for the labour that went to their preparation.

In 1920 the climatological work hitherto done by the Society was taken over by the Meteorological Office, and the Society was amalgamated with the Royal Meteorological Society. Mr. Watt loyally assisted in carrying through these changes, though they meant for him a change from a position of comparative freedom to shape his own work to one subject to the restraints of departmental control. In a man of less generosity and loyalty of character, this might have resulted in friction and disappointment, but to his superiors in the Meteorological Service he continued to give of his best with cheerful willingness.

With his marriage to Winifred Attwell there commenced what was probably the happiest period of his life, a period which was terminated by her death in August, 1927, after a prolonged illness. From the stress of this illness and the loss of his devoted companion in life, Andrew Watt seemed never fully to recover, but the sudden nature of his own end was quite unexpected. On Wednesday, January 9th, he had attended to his duties as usual; the same evening death overtook him.

Mr. Watt was approaching the age limit for the Meteorological Service and his friends could have wished that he had lived to complete his full period and to enjoy the leisure of retirement. He is survived by his younger brother, James Watt, C.M.G., and two sisters.

A. H. R. G.

The Weather of January, 1929

Quiet, dry, cold weather with much frost and fog at times prevailed generally during the month. In most parts of the country it was the coldest January since 1917. During the first week the conditions were anticyclonic and the temperature readings low; at several inland places in south Scotland and south-east England temperature did not rise above freezing point for two or three consecutive days. In Scotland the lowest temperatures occurred between the 1st and 4th and in England between the 5th and 8th. The lowest maximum recorded for the month, 24°F., occurred at Renfrew on the 4th and the lowest minimum in the screen, 7°F., at Markree Castle on the 1st. Snow, sleet and hail were recorded locally during this time and became more general on the 5th and 6th, but the amounts measured were small. Much sun was experenced in the north during the first few days, but in the south the whole week was dull. On the 8th, conditions changed in Ireland as a depression approached the northwest coasts. Heavy rain fell in Mayo on the night of the

8th to 9th and precipitation became general over the whole country on the 9th, being mostly in the form of snow or sleet in the north and east, 0.77in. was measured at Rothesay on the 9th. On the 11th anticyclonic conditions became re-established and the winds easterly. These gradually backed to north and snow or sleet showers were experienced in the eastern districts as depressions moved southwards across the eastern North Sea. Snow lying to a depth of 3 or 4in. was reported from Marchmont on the 15th and 16th and from Durham on the 16th. During this time conditions were much milder in the west, where the temperature rose above 50°F. On the 18th these milder conditions spread over the rest of the country and the 19th and 20th were mild sunny days with over 7hrs. bright sunshine at many places and over 8hrs. in the Channel Islands. The next day there was a renewal of the cold weather in the north and east and much fog prevailed on the 21st and 22nd. Heavy rain occurred in the southwest on the 22nd when 1.33in. fell at St. Austell (Cornwall). Cold northerly winds occurred generally between the 23rd and 27th with showers of snow, sleet or rain, but many bright intervals. On the 28th a deep depression approached from the Atlantic with a consequent change to warm southwesterly winds. Temperature rose generally to between 50° and 60° on the 30th and 31st, 61°F. was reached at Phœnix Park, Dublin, on the 30th, while heavy rain fell locally; 2.10in. were measured at Holne (Devon) on the 31st. The total rainfall for the month was below normal except for a small area in northeast England,* while sunshine records were above normal in the west but below normal in the east. The distribution for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	48	+20	Valentia	52	+ 4
Aberdeen	37	—11	Liverpool	37	—18
Dublin	29	—28	Falmouth	63	+ 5
Birr Castle	36	—13	Kew	32	—11

Pressure was much above normal over the whole of western Europe and at Bermuda, the greatest excess being 24.2mb. at Isafjord, while pressure was below normal over the North Atlantic, where the greatest deficit was 11.1mb. at Horta. Temperature was below normal except in the north of Scandinavia and in Portugal, being as much as 6°F. below normal in south Sweden and at Spitsbergen, while precipitation totals were deficient except in Spitsbergen and eastern Sweden.

Heavy and continuous rains accompanied by thunder, snow and hail storms during the first few days of the month resulted in floods in many parts of Italy. The Tiber is reported to

* *See page* 16.

have risen to 50ft., making it the worst flood experienced in Rome since February, 1915. Other large towns to be severely affected were Pisa, Florence and Naples. Cold weather with heavy falls of snow occurred generally over the whole of Europe even as far south as the Riviera during the first half of the month. At Majorca the temperature was almost down to freezing point but the weather was sunny. In Central Europe the snow falls were so heavy that railway and telegraph communications were broken in several places. The ice on the Elbe above Hamburg was so thick that the river could be crossed on foot; navigation on the tributaries of the Rhine also came to a standstill about the 16th. For the first time since 1917 skating was permitted on the lakes in the Bois de Boulogne (Paris) on the 17th and 18th. After a milder spell lasting about three days heavy snow fell generally on the 25th, and as far south as the Riviera on the 25th, 27th, 28th. Severe cold was experienced during this time with violent storms in Yugoslavia.

On the 23rd and 24th after a week of severe weather there was a heavy fall of snow in Jerusalem. Gales and snowstorms accompanied by high tides caused much damage along the northeastern coasts of Japan during the first week of the month.

Extensive bush fires occurred in the central and southern parts of New South Wales between the 12th and 18th, but on the 21st heavy rains were experienced over the State generally except on the Victorian border.

Heavy rains were general throughout southern Rhodesia and the Pungwe areas near the end of the month.

During the first week precipitation was above normal and the weather cold generally in the United States. This was followed by a milder period with varying amounts of precipitation. Later in the month a severe cold spell swept across the north-western districts. Violent windstorms were experienced in Missouri, Indiana and Illinois on the 18th.

Gales were experienced frequently on the western North Atlantic.

The special message from Brazil states that the rainfall in the northern regions was scarce with 1.57in. below normal, irregular in the central regions with 0.16in. below normal and plentiful in the southern regions with 6.54in. above normal. Numerous depressions passed across the country but only two depressions. The rainfall in the south was prejudicial to the crops. Pressure at Rio de Janeiro was 2.4mb. below normal and temperature 0.4°F. below normal.

Rainfall, January, 1929.—General Distribution

England and Wales	71	per cent. of the average 1881-1915.
Scotland...	49	
Ireland	57	
British Isles	63	

Rainfall: January, 1929: England and Wales

Co.	Station	In.	Per cent of Av.	Co.	Station	In.	Per cent of Av.
Lond .	Camden Square	·96	52	*Leics* .	Belvoir Castle	1·27	72
Sur .	Reigate, The Knowle	1·54	68	*Rut* .	Ridlington	1·40	...
Kent .	Tenterden, Ashenden	1·38	55	*Linc* .	Boston, Skirbeck	1·96	121
,, .	Folkestone, Boro San.	1·14	...	,, .	Lincoln, Sessions House	1·69	100
,, .	Margate, Cliftonville	·78	47	,, .	Skegness, Marine Gdns	1·92	111
,, .	Sevenoaks, Speldhurst	1·26	...	,, .	Louth, Westgate	1·63	75
Sus .	Patching Farm	1·46	56	,, .	Brigg, Wrawby St.	1·84	...
,, .	Brighton, Old Steyne	1·50	62	*Notts* .	Worksop, Hodsock	1·70	96
,, .	Tottingworth Park	1·45	54	*Derby* .	Derby, L. M. & S. Rly.	1·27	63
Hants .	Ventnor, Roy. Nat. Hos.	1·69	66	,, .	Buxton, Devon Hos.	2·22	50
,, .	Fordingbridge, Oaklnds	1·38	50	*Ches* .	Runcorn, Weston Pt.	2·03	86
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	1·69	...
,, .	Sherborne St. John	1·33	57	*Lancs* .	Manchester, Whit. Pk.	1·83	73
Berks .	Wellington College	1·05	53	,, .	Stonyhurst College	2·06	48
,, .	Newbury, Greenham	1·27	55	,, .	Southport, Hesketh Pk	1·40	55
Herts .	Benington House	1·70	94	,, .	Lancaster, Strathspey	1·89	...
Bucks .	High Wycombe	1·39	67	*Yorks* .	Wath-upon-Dearne	1·64	85
Oxf .	Oxford, Mag. College	1·09	61	,, .	Bradford, Lister Pk.	2·20	76
Nor .	Pitsford, Sedgebrook	1·55	83	,, .	Oughtershaw Hall	3·14	...
,, .	Oundle	1·06	...	,, .	Wetherby, Ribston H.	2·10	102
Beds .	Woburn, Crawley Mill	1·16	68	,, .	Hull, Pearson Park	2·08	116
Cam .	Cambridge, Bot. Gdns.	1·27	85	,, .	Holme-on-Spalding	2·08	...
Essex .	Chelmsford, County Lab	1·39	91	,, .	West Witton, Ivy Ho.	1·38	...
,, .	Lexden Hill House	1·59	...	,, .	Felixkirk, Mt. St. John	2·94	147
Suff .	Hawkedon Rectory	1·85	106	,, .	Pickering, Hungate	2·71	.
,, .	Haughley House	1·70	...	,, .	Scarborough	2·30	115
Norf .	Norwich Eaton	1·82	93	,, .	Middlesbrough	2·41	150
,, .	Blakeney	...	...	,, .	Baldersdale, Hury Res.	1·29	...
,, .	Little Dunham	2·55	131	*Durh* .	Ushaw College	1·99	97
Wilts .	Devizes, Highclere	1·53	70	*Nor* .	Newcastle, Town Moor	2·61	128
,, .	Bishops Cannings	1·36	59	,, .	Bellingham, Highgreen	1·79	...
Dor .	Evershot, MelburyHo.	1·91	55	,, .	Lilburn Tower Gdns.	2·08	...
,, .	Creech Grange	2·04	...	*Cumb* .	Geltsdale	1·38	...
,, .	Shaftesbury, Abbey Ho.	1·32	51	,, .	Carlisle, Scaleby Hall	1·05	42
Devon .	Plymouth The Hoe	3·47	104	,, .	Borrowdale, Seathwaite	3·71	28
,, .	Polapit Tamar	2·44	65	,, .	Borrowdale, Rosthwaite	3.38	...
,, .	Ashburton, Druid Ho.	1·37	27	,, .	Keswick, High Hill	1·30	...
,, .	Cullompton	1·83	57	*Glam* .	Cardiff, Ely P. Stn.	1·81	48
,, .	Sidmouth, Sidmount	2·04	71	,, .	Treherbert, Tynywaun	3·88	...
,, .	Filleigh, Castle Hill	1·96	...	*Carm* .	Carmarthen Friary	2·63	60
,, .	Barnstaple N. Dev. Ath	1·91	58	,, .	Llanwrda	1·77	33
Corn .	Redruth, Trewirgie	4·21	100	*Pemb* .	Haverfordwest, School	3·61	78
,, .	Penzance, Morrab Gdn.	3·13	83	*Card* .	Aberystwyth	·97	...
,, .	St. Austell, Trevarna	4·35	102	,, .	Cardigan, County Sch.	1·52	...
Soms .	Chewton Mendip	1·62	42	*Brec* .	Crickhowell, Talymaes	2·10	...
,, .	Long Ashton	1·15	...	*Rad* .	Birm W.W. Tyrmynydd	2·21	35
,, .	Street, Millfield	1·36	..	*Mont* .	Lake Vyrnwy	2·42	43
Glos. .	Cirencester, Gwynfa	1·18	47	*Denb* .	Llangynhafal	1·08	...
Here .	Ross, Birchlea	·93	38	*Mer* .	Dolgelly, Bryntirion	2·46	43
,, .	Ledbury, Underdown	1·21	55	*Carn* .	Llandudno	1·10	41
Salop .	Church Stretton	1·88	74	,, .	Snowdon, L. Llydaw 9	8·05	...
,, .	Shifnal, Hatton Grange	1·37	70	*Ang* .	Holyhead, Salt Island	2·39	82
Worc .	Ombersley, Holt Lock	1·34	70	,, .	Lligwy	1·87	...
,, .	Blockley	1·84	...	*Isle of Man*			
War .	Farnborough	1·75	81	-	Douglas, Boro' Cem.	3·18	95
,, .	Birminghm, Edgbaston	1·26	62	*Guernsey*			
Leics .	Thornton Reservoir	1·49	75		St. PeterP't. GrangeRd.	2·50	86

Rainfall : January, 1929 : Scotland and Ireland

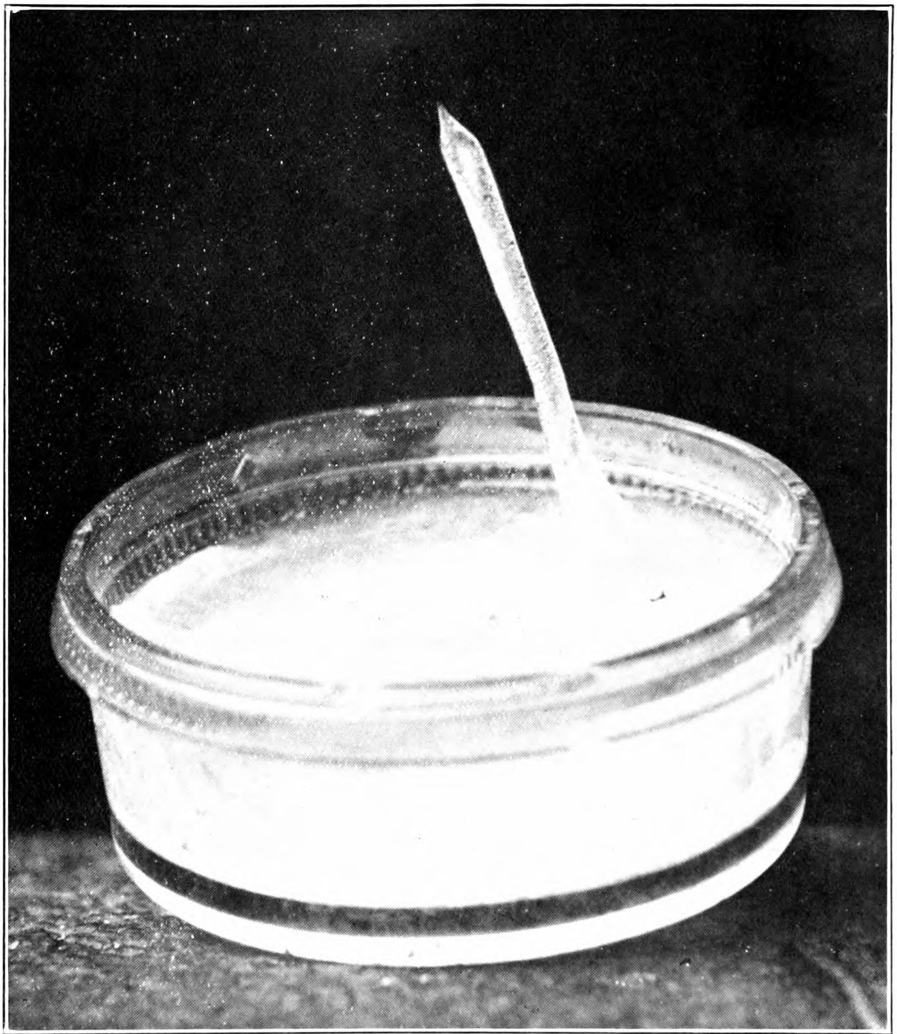
Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	2·42	82	*Suth* .	Loch More, Achfary ...	2·97	41
,, .	Pt. William, Monreith	2·88	...	*Caith* .	Wick	1·28	52
Kirk .	Carsphairn, Shiel.	3·37	...	*Ork* .	Pomona, Deerness	1·35	39
,, .	Dumfries, Cargen	...	...	*Shet* .	Lerwick	2·67	63
Dumf.	Eskdalemuir Obs.	2·21	41	*Cork* .	Caheragh Rectory	3·12	...
Roxb .	Branxholm	1·03	37	,, .	Dunmanway Rectory...	3·29	53
Selk .	Ettrick Manse	...	...	,, .	Ballinacurra	2·73	69
Peeb .	West Linton	1·08	...	,, .	Glanmire, Lota Lo. ...	2·39	56
Berk .	Marchmont House......	2·17	97	*Kerry*.	Valentia Obsy.	3·56	65
Hadd.	North Berwick Res. ...	·90	52	,, .	Gearahameen	4·40	...
Midl .	Edinburgh, Roy. Obs.	·80	46	,, .	Killarney Asylum	1·32	22
Ayr .	Kilmarnock, Agric. C.	1·68	49	,, .	Darrynane Abbey	2·77	55
,, .	Girvan, Pinmore	2·20	47	*Wat* .	Waterford, Brook Lo...	2·48	67
Renf .	Glasgow, Queen's Pk. .	1·33	40	*Tip* .	Nenagh, Cas. Lough...	1·66	42
,, .	Greenock, Prospect H.	2·90	42	,, .	Roscrea, Timoney Park	1·56	...
Bute .	Rothesay, Ardencraig.	2·63	58	,, .	Cashel, Ballinamona...	1·59	41
,, .	Dougarie Lodge	2·57	...	*Lim* .	Foynes, Coolnanes......	1·80	48
Arg .	Ardgour House	3·08	...	,, .	Castleconnel Rec.	1·66	...
,, .	Manse of Glenorchy ...	...	...	*Clare* .	Inagh, Mount Callan...	3·00	...
,, .	Oban	2·53	...	,, .	Broadford, Hurdlest'n.	1·89	...
,, .	Poltalloch	...	...	*Wexf*.	Newtownbarry	2·73	...
,, .	Inveraray Castle...	2·84	35	,, .	Gorey, Courtown Ho ..	2·82	90
,, .	Islay, Eallabus	2·63	56	*Kilk* .	Kilkenny Castle.........	1·67	52
,, .	Mull Benmore	...	...	*Wic* .	Rathnew, Clonmannon	2·43	...
,, .	Tiree	1·98	...	*Carl* .	Hacketstown Rectory..	2·46	69
Kinr .	Loch Leven Sluice......	1·20	38	*QCo* .	Blandsfort House	1·96	60
Perth .	Loch Dhu	...	...	,, .	Mountmellick...........	2·07	...
,, .	Balquhidder, Stronvar	2·42	...	*KCo* .	Birr Castle	1·47	52
,, .	Crieff, Strathearn Hyd.	1·79	44	*Dubl* .	Dublin, FitzWm. Sq...	1·05	45
,, .	Blair Castle Gardens ...	1·36	41	,, .	Balbriggan, Ardgillan.	1·92	84
,, .	Dalnaspidal Lodge ...	2·59	38	*Me'th* .	Beauparc, St. Cloud...	1·79	...
Forf .	Kettins School	1·65	68	,, .	Kells, Headfort	...	...
,, .	Dundee, E. Necropolis	1·25	64	*W.M* .	Moate, Coolatore	1·97	...
,, .	Pearsie House...........	2·68	...	,, .	Mullingar, Belvedere..	2·35	73
,, .	Montrose, Sunnyside...	...	...	*Long* .	Castle Forbes Gdns......	2·50	75
Aber .	Braemar, Bank	1·12	35	*Gal* .	Ballynahinch Castle ...	3·47	56
,, .	Logie Coldstone Sch....	1·50	68	,, .	Galway, Grammar Sch.	2·64	...
,, .	Aberdeen, King's Coll.	1·84	84	*Mayo* .	Mallaranny..............	2·60	...
,, .	Fyvie Castle	3·01	...	,, .	Westport House.........	1·82	39
Mor .	Gordon Castle	1·19	59	,, .	Delphi Lodge	6·09	...
,, .	Grantown-on-Spey ...	1·34	55	*Sligo* .	Markree Obsy...........	1·57	26
Na .	Nairn, Delnies	·30	15	*Cav'n* .	Belturbet, Cloverhill...	1·85	62
Inv .	Kingussie, The Birches	·63	...	*Ferm* .	Enniskillen, Portora...	1·33	...
,, .	Loch Quoich, Loan ...	4·00	...	*Arm* .	Armagh Obsy...........	1·30	52
,, .	Glenquoich..............	3·68	27	*Down* .	Fofanny Reservoir......	6·76	...
,, .	Inverness, Culduthel R.	·43	...	,, .	Seaforde	2·35	75
,, .	Arisaig, Faire-na-Squir	2·04	...	,, .	Donaghadee, C. Stn ...	1·98	78
,, .	Fort William	1·99	...	,, .	Banbridge, Milltown...	1·41	63
,, .	Skye, Dunvegan	2·68	...	*Antr* .	Belfast, Cavehill Rd ...	2·15	...
R & C.	Alness, Ardross Cas. ...	·99	26	,, .	Glenarm Castle	2·71	...
,, .	Ullapool	1·37	...	,, .	Ballymena, Harryville	1·95	53
,, .	Torridon, Bendamph...	2·16	23	*Lon* .	Londonderry, Creggan	1·23	34
,, .	Achnashellach	2·85	...	*Tyr* .	Donaghmore	1·98	...
,, .	Stornoway	1·85	35	,, .	Omagh, Edenfel.........	1·48	42
Suth .	Lairg	1·26	...	*Don* .	Malin Head..............	1·37	53
,, .	Tongue	2·08	53	,, .	Dunfanaghy	1·22	...
,, .	Melvich	2·40	73	,, .	Killybegs, Rockmount.	1·36	24

Climatological Table for the British Empire, August, 1928.

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.	1014·5	— 0·8	79	46	69·3	54·0	61·7	+ 0·1	55·4	86	5·8	2·59	+ 0·35	16	6·5	45
Gibraltar	1014·9	— 1·8	95	63	85·0	69·7	77·3	+ 1·3	67·6	79	3·6	0·03	— 0·10	1	..	..
Malta	1015·4	+ 0·1	94	71	87·2	74·6	80·9	+ 1·8	74·0	74	1·1	0·00	— 0·14	0	12·4	92
St. Helena	1017·1	+ 3·3	64	52	60·6	53·9	57·3	— 0·6	54·7	94	9·5	2·43	— 1·29	19	..	..
Sierra Leone	1014·4	+ 1·7	86	69	80·4	71·1	75·7	— 2·2	74·1	92	9·7	37·50	+ 0·93	30	..	..
Lagos, Nigeria	1012·6	— 1·0	83	70	80·8	74·5	77·7	0·0	74·2	86	6·7	2·05	— 0·75	13	..	..
Kaduna, Nigeria	1016·3	+ 2·5	87	64	81·6	66·8	74·2	+ 0·3	70·0	89	..	8·92	— 0·76	24	..	..
Zomba, Nyasaland	1018·9	+ 2·1	84	49	73·9	54·6	64·3	— 0·6	..	59	3·7	0·03	— 0·31	2	..	..
Salisbury, Rhodesia	1017·4	+ 0·6	83	34	74·1	45·1	59·6	— 0·6	50·2	45	1·0	0·00	— 0·08	0	10·2	89
Cape Town	1022·3	+ 2·1	82	39	65·6	48·0	56·8	+ 1·2	48·9	81	4·7	2·27	— 1·12	8	..	..
Johannesburg	1024·1	+ 1·4	74	31	63·1	42·6	52·9	— 1·4	40·5	45	2·8	0·46	— 0·05	3	9·2	82
Mauritius	1021·7	+ 1·2	77	58	74·1	62·6	68·4	— 0·1	63·3	76	4·1	1·12	— 1·23	25	8·4	74
Bloemfontein	..	..	78	26	64·8	36·4	50·6	1·6	39·7	60	2·0	0·59	+ 0·12	3	..	..
Calcutta, Alipore Obsy.	1001·1	+ 0·1	94	76	89·6	79·0	84·3	+ 1·3	79·9	91	8·7	16·32	+ 3·63	22*	..	..
Bombay	1006·1	+ 0·2	88	73	85·3	76·3	80·8	+ 0·1	76·8	86	8·5	16·65	+ 2·20	27*	..	..
Madras	1005·8	+ 0·3	103	74	94·6	77·5	86·1	+ 0·2	75·5	73	7·2	4·93	+ 0·29	17*	..	..
Colombo, Ceylon	1011·0	+ 1·3	87	73	85·4	77·4	81·4	+ 0·3	76·8	77	8·0	2·12	— 1·01	14	6·2	50
Hongkong	1003·3	— 1·8	92	76	87·5	78·7	83·1	+ 1·0	79·2	85	7·6	12·91	— 1·14	19	6·6	51
Sandakan	..	..	91	71	89·2	74·5	81·9	+ 0·1	77·2	83	..	6·42	— 1·64	13	..	..
Sydney	1016·6	— 1·6	80	44	67·6	50·6	59·1	+ 4·1	52·8	78	4·2	1·41	— 1·60	8	6·5	61
Melbourne	1019·8	+ 1·7	70	33	61·6	43·5	52·5	+ 1·4	46·8	69	4·7	0·82	— 0·99	13	6·1	57
Adelaide	1020·3	+ 1·0	81	35	65·6	46·8	56·2	+ 2·2	49·5	63	4·2	0·77	— 1·74	7	6·9	64
Perth, W. Australia	1017·4	— 1·4	69	41	64·2	50·5	57·3	+ 1·4	53·6	76	6·5	12·21	+ 6·59	26	5·3	49
Coolgardie	1017·7	— 1·6	84	35	68·3	42·8	55·5	+ 1·9	48·2	54	1·9	1·20	+ 0·18	7	..	..
Brisbane	1021·2	+ 2·0	89	42	74·0	51·4	62·7	+ 2·3	55·7	72	2·7	1·05	— 1·08	6	8·0	71
Hobart, Tasmania	1012·4	— 1·2	69	36	57·4	43·1	50·3	+ 2·3	44·7	70	6·1	2·11	+ 0·27	20	5·7	55
Wellington, N.Z.	1015·2	+ 0·1	56	36	52·2	42·7	47·5	— 1·1	45·1	79	7·0	9·34	+ 5·35	16	4·4	42
Suva, Fiji	1015·5	+ 1·2	84	64	77·5	68·6	73·1	— 0·6	69·3	78	7·3	7·18	— 1·06	20	3·9	34
Apia, Samoa	1013·3	+ 1·1	87	70	81·2	73·9	77·5	— 0·3	..	..	1·4	6·02	+ 2·87	16	8·3	71
Kingston, Jamaica	1013·8	+ 0·3	93	68	87·9	72·6	80·3	— 1·2	72·2	86	4·3	12·57	+ 9·02	13	6·9	54
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1015·9	+ 0·5	90	52	80·1	60·9	70·5	+ 3·9	64·2	77	4·2	4·99	+ 2·22	12	9·1	65
Winnipeg	1013·7	— 0·2	92	38	75·1	53·0	64·1	+ 1·1	53·9	87	4·1	3·18	+ 0·74	14	9·4	65
St. John, N.B.	1017·3	+ 1·9	85	49	69·1	56·2	62·7	+ 2·1	59·6	85	7·3	2·87	— 0·99	19	5·6	40
Victoria, B.C.	1018·2	+ 1·0	77	48	65·9	51·9	58·9	— 1·2	54·8	79	4·0	0·23	— 0·42	2	10·2	71

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

facing p. 29



Lewis G. Ball, Photographer, Crawley

A CURIOUS ICE STRUCTURE. (See p. 44.)

M.O. 313.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 64
Mar. 1929
No. 758

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

The Cold Spell during February and early March, 1929

BY J. CRICHTON, M.A., B.Sc.

On February 3rd the cold wave over Europe extended its influence over eastern England, the attack, however, not becoming severe until the night of the 10th to the 11th. On the morning of the 11th the temperature at Kew in the shade at 7 a.m. was 29°F., and this had fallen to 27°F. by 1 p.m.; at Folkestone the maximum day temperature was only 23°F.; snow fell in many parts of eastern Scotland, England, northern Wales and northern Ireland. From this date onwards to the 20th, large tracts of Great Britain experienced continuous shade temperatures, both day and night, below 32°F. At 10 p.m. on Sunday, the 10th, the thermometer in the screen went below 32°F. at Kew and remained continuously below that figure until shortly after mid-day on the 17th, a period of just over 158 hours. At Manston similar but more severe conditions prevailed; here the temperature went below 32°F. at 11 p.m. on the 10th, and did not reach it again until 9 a.m. on the 20th, a period of no less than 226 hours continuous frost. On the 20th the thermometer generally rose to or exceeded 32°F. over most of the British Isles.

During the period from the 10th to the 20th the frosts were very severe, and these coupled with the recurrence of snow greatly interfered with the normal life of the nation as a whole. Roads were blocked and impassable in parts of Scotland, Wales

(83328) P. S. 1602/81. 1,000 3/29 M. & S. Gp. 303.

and southwest England, and it was not until the 23rd that the Royal Automobile Club declared that all roads were open to traffic. Thousands of homes were affected throughout the country through their domestic water supplies becoming frozen and many deaths were reported through the bursting of kitchen boilers. The rivers in many parts of the country became frozen over, and ice-breakers were used in the Thames in an endeavour to keep the water open for traffic. This was not, however, entirely successful, many of the upper reaches being frozen over for considerable stretches. On the reach of the Thames above Benson Lock (near Wallingford) on the 17th the river was frozen over for a mile, and more than fifty people were on the ice there in the afternoon, and it was possible to walk across from bank to bank. Canals and lakes were also generally frozen over, and on Lake Windermere there were as many as fifty thousand people on the ice at one time. Skating has not been so frequent since at least 1895.

TABLE I.

Station.	Lowest Minimum.	Date.	Lowest Grass Minimum.	Date.	No. of ground frosts.
	°F.		°F.		
Aberdeen	15	14	3	14	17
Renfrew	11	15	6	15, 16	19
Leuchars	10	16	6	14	22
Newcastle	11	14	9	14	23
Chester	12	15	7	15	22
Birmingham	13	14	−2	15*	26
Ross-on-Wye	−1	14	−8	14†	22
Oxford	10	15	0	16	28
Manchester	7	15	0	15	26
South Farnborough	5	15	−1	15	27
London { Kew	13	15	4	15	26
London { Greenwich	12	15	4	15	28
London { Hampstead	9	15	−2	15	29
Cardington	11	14	8	14	27
Manston	14	15	9	15	26
Lympne	8	15	5	15	27

* Also −1° on 14th. † Also −6° on 13th and −4° on 15th.

At Ross-on-Wye the temperature of −1°F. in the screen was the lowest for at least 70 years, while that at Greenwich of 12°F. on the 15th was the lowest in February since 1895, 7°F. occurring in that year.

Great Britain only shared the cold wave, it was general over most of Europe, blizzards being frequent on the Riviera, snow storms with very low temperatures occurring as far south as Greece and Arctic conditions being experienced in the Black Sea.

In Venice the canals were frozen over, and after a fall of rain at Siwa Oasis the ground became covered with ice.

The Times on March 1st contained the following paragraph :—"Sir Arthur Steel Maitland, the Minister of Labour, in a written reply to Sir John Power, M.P., states :—It is estimated that the recent severe weather caused an increase in the number of persons on the registers of employment exchanges in Great Britain of between 140,000 and 150,000." In connexion with this statement Table I shows the lowest minimum temperatures in the screen and on the grass together with the number of ground frosts between February 4th and March 5th (both days inclusive), a period of 30 days, for various stations in the British Isles. The table illustrates the continuity of the night frosts which were unusually severe. The stations are representative of their neighbourhood, but are not taken as being the lowest in any record sense.

In Table II the mean temperature at a few selected stations has been taken out for February, 1929, the mean being $\frac{1}{2}$ (maximum + minimum).

TABLE II.

Station	Mean Temperature °F	Station	Mean Temperature °F
Lympne ...	31·1	Leuchars ...	33·9
Manston ...	31·5	Chester ...	34·2
Cardington ..	32·3	Aberdeen ...	35·3
Winchester ...	32·3	Valentia ...	45·3
Kew... ...	33·0		

As an illustration of how meteorological records were affected the following details concerning the R.A.F. meteorological station at Leuchars, near St. Andrews, are of interest:—

Lowest day maximum, 26°F., 9 degrees lower than previous February lowest.

Lowest grass minimum, 6°F., 8 degrees lower than previous February lowest.

Mean maximum, 38.1°F., lowest in any month.

Mean minimum, 29.6°F., lowest in any February.

Absolute minimum, 10°F., lowest in any month.

Leuchars has a record of less than 10 years, and thus a comparison cannot be made with previous severe winters.

In February, 1917, in the screen −4°F. was registered at Benson and −3°F. at Wellington, Shropshire, but February, 1917, was not so cold on the whole as that of 1929; February, 1895, was, however, distinctly colder. In Fig. 1 diagrams, representing mean temperatures at four stations in eastern coastal districts and four in the west, are shown for both February, 1895 and 1929. Each diagram brings out clearly that 1895 was during the first 10 or 11 days distinctly colder than 1929. In the west at Scilly, Birr Castle and Stornoway,

MEAN DAILY TEMPERATURES, FEBRUARY, 1895 AND 1929
[½(MAXIMUM + MINIMUM)].

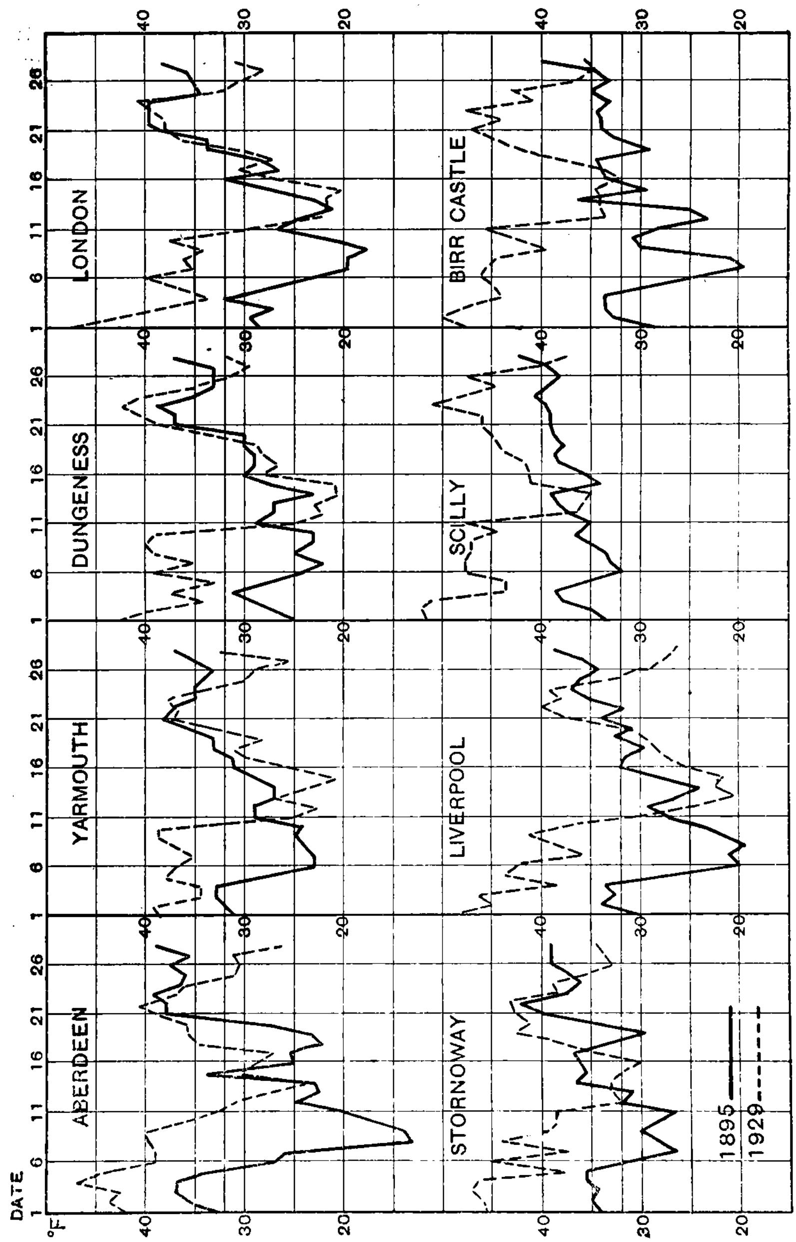


Fig. 1.

1895 practically remains colder throughout the month, Scilly and Birr Castle being distinctly milder in 1929. At Kew, Dungeness, Yarmouth and Liverpool between the 11th and 20th

UPPER AIR TEMPERATURES, FEBRUARY, 1929.

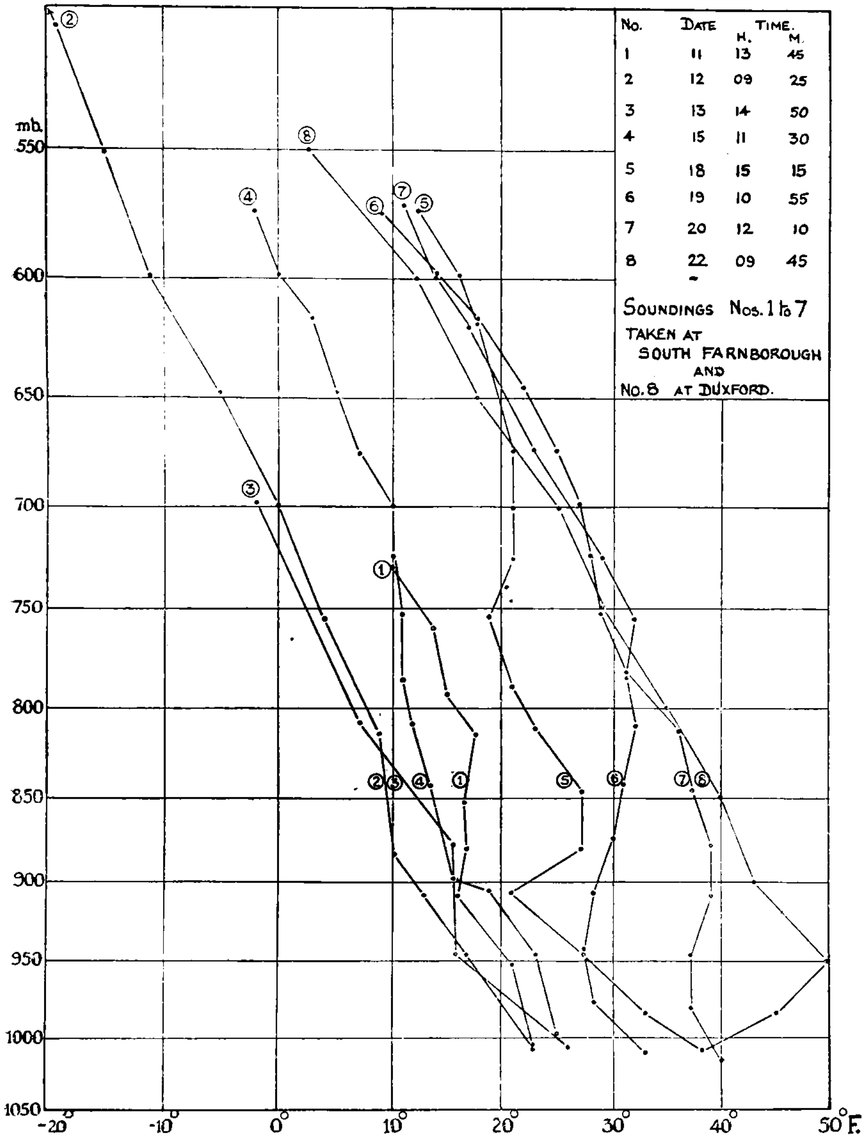


FIG. 2.

the curves are very similar in both years, Dungeness, Yarmouth and Liverpool being if anything colder in 1929 than in 1895. A return of the cold wave about the 24th in 1929 brought lower mean temperatures than in 1895 to most of the stations, and this cold spell lasted for about a week. Thereafter, until March 5th, the two years were once more very similar, during this period

1895 being perhaps the colder. The horizontal line in each diagram is drawn through 32°F., the freezing point of water, and the intersections of this line and the curves brings out very clearly the period of continuous frost both by day and by night.

A good series of upper air temperatures is illustrated in Fig. 2, the readings of pressure and temperature being obtained by means of aeroplane ascents, the ascents are numbered from 1 to 8 in accordance with the dates on which they were made.

Ascent 1 shows a cold air layer to 2,650ft., and then an isothermal one to 5,480ft., after which the temperatures follow the ordinary lapse rate. In ascent 2 the isothermal layer is raised approximately 1,000ft., and its thickness decreased by about the same amount. Ascent 3 indicates a new supply of cold air; there is an isothermal layer here from 1,900ft. to 3,800ft. Ascent 4 has an isothermal layer from 5,600ft. to 9,500ft., and indicates the gradual rise in temperature in the upper layers, this being continued and extended downwards through ascents 5 to 8. In ascent 8 this reaches down to 2,000ft., there being a sharp inversion from the surface to this level. Through the sun's heating of this lower layer a temporary thaw was brought to England. A renewed sweep of cold continental air soon reduced temperatures from the surface upwards.

In conclusion, upon examination of the Greenwich mean temperature records from 1841 for the winter months December to February, only five previous winters prove colder than that of 1928-9. The winter of 1890-1 was the coldest with a mean temperature of 34·1°F., 5·4°F. below the normal. In 1928-9 the mean temperature was 35·2°F., 4·3°F. below the winter normal and only 1·1°F. warmer than 1890-1.

The Structure of Depressions

At the meeting of the Royal Meteorological Society on February 20th described on p. 42, the paper by C. K. M. Douglas and the resulting discussion, were of great interest in providing an insight into the most modern ideas on the structure of barometric depressions. The following sketch represents an attempt by an inexpert member of the audience to set out the impressions which he gained.

A little preliminary explanation may be helpful. The earliest idea of a depression, then known as a cyclone, was simply a column of warm moist rotating air, the warmth and moisture providing the low pressure, and the ascent of air the precipitation. This idea is probably essentially correct for tropical cyclones, but has long been known to be inadequate for those of temperate latitudes. For one thing, the amount of actual rotation of air about the centre is often relatively small, and the practice accordingly grew up of giving these weak and sometimes irregularly shaped "cyclones" the non-committal name of "barometric depressions." So far their structure was known only at the surface; when the study of their solid structure began, other difficulties appeared. The late Mr. W. H. Dines showed that in this country at least the air in a depression, from a short distance above the surface to a height of ten kilometres or so, was on the average not warm but cold, and in a well-known diagram he attributed the source of the low pressure to a column of warm air in the stratosphere. For convenience we may term this symmetrical depression with cold air below and warm air above the "Dines depression." Similarly the high pressure of anticyclones was attributed to a column of cold air in the stratosphere.

W. H. Dines's idea of the structure of anticyclones has held the field, as far as concerns the great slow-moving anticyclones of long duration which wander into temperate latitudes from sub-tropical regions. There seems little doubt that these are really due to pieces of the high cold stratosphere of low latitudes. Beneath the stratosphere the air is slowly descending and is warmed by compression; hence in the troposphere the air of an anticyclone is warm. The more rapidly moving anticyclones which separate successive depressions have a different structure, and are formed in cold polar air. The theory of depressions on the other hand has undergone great changes, due mainly to the investigations initiated in Norway. According to the well-known diagrams of Bjerknes and Solberg, depressions originate at a wave front between a stream of cold "polar" air moving from the east and a stream of warm "equatorial" air moving from the west. A tongue of equatorial air penetrates the polar air, rising above it along a sloping surface known as the "warm front," while a wedge of polar air cuts into the rear of the warm air along the "cold front." The cold front gradually approaches and finally overtakes the warm front, at which stage the warm air is lifted bodily off the surface and is said to be "occluded." Finally the mass of warm air disappears entirely, and there is left only a whirl of polar air. These ideas were elaborated entirely from the study of surface observations and clouds, and are apparently in direct conflict with the results obtained by W. H. Dines, for they give to the depression a warm centre.

Two results follow immediately from the Norwegian conception of the depression. The first is that rain and snow are formed mainly along the "fronts," and subsequent investigations have shown that there is in fact a very close relationship between rain and fronts. The second inference is that a depression should continue to grow in intensity while there is a warm sector at the surface, but that after it is occluded its intensity should decrease, and this does not always hold. A depression with a warm sector does not always grow deeper, and an occluded depression sometimes intensifies when it should be filling up. Other difficulties were explained at the meeting. There should be an east wind on the northern side of the future depression, but it appears that as a rule the east wind does not develop until after the depression has formed. Moreover depressions develop in different ways, sometimes without the agency of equatorial air at all, and in fact the only thing which all depressions have in common is a centre of low pressure.

The Dines depression represents the average conditions found in a large number of depressions investigated by sounding balloons in this country, and there is no doubt that as an average it is substantially correct. On the other hand depressions are occasionally found in which the low pressure is actually due to warm air in the lower layers of the troposphere. In one example quoted in the paper pressure fell 12mb. at the surface as the centre approached, while at a height of 4km. it fell hardly at all, and at still higher levels pressure must have risen. The structure of this typical Bjerknes depression was the direct opposite of the Dines depression. The tentative explanation suggested for the contradiction was that the Dines depression was a late stage, which had been reached by the majority of those reaching the British Isles. The difficulties were that there was no obvious way in which the change over from warm air below to warm air above could take place, and that the theoretically dying depressions sometimes continued to grow in intensity.

A way out of both difficulties is given in section 3 of Douglas's paper, based on the circumstance that a very favourable condition for the deepening of a depression is the occurrence of a pronounced polar current behind it. At the surface such a current may be travelling from due north to south, but owing to the general fall of temperature from low to high latitudes there is always a tendency for air at high levels to move from west to east, to some extent independently of fronts. This tendency is especially strong at the upper boundary of the warm sector, at a height of 9km. or so, the height which Dines regarded as specially important. Hence at about this level the polar current, due north at the surface, has a large component towards the east. It over-runs the centre of the depression, and brings with it part of the low warm stratosphere belonging to the polar air. In the lower troposphere warm air is being slowly eliminated, with a consequent tendency for pressure to rise, but at the same time the stratosphere is becoming much warmer, with a tendency for pressure to fall. When the latter tendency predominates, the depression continues to deepen, in spite of being occluded. The complete depression is therefore a complex affair, due to the superposition of a high-level element above a low-level element. One gathers that the arrival of the high-level depression is not adventitious, but that it must be related to the energy supplied by the juxtaposition of warm and cold air in the lower layers.

Captain Douglas considers this a possible key to the problem of depressions, but adds that the prospects of a complete theory are still remote. In spite of this warning one cannot refrain from feeling that a great step forward has been made, and the paper, with the resultant discussion, will not soon be forgotten by those who had the good fortune to be present.

British Floods and Droughts*

The indefatigable authors of this book have produced a volume which is of permanent value as a work of reference, if for nothing else. It contains descriptions of all the more important periods of excessive and deficient rainfall and of the floods and droughts which have been recorded in the British Isles, with such numerical details as are required for an appreciation of the intensity of the abnormalities. The period of time considered stretches back to the year A.D. 9, when a flood is recorded to have occurred in the Thames. Naturally the records of the floods and droughts of the earlier years are much less exact than those which are available for the last 70 years or so, thanks mainly to the public spirited action of numerous local authorities and private persons who have kept rainfall and other meteorological records and placed them at the disposal of the public. There are chapters on historic rains, floods and droughts, the droughts of the middle ages, the dry years of the eighteenth century, the rainy seasons of the 'seventies, the dry years 1887 and 1921, the year 1903 with two wet spells, the wet summer of 1924, the wet year 1927 and extremes of rainfall.

Meteorologists will, however, turn with greatest interest to Chapters I, VIII and XIV, dealing respectively with the causes of persistent rain, the causes of drought and cycles of weather. These are subjects in which Dr. Brooks has worked for many years, and the three chapters mentioned contain a brief account of much of his most recently published work. It is impossible not to admire the persistence with which he attacks these very difficult problems. Similar problems have been studied in India by distinguished meteorologists for a very long period of time, but it cannot be said that they have been solved for that country with sufficient accuracy to permit of really reliable forecasts of

1 *By C. E. P. Brooks, D.Sc., and J. Glasspoole, M.Sc., Ph.D. Size $8\frac{1}{2} \times 5\frac{1}{2}$in. pp. 199. *Illus.* London : E. Benn Ltd. 1928. 10s. 6d. net.

monsoon rainfall to be made. Owing to the regularity of the monsoons, it is generally considered that the preparation of seasonal forecasts for India is a less difficult problem than the corresponding problem for the British Isles. Here day to day weather is very variable owing to the continual advance and retreat across the country of " fronts " separating cold and warm air masses; and on many occasions—the recent cold spell is a good example—the British Isles are situated partly in one weather region and partly in another. A hundred miles or so may make all the difference between the conditions of a warm wet spell and those of a cold dry spell. It is therefore no disparagement to the authors to say that two of the three chapters referred to cannot be regarded as giving more than tentative indications of certain meteorological and hydrographical factors which have in the past been associated, more or less consistently, with prolonged rains and droughts in the British Isles. The authors use the word " cause " in these chapters more frequently than seems to be justified. They appear often to regard an event as " causing " another event, if there is a correlation between the two events, and if in addition, the former event precedes the latter in point of time. But more evidence than this is needed to prove that one event is the cause of another; both might well be products of some one or more entirely different event or events. Sometimes, however, the authors appear to require also some evidence of a physical connexion between the two events: for example, they are careful, in alluding to the relation between the abnormality of the Nile flood in summer and that of pressure in Iceland in the following winter and early spring, to say " it is not possible that the amount of water in the Nile should directly influence the subsequent weather over the British Isles." The reviewer would extend the cautious principle underlying this statement much further than the authors. He would affirm that it is doubtful whether it is legitimate to assume, as the authors do, a causal relation between variations in the ice carried by the Labrador current and subsequent variations in British weather, in the absence of any convincing proof that there is a chain of physical events connecting these two phenomena in a definitely progressive way, and that this chain actually operates in the manner suggested. It is of course easy to make criticisms, and probably very difficult to substantiate the reality of any physical chain of the kind described. Nevertheless the reviewer feels that until the physical connexions are placed on a much firmer foundation than they are at present, it is premature to speak of " causes," and better to be content with some non-committal word such as " associations." Such limitation of language would not in the least detract from the value which the work may have towards solving the problem of forecasting the weather of seasons.

The authors are to be congratulated on the production of a book which must have demanded the expenditure of not a little time and labour, and which is destined to be regarded as a standard work of reference.

R. CORLESS.

OFFICIAL PUBLICATION

The following publication has recently been issued :—

PROFESSIONAL NOTES—

No. 51. Changes of zero in spirit thermometers. By W. F. Higgins, M.Sc., Physics Dept., National Physical Laboratory, and E. G. Bilham, B.Sc., A.R.C.S., D.I.C., Superintendent of Instruments, Meteorological Office (M.O. 273k).

In an attempt to explain the fall of reading noted over a period of some years in certain spirit thermometers, experiments have been carried out to ascertain the effect of the presence of acetone, in the filling liquid, upon the readings of spirit thermometers over a period of time. It is found that in spirit thermometers containing acetone a marked fall of reading is obtained in course of time when the thermometers are exposed to light. It is suggested that the effect is due to the contraction of the liquid consequent upon the formation of condensation products from the acetone under the influence of light. Acetone is known to be a common impurity in commercial methylated spirit, and it is shown that the use of this material either in the commercial or redistilled form should be avoided in the construction of spirit thermometers. No objection appears to attach to the use of pure ethyl alcohol, or acetone-free methyl alcohol, but a mixture of these two substances should be avoided.

Discussions at the Meteorological Office

February 11th—*Solar activity and long-period weather changes.* By H. H. Clayton (Smithsonian Misc. Coll., 78, No. 4, 1926). *Opener.*—Mr. B. C. V. Oddie, B.Sc.

This paper was reviewed in the June, 1927, number of the *Meteorological Magazine*, page 115. It gave rise to an animated discussion, several speakers pointing out that solar influences could be readily discerned in pressure and temperature variations within the tropics, but that they could only play a minor rôle in temperate latitudes.

Mr. D. Brunt called attention to a table showing the relationships between the daily measurements of the solar constant at Mount Wilson (California) and Calama (Chile), which he considered to be the strongest argument yet put forward in favour of the reality of day to day variations of solar radiation.

February 25th. *Relations between changes of atmospheric pressure and temperature. A contribution to the question of the "seat" of pressure variations.* By Bernhard Haurwitz (Leipzig, Geophys. Inst. der. Univ. Veröff 2nd Series, Bd. 3, H. 5, 1927, pp.267-336) (in German). *Opener*—Mr. L. Dods, B.Sc.

The paper is divided into three sections, a mathematical discussion of pressure-temperature relations, a statistical survey of a large number of ascents of registering balloons and a synoptic demonstration of temperature and mass changes on two occasions in 1911. The mathematical part was not discussed. For the statistical treatment the author investigates a large number of ascents during the years 1907—13, published in the *Reports of the International Commission for the Investigation of the Upper Air.* Those ascents are used which took place within about 24 hours of each other from the same places; 328 of these "pairs" have been taken from all over Europe. The pressure and temperature for each kilometre height have been found, and the pressure and temperature changes that have taken place within the 24 hours are arranged in various groups. One such group is the following:—

ΔP positive, ΔT positive ; ΔP negative, ΔT negative ;
ΔP positive, ΔT negative ; ΔP negative, ΔT positive.

where ΔP, ΔT are respectively the pressure change at the earth and the change in the mean temperature of the air layer next the earth in the 24 hours. Diagrams are given showing the algebraical means of the pressure and temperature changes at different heights in the atmosphere. The most interesting group is that for ΔP positive, ΔT positive. For this group the pressure increase at different heights is almost the same throughout the troposphere but falls off rapidly with increasing height in the stratosphere. The temperature change is positive in the troposphere and negative in the stratosphere. In connexion with this various writers have suggested that the development of the large warm anticyclones of our latitudes may be due to a burst of tropical air at great heights, bringing with it high pressure in the upper atmosphere and cold air in the stratosphere. The author comes to the conclusion that in 68 per cent. of the cases considered, the pressure change at the earth's surface is determined by the temperature changes in the troposphere and stratosphere, and in 18 per cent. by the temperature changes in the upper atmosphere, but that in 14 per cent. the observed pressure change cannot be explained by the temperature changes. The author does not attempt to point out the origin of the temperature changes.

Finally, in the last part of the paper two occasions in 1911 are dealt with synoptically, and a number of diagrams are given showing temperature and mass changes at different heights, and the changes in the height of the troposphere and the temperature at the base of the stratosphere that have taken place in 24 hours.

With regard to a point raised during the discussion as to whether the large winter anticyclones of Russia and Scandinavia extend to all heights of the atmosphere, the following ascents of registering balloons on December 7th, 1911 (the first case considered in the synoptic demonstration of simultaneous ascents), may be interesting. In that case an occluded trough of low pressure was over the British Isles, while a large intense anticyclone was centred over Russia. The ascents were not simultaneous, but took place within a few hours of each other.

	Trappes (Paris)		Pavlovsk		Ekaterinburg	
Height above Sea Level	p	t	p	t	p	t
	mb.	°F.	mb.	°F.	mb.	°F.
290 m.	*976	—	1001	20·1	1000	13·3
1 km.	895	36·0	915	21·9	915	25·7
2 ,,	788	28·9	804	12·6	805	21·4
3 ,,	695	23·0	*705	*6·1	709	13·3
4 ,,	611	12·7	619	3·9	621	1·0
5 ,,	536	2·1	541	- 7·2	544	- 10·3
6 ,,	468	- 9·6	472	- 20·2	475	- 20·7
7 ,,	407	- 23·8	409	- 34·1	412	- 34·8
8 ,,	353	- 36·4	353	- 49·9	356	- 49·0
9 ,,	304	- 56·2	304	- 63·0	305	- 62·7
10 ,,	260	- 74·0	260	- 68·4	261	- 75·8
11 ,,	221	- 73·8	223	- 62·0	223	- 85·0

*** Values interpolated.**

Unfortunately no ascent was made through the centre of the Russian anticyclone, but it is probable that an anticyclonic circulation was still maintained at 10km. The highest pressure (268mb.) at 10km., recorded in the ascents, was at Pavia (northern Italy), although in that region sea-level pressure was much lower than over Russia. The ascent at Trappes shows at all heights in the troposphere considerably higher temperatures than over the Russian anticyclone.

During the cold spell in the middle of last February, with a large intense " high " over Scandinavia, the cirrus motion over our Islands was persistently from the northwest or north over a southeasterly or southerly surface current. This suggests that in many cases the large cold, winter anticyclones of Scandinavia and Russia do not extend to great heights, pressure high up often being lower over them, than over the warm air currents experienced farther to the west. The problem requires much investigation. L. Dods.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, February 20th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, in the Chair.

The experiment of a short introductory talk on some topical subject, first tried at the meeting in January, was repeated, Capt. C. K. M. Douglas giving an account of the pressures and winds over Europe associated with the cold spell.

L. H. G. Dines, M.A.—The Baker automatic release for dropping the meteorograph from a registering balloon at a predetermined height.

In making soundings with free balloons it is sometimes desirable to limit the height to which the recording apparatus is carried before being dropped to earth again, in order to prevent its being lost in the sea. The instrument releases the balloon at a predetermined height. The setting of the device to ensure release at the desired height is determined by means of a special preliminary calibration.

C. K. M. Douglas, B.A.—Some aspects of surfaces of discontinuity.

The paper is based mainly on observations of upper air temperature and wind velocity through surfaces of discontinuity. It is shown that the typical sloping " polar front " surface is smoothed out through a layer about a kilometre thick, inversions being rare. The ordinary inversions with dry air above them are attributed to subsidence combined with turbulence up to a definite level. The general line of argument is that the more important pressure changes on weather maps are due mainly to large-scale horizontal movements at levels round about the base of the stratosphere, considered in conjunction with movements at lower levels. The changing pressure fields cause converging and diverging movements, which influence fronts and produce inversions where the air is subsiding. *See* also p. 34.

E. Kidson, O.B.E., D.Sc., and H. M. Treloar, B.Sc.—The rate of ascent of pilot balloons at Melbourne.

In pilot balloon observations at Melbourne the use of a rangefinder in combination with a theodolite has enabled the balloon heights to be determined in the lower levels. The paper treats of the records for three and a half years with two ascents daily. The nature of the variation of the heights from those deduced by formula is discussed. It is concluded that atmospheric turbulence is the most important cause of departures from the normal rate of ascent. The effect of turbulence is to cause great variations in the height after a given interval from the release of the balloon. The greater the turbulence the greater is the mean height. The turbulence due to surface-heating of the air is more effective than wind turbulence in increasing the rate of ascent in the lowest layers. This is attributed to the former having smaller dimensions. The heat turbulence is effective chiefly near the surface and in light winds. The view is also advanced that the rate of ascent is less in stable than in unstable air under the same conditions as to turbulence. An annual variation in the rate of ascent and relationships with wind velocity and weather types are claimed to be in accordance with the foregoing conclusions.

Correspondence

To the Editor, *The Meteorological Magazine*

Some Notes on the Frost

The following paragraphs are selected from a large number of letters containing details of the low temperatures and other weather conditions of February, which space prevents us from publishing in full :—

Rev. R. P. Dansey, Kentchurch Rectory, Hereford (12 miles west of Ross-on-Wye) :—

Feb.	"Grass" Min.	Shade Max.		Feb.	"Grass" Min.	Shade Max.
12th	—	26°	...	17th	−4°	27°
13th	−9°	26°	...	18th	−5°	35°
14th	−11°	23°	...	19th	17°	34°
15th	−9°	23°	...	20th	9°	37°
16th	—	30°	...			

In the rapid streams of the River Monnow so much ice formed in the bed over the stones and rocks that the river level was raised 6in. to a foot owing to the amount of space taken up by the ice. The river was low at the time, but it looked as if in spate though clear. In calm stretches it was normal height and was skatable for about five days.

I have only registered temperature below zero four times in forty years, February 6th and 7th, 1917, −1°; March 5th, 1909, and February 9th, 1895, −4°.

Mr. R. G. Sandeman, Dany Park, Crickhowell, South Wales :—

An exposed thermometer 22in. off the ground fell to at least −11°F. on the night of February 13th. On that night it was dangerous to touch any iron as the metal stuck to the hand and took the skin off. The river Usk is freezing in places and sheets of ice coming down.

Mr. C. P. Hooker, Wyeland House, Putsam, Hereford :—

Screen temperatures.

Feb.	Max.	Min.		Feb.	Max.	Min.
12th	30°	18°	...	16th	25°	15°
13th	25°	0°	...	17th	31°	5°
14th	29°	−1°	...	18th	30°	1°
15th	27°	−2°	...			

*Mr. G. E. Dacey, 65, Clarendon Road, London S.E.*13 :—
Screen temperatures.

Feb.	Max.	Min.		Feb.	Max.	Min.
12th	24°	14°	...	16th	27°	21°
13th	24°	11°	...	17th	25°	16°
14th	25°	13°	...	18th	33°	9°
15th	26°	6°	...	19th	31°	23°

Mr. L. C. W. Bonacina, 27, Tanza Road, Hampstead:—
The Rev. H. H. Breton has reported to me a depth of snow on February 16th of 3ft. undrifted near Buckfastleigh and of 6ft. undrifted higher up on Dartmoor. He also reports a great ice-storm (silver thaw called " ammil " on Dartmoor) on February 26th during the night.

A Curious Ice Structure

The photograph which forms the frontispiece of this number of the magazine, and which has kindly been sent by Mr. Basil Longley, of Crawley, Sussex, shows a curious effect of the frost on a bowl of water. Mr. Longley writes :—

" This ordinary tongue jar was placed out on a grass lawn at least 20ft. away from the nearest tree or obstacle on Sunday afternoon last (February 3rd), being full of water for birds. It was a great surprise to me, therefore, to see first thing on Monday morning what appeared to be an inverted icicle rising out of the centre of the bowl.

The only explanation that I can offer is that the water froze rapidly on top, and when the expansion took place underneath, the surface ice broke (this can be seen), and owing to the continuing pressure of the water expanding, it gradually oozed out freezing as it came. There was a tiny hole up the centre of the column which justifies this theory.

The temperature fell to 17°F. during the night and in the early part of the evening dropped very rapidly.

The photograph was taken by Mr. Lewis G. Ball, the local photographer."

A rough calculation shows that Mr. Longley's explanation is probably correct. The volume of the " inverted icicle " is about one-hundredth of the volume of the ice in the jar, while water expands by about nine-hundredths in the process of freezing.

Ice Crystals

While recently spending a holiday in the Bernese Oberland, I noticed on several occasions a thin veil of ice crystals enveloping both mountains and valleys, and causing a halo. On all the occasions (January 25th to 27th and February 12th to 14th) the temperature was very low, ranging from 10° to —20°F. Simultaneously with the ice crystal clouds there were often some ordinary detached clouds of a short-lived character, and I have no doubt that these consisted of super-cooled water drops. The crystals were small but were large enough to be seen and felt. When they were sparsely scattered the visibility sometimes reached 10 miles. On one occasion the veil thickened to alto-stratus, and at a height of 7,000ft. the horizontal visibility of large objects was about 1½ miles. I am inclined to regard this as typical of thin alto-stratus clouds with the sun just visible, since when flying I more than once saw the ground through a vertical thickness of over a mile of alto-stratus clouds, the total thickness of the clouds being much greater than this. On one occasion floating ice crystals developed from a shallow valley fog, which did not itself consist of crystals. The frequent occurrence of low ice crystal clouds in high latitudes has been noted by many observers, and the difficulty involved in fitting them into the existing cloud classification has often been commented on. I should like to express the personal opinion that all considerations of height should be abolished from the cloud classification, so as to allow clouds in the cirrus and alto-stratus groups to exist right down to sea level.

Even in the absence of ice crystals, very cold weather in the Alps is apt to be hazy, since air which is cold aloft is easily penetrated by convection. The perfect transparency of typical Alpine air is usually associated with the slowly descending air of anticyclones. This type of weather is fortunately very frequent, as one would expect from the mean isobaric distribution.

A good display of alto-cumulus castellatus clouds was observed on February 10th, and snow followed in six hours. Detached cirrus was first visible some hours earlier on the horizon, but considering that there had been nine practically cloudless days, the breakdown was unusually sudden.

C. K. M. DOUGLAS.

On the morning of February 9th, 1929, there appeared on the "Hogs Back" road a phenomenon of, presumably, very rare occurrence. The weather was a little foggy, but very frosty. The frost was, however, disappearing under a gentle breeze and a rising temperature, whilst along the roadside and the gravel side-walk (in open country with fields on either side) for several hundred yards were scattered quantities of ice formations resembling thin strips of glass which might have been cut with a glazier's diamond. There were some rather small trees along the roadside at intervals averaging 50ft., and although the larger pieces of ice were found near the base of the trees, the formations were not limited to such places, but were regularly strewn in practically an unbroken stretch, the whole of the distance. Moreover, they were quite flat and not curved or irregular as would have been expected had the formations fallen from the trees. They were regular in shape, differing only as regards length, being (1) rectangular, (2) of same width, (3) of same thickness. Their dimensions were approximately, breadth ¼in., thickness 1/12in. and varied from ½in. to 2½in. in length. The majority were approximately 1in. in length, but there were quite a number of pieces, usually together, of lengths above 1in. It would be interesting to know the cause of these formations, and whether this phenomenon has been witnessed on any previous occasion. H. J. WELLER.

Guildford. March 7th, 1929.

A curious phenomenon occurred here this morning. I was on the Observatory Tower and noticed some "dancing-tinsel" effects in the sunshine like very fine broken shimmering silver wire—scintillating like long "sparks." Could this be the frozen water vapour in the air or frozen fog particles scintillating in the sunshine? I have never observed such a thing before. The tinsel-threads could not have been spider-web threads, as they were in the air a good distance from the tower, and 25 to 30ft. above the ground. F. J. PARSONS.

County Observatory, Ross-on-Wye, Herefordshire. February 14th, 1929.

A phenomenon frequently observed in polar regions is a fall of ice crystals from a cloudless sky. A similar occurrence was noted here on the morning of February 14th. The fall commenced about 7h. 30m. G.M.T. and continued for two hours. At the commencement the sky was almost half-covered with stratocumulus cloud at 4,000ft. This cloud gradually dispersed whilst moving from east to southeast of the station, and by 9h. the sky was cloudless. From 9h. to 9h. 30m. ice crystals continued to fall from a clear blue sky whose intensity appeared undiminished by the precipitation. A close examination showed their structure to be in the form of a central hub with six radiating spokes, the largest crystal being about 5 millimetres in diameter. They were sufficiently numerous to give the impression of slight snow. As far as can be ascertained the fall took place within at least a two mile radius.

At this period the station was situated in the very cold circulation around an anticyclone over north Scandinavia. The temperature at 7h. was only 9.6°F., but by 9h. 30m. had risen to 17.5°F. Upper winds showed a NE. to ENE. drift up to 3,000ft., backing gradually to N. at 8,000ft.; speed 10 to 20 miles per hour.

Precipitation in the form of ice crystals was also observed on February 13th, 16th and 26th under cloudy conditions.

W. H. BIGG.

South Farnborough. March 4th, 1929.

Pack Ice on the Maplin Sands

The Maplin Sands, which extend along the Essex coast between the estuaries of the Thames and the Crouch, form a very extensive area of nearly level firm sand when the tide is out. This morning the sands for about half a mile from high-water mark were covered with pack ice and brash to a depth of about a foot. A number of barges which were close in shore presented the appearance of being completely ice bound. The same phenomenon was to be seen along the foreshore at Southend and Westcliff although much less pronouncedly than at Shoeburyness.

C. E. BRITTON.

New Ranges, Shoeburyness. February 12th, 1929.

Air Temperatures in a Well

The writer made some observations of temperature at depths from the well-head to near the surface of the water from February 20th to 25th, a period of comparatively warm weather between the two great frosts of that month.

The well has a diameter of about 5 ft. and the depth to the surface of the water is 25ft., there being 5ft. of water. The well-head is 350ft., about, above mean sea level. It is not used, so that the air is seldom disturbed.

It would appear that the temperature at any depth is constant, as follows :—

Depth ft.	*Temp.* F.°
3	41
6	41-42
12	42-43
18	43
24	44

The external air temperature varied from 30° to 39°.

M. A. CARLISLE CROWE.

Pye Hill, Finchampstead, Berks. March 1st, 1929.

Slight Rain with Low Humidity

Snow lay on Salt Island (surrounded by sea at high tide), Holyhead, from February 11th to 20th, 1929, and it was noted that snow lay down to high-water mark until the 19th.

On the 19th, 20th and 21st the humidity was below 80 per cent. generally becoming as low as 55 per cent. at times, the wind mainly between SE. and S., light to moderate and the visibility never exceeding 6 miles.

On the 20th there was slight rain at times, and on the 21st almost continuous rain until 19th, 7mm. falling between midnight and 19h. It is thought that the humidity of 55 per cent.

at 13h. on the 20th with intermittent slight rain and the rainy day of the 21st with humidity varying between 65 and 80 per cent. are worthy of note. H. L. PACE.

Salt Island, Holyhead, Anglesey. February 22nd, 1929.

Winter Thunderstorms

The annual census of winter thunder in the British Isles is being made for the last time during the present season. Before closing the work it is necessary to make special inquiries into the frequency of winter thunder in a number of areas from which insufficient data have been obtained during the past five years. It is very probable that the majority of these areas seldom experience a storm, but it is also possible that the shortage of data may be due to thinness of population: in either case definite evidence, negative or otherwise, is extremely necessary.

I shall be very grateful if any of your readers, resident for a number of years in any of the undermentioned areas, will be good enough to send me their estimate of the number of times thunder is heard in their district during the six winter months (October 1st to March 31st) on the average each year. Probably in some areas the frequency will be as low as once in three or four winters, or perhaps no winter thunder may be remembered; in any case the actual experience of the observer will be extremely welcome.

In England and Wales the areas extend from 10 to 15 miles round the places, and for a similar distance on either side of lines joining the groups of places, specified below. In Scotland and Ireland areas are specified by counties:—

England and Wales.—Cornwall: Wadebridge-Boscastle. Devon and Somerset: Lynton-Exmoor-Minehead. Norfolk: Fakenham-Aylsham. Cheshire: Malpas-Nantwich. Lincolnshire: Brigg. Yorkshire: Pocklington-Kirkby Moorside-Guisboro'. Westmorland and Yorkshire Kirkby Lonsdale-Hawes-Brough. Cumberland: Cross Fell-Brampton. Northumberland: Rothbury-Wooler. Cardigan: Lampeter-Cardigan. Carmarthen and Brecknock: Llangadock-Brecon. Carnarvon, Denbigh and Merioneth: Llanberis-Ruthin-Bala.

Scotland.—Counties:—Bute, Ayr, southern Lanark and Peebles, northern Perth, northern Forfar and western Aberdeen, eastern Inverness, Sutherland and Caithness.

Ireland.—Counties:—Limerick, northern Tipperary and southern Galway, Wexford and southern Wicklow, Sligo, northern Roscommon, Longford, Cavan, Monaghan and Louth, western Tyrone and eastern Donegal, northern Antrim and southern Londonderry.

This inquiry is in no way intended to cast doubt on the records already received for these areas, but hopes to secure fuller information where it has not been possible to draw adequate conclusions. Records of thunderstorms are requested up to March 31st next as usual. S. MORRIS BOWER.

10, *Langley Terrace, Oakes, Huddersfield. February 21st,* 1929.

NOTES AND QUERIES

Thomas Gray Memorial Fund

The Council of the Royal Society of Arts announce that under the will of the late Thomas L. Gray, the Royal Society of Arts has been appointed residuary legatee of his estate for the purpose of founding a memorial to his father the late Thomas Gray, C.B., who was for many years Assistant Secretary to the Board of Trade (Marine Department). The objects of the Trust are "The advancement of the Science of Navigation and the Scientific and Educational Interests of the British Mercantile Marine."

The Council now offer the following prizes:—

(1) A prize of £150 to any person who may bring to their notice a valuable improvement in the Science or Practice of Navigation proposed or invented by himself in the years 1928 and 1929.

(2) A prize of £50 for an essay on the following subject:—"You are overtaken by a revolving storm. Discuss the handling of a low-powered steamer from the time of the first indication of the approach of the storm until the storm has passed, supposing the ship to be in (*a*) the safe semicircle, (*b*) the dangerous semicircle, and (*c*) the direct path of the storm's centre."

Competitors must send in their proofs of claim or essays not later than December 31st, 1929, to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.2.

The essays must be sent in under a motto, accompanied by a sealed envelope enclosing the author's name, which must on no account be written on the essay.

Review

Müller-Pouillets's *Lehrbuch der Physik.* Eleventh edition, fifth volume, first part. *Physik der Erde.* Edited by Alfred Wegener. Size $9\frac{1}{2} \times 6\frac{3}{4}$in. pp. xviii + 840. Brunswick, 1928.

The eleventh edition of Müller-Pouillet's *Lehrbuch der Physik* has a special interest as signalising in a sense the centenary of the work, for the two volumes of Pouillet's *Elements de physique et de météorologie* were first published in 1827, though Müller's translated and expanded version did not appear until 1842, and it was in 1856 that the two names were coupled on the title-page. The work has continued to grow with the years, and while meteorology is still dealt with at a length unusual in text-books of physics, a considerable part of the present half-volume of 830 pages deals with the new science of geophysics.

The first chapter, on meteorology, covering 168 pages, comes from the able pen of Professor H. von Ficker, and is written with an appropriate physical bias; thus long sections are devoted to the subjects of solar radiation, the applications of the physics of gases to atmospheric processes, and the circulation of water in the atmosphere. The remaining sections of this chapter are:—The meteorological elements, their measurement and calculation; Atmospheric movements; The diurnal and annual periods of the meteorological elements; The average distribution of the meteorological elements in horizontal and vertical directions; Atmospheric disturbances. The second chapter by Professor A. Wegener (who also, after the death of Dr. O. Lummer in 1925, assumed the task of editing the whole volume) is a comprehensive discussion of Atmospheric Acoustics, including the phenomena and explanation of the outer zone of audibility. Wegener has also prepared the third chapter, on Optics of the Atmosphere, a very compact and useful summary. The phenomena are classified under the three headings of refraction, diffuse reflection and optical phenomena connected with the products of condensation. This chapter is remarkably well illustrated, with 58 figures in the text and three full-page plates in half tone.

Chapter 4, by H. Thorade, deals with the Physics of the Sea, including the physical peculiarities of sea water, the processes of warming and cooling of the oceans, ocean currents (mainly a discussion of the work of Ekman), waves and tides. The fifth chapter; the Physics of Glaciers, by H. Hess, contains some useful data on the physical characteristics of ice. This chapter is short; it might have been made longer with advantage by the inclusion of some reference to the inland ice sheets of Greenland and the Antarctic. Chapter 6, on Terrestrial Magnetism, by A. Nippoldt, is especially adequate from the instrumental side, and is also well illustrated by means of charts. G. Angenheister has contributed a short chapter on the Aurora (relatively short, for the 32 pages contain space for a great deal both of observation and of theory), while H. Benndorf and V. F. Hess have written the following very long chapter on Atmospheric Electricity, chiefly from the physical side. The last chapter, on the Mechanics and Thermodynamics of the Earth, was partly written by the late Prof. B. Gutenberg and was completed by Prof. E. Wiechert.

The death of Prof. Gutenberg, following on that of the first editor, delayed publication considerably, and has resulted in the different sections differing considerably in the degree to which recent work has been incorporated. For example, the section on Oceanography was completed before the return of the *Meteor*; and the rich harvest of this expedition has not found a place More serious from our point of view is the tendency to ignore the recent work of English meteorologists. The index does not contain the names of Simpson, Shaw, Gold, Dines or Chree—not that this is conclusive, for the index is decidedly incomplete, and Dr. Simpson's work on the mechanism of thunderstorms is in fact described on page 651. For a survey of the essentials of meteorology and geophysics however the book may be recommended to those who do not mind stiff reading. It is certainly good value for the money, but the purchaser is recommended to spend the extra few shillings charged for the bound edition, as the book is so heavy that unbound copies would soon become tattered. It only remains to add that the printing is excellent and the abundant illustrations remarkably clear.

C. E. P. BROOKS.

News in Brief

The tenth Annual Soirée of the Meteorological Office Staff was held at the Portman Rooms on February 28th and was well attended by the staff and their friends. The function consisted of dancing interspersed with concert items, and amongst those who enjoyed a thoroughly sociable evening were the Director and the Assistant Directors.

The Eighth Annual Dinner of the Staff of the Meteorological Office at Shoeburyness was held at the Queen's Hotel, Westcliff, on February 16th. Mr. D. Brunt, Superintendent of Army Services, was the guest, and a number of past members of the staff were present. Following the dinner and the usual toasts, an entertainment consisting mostly of original items was enjoyed.

The Weather of February, 1929

In many parts of England February, 1929, will be remembered as the coldest February experienced since 1895: in Scotland the conditions were less extreme, while in western Ireland the mean temperature was slightly above normal. The month opened with mild unsettled weather and rain at times, 1·86in. fell at Fofanny, Co. Down, and 1·36in. at Patching Farm, Sussex, on the 2nd. On the 3rd, with the advance westward of the anticyclone centred over Germany, there was a general change to sunny conditions, especially in the south and east of England and the Channel Islands, over 8hrs. bright sunshine being enjoyed at several places, 8·7hrs. at Hastings on the 3rd and 8·7hrs. at Jersey on the 4th. During these four days, temperature rose in most parts to above 50°F. and reached 58°F. at Cambridge on the 1st, but after the 2nd night frosts became general. Subsequently pressure fell generally, the dull weather of the extreme northwest spread over the rest of the country, and there were heavy showers of rain, hail or sleet. Snow was reported from the Midlands on the 9th. Then the large intense anticyclone over northern Europe spread slowly southwestwards and there was a general fall in temperature over Great Britain as the easterly winds brought cold air from central and eastern Europe. On the 11th snow fell in many parts, and strong southeasterly winds and gales were reported from exposed places over the country generally; Beaufort force 9 (49 m.p.h.) occurring throughout the day at Wick. The winds decreased the next day, but the intense cold* continued, and temperature remained below the freezing point day and night in many districts for about six days, except in the extreme west, which after about the 13th came under the influence of southwesterly winds, part of a depression over the Atlantic. In Great Britain snow lay in deep drifts in many parts, but the conditions were often sunny and precipitation was slight; 8·8hrs. of bright sunshine occurred at Bath on the 12th, and 8·6hrs. at Aspatria on the 14th. On the 20th the anticyclone over Scandinavia began to move southwards, and day temperatures in Great Britain rose considerably, though night frosts continued and there was much mist and fog. In Ireland a shallow secondary depression caused heavy rain on the 20th, 4·26in. falling at Kilmacthomas, Waterford, and 1·65in. at Fofanny, Co. Down. Day temperatures continued relatively high on the 22nd and 23rd, but on the 24th the depression to the west of the Bay of Biscay began to move eastwards. There was a renewal of east winds and cold conditions (though not so severe as earlier in the month) with further snow in Great Britain and eastern Ireland. Easterly gales were experienced in the south on the 27th, and quiet cold sunny weather generally on the 28th, 9·1hrs. bright sunshine being recorded at Bath on that day. The distribution of sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	65	+8	Valentia	49	−20
Aberdeen	37	—36	Liverpool	59	− 9
Dublin	42	—31	Falmouth	55	−28
Birr Castle	32	—35	Kew	51	− 9

The distribution of pressure over Europe during the month was highly abnormal. An intense anticyclone covered Scandinavia and Finland, the average being 1,025mb. along the whole west coast and exceeding 1,030mb. over the Gulf of Bothnia, where it was 20mb. above normal. From the coast of Norway pressure decreased rapidly to 1,003mb. over north-west Iceland, where it was only 2mb. above normal, but the lowest pressure was found over the North Atlantic, about 1,000 miles west of Ireland, where it averaged 1,002mb., 6mb. below normal Pressure was also relatively low over the Mediterranean, 1,012mb. at Rome, or 4mb. below normal. In place of the usual system of south-westerly winds across western and central Europe there were accordingly two currents of air, easterly winds over Germany, Switzerland and France, and southerly winds over western Ireland, the Faroes, Iceland and Spitsbergen. In the region of easterly winds temperature was abnormally low, 10°F. below normal at Stockholm and 18° below normal at Zürich, but in the region of southerly winds temperature was abnormally high, the excess reaching 20°F. at Spitsbergen,

* See p. 29

where the average temperature for the month was the same as at Zürich, normally nearly 40° warmer. Precipitation was deficient in the region of easterly winds—in western Gothaland it was only about 15 per cent. of the normal—while in the region of southerly winds it was above normal.

The worst conditions, briefly reported in the issue for February, occurred during the first half of the month. From the 1st to 5th a violent gale accompanied by snow swept over Constantinople, and on the 3rd snow was reported at Palermo in Sicily. Canals in Holland froze early in the month, and by the 12th parts of the rivers and some of the largest lakes were frozen over—the Elbe from Hamburg to Dresden, the Rhine and Lake Constance. Parts of the Baltic froze, and the Great and Little Belts and Copenhagen Sound were almost completely blocked on the 11th. On the 15th ice floes were floating on the Grand Canal at Venice. Conditions in Scandinavia continued severe until the end of the month, but on the 17th and 18th there was a marked rise of temperature in France, Germany, Switzerland and further south. Floods were reported from Bavaria, Macedonia and Thrace, and further heavy falls of snow in Jugo-Slavia again blocked the railway. In Germany and Switzerland there was a general thaw between the 22nd and 26th, but on the 28th cold northeasterly gales in Switzerland and France brought a return of the cold.

Heavy rain prevailed in Transjordan on the 20th. A violent storm swept across Beira (Portuguese East Africa) on the 3rd, and heavy rains in the neighbourhood on the following days caused several washaways on the Rhodesian railways.

Aided by the intense heat and high winds bush fires in New South Wales did much damage early in the month. On the 10th, however, floods occurred round Sydney, Gloucester and Wingham.

In the United States temperature was generally below normal except along the Pacific coast during the first and last week, and part of the Atlantic coast the other two weeks. Precipitation was mostly slight up to about the 21st, when there was a severe snowstorm over the eastern States.

The special message from Brazil states that the rainfall in the northern and central regions was very plentiful with 2·87in. and 3·03in. above normal respectively, while the distribution in the southern regions was irregular with 1·26in. above normal. Five anticyclones passed across the country and rainstorms were experienced in the extreme south. Crops were in good condition owing to the favourable weather. At Rio de Janeiro pressure was 2 mb. below normal and temperature 0.5°F. above normal.

Rainfall, February, 1929.—General Distribution

England and Wales	49	per cent. of the average 1881-1915.
Scotland...	54	
Ireland	129	
British Isles	67	

Rainfall: February, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.
Lond	Camden Square	·58	35
Sur	Reigate, The Knowle	·45	22
Kent	Tenterden, Ashenden	1·00	51
,,	Folkestone, Boro. San.	·76	...
,,	Margate, Cliftonville	·46	33
,,	Sevenoaks, Speldhurst	·52	...
Sus	Patching Farm	2·22	100
,,	Brighton, Old Steyne	1·73	86
,,	Tottingworth Park	·93	40
Hants	Ventnor, Roy. Nat. Hos.	1·47	70
,,	Fordingbridge, Oaklnds	1·06	43
,,	Ovington Rectory	...	...
,,	Sherborne St. John	·67	31
Berks	Wellington College	·46	24
,,	Newbury, Greenham	·77	35
Herts	Benington House	·58	36
Bucks	High Wycombe	1·19	64
Oxf	Oxford, Mag. College	·53	33
Nor	Pitsford, Sedgebrook	·54	32
,,	Oundle	·78	...
Beds	Woburn, Crawley Mill	·63	43
Cam	Cambridge, Bot. Gdns.	·48	38
Essex	Chelmsford, County Lab	·45	30
,,	Lexden Hill House	·48	...
Suff	Hawkedon Rectory	·55	36
,,	Haughley House	·36	...
Norf	Norwich Eaton	·87	53
,,	Blakeney	...	...
,,	Little Dunham	·81	50
Wilts	Devizes, Highclere	·95	48
,,	Bishops Cannings	1·02	48
Dor	Evershot, Melbury Ho.	1·42	45
,,	Creech Grange	1·86	...
,,	Shaftesbury, Abbey Ho.	1·30	56
Devon	Plymouth The Hoe	3·09	105
,,	Polapit Tamar	1·52	47
,,	Ashburton, Druid Ho.	3·71	78
,,	Cullompton	1·88	68
,,	Sidmouth, Sidmount	2·57	103
,,	Filleigh, Castle Hill	1·73	...
,,	Barnstaple N. Dev. Ath.	1·54	57
Corn	Redruth, Trewirgie	3·33	88
,,	Penzance, Morrab Gdn.	3·34	100
,,	St. Austell, Trevarna	4·30	100
Soms	Chewton Mendip	1·54	45
,,	Long Ashton	1·41	...
,,	Street, Millfield	·99	...
Glos.	Cirencester, Gwynfa	·68	30
Here	Ross, Birchlea	1·21	60
,,	Ledbury, Underdown	·68	37
Salop	Church Stretton	·66	30
,,	Shifnal, Hatton Grange	·60	37
Worc	Ombersley, Holt Lock	·68	41
,,	Blockley	·65	...
War	Farnborough	·55	27
,,	Birminghm. Edgbaston	·56	33
Leics	Thornton Reservoir	·43	26

Co.	Station	In.	Per-cent. of Av.
Leics	Belvoir Castle	·50	30
Rut	Ridlington	·57	...
Linc	Boston, Skirbeck	·56	38
,,	Lincoln, Sessions House	·79	54
,,	Skegness, Marine Gdns	·61	40
,,	Louth, Westgate	·84	44
,,	Brigg, Wrawby St.	·53	...
Notts	Worksop, Hodsock	·51	33
Derby	Derby, L. M. & S. Rly.	·44	27
,,	Buxton, Devon Hos.	·85	23
Ches	Runcorn, Weston Pt.	1·08	58
,,	Nantwich, Dorfold Hall	·77	...
Lancs	Manchester, Whit. Pk.	1·02	53
,,	Stonyhurst College	1·01	30
,,	Southport, Hesketh Pk	·93	44
,,	Lancaster, Strathspey	1·02	...
Yorks	Wath-upon-Dearne	·94	57
,,	Bradford, Lister Pk.	·73	31
,,	Oughtershaw Hall	1·83	...
,,	Wetherby, Ribston H.	·66	38
,,	Hull, Pearson Park	·90	54
,,	Holme-on-Spalding	·67	...
,,	West Witton, Ivy Ho.	·98	...
,,	Felixkirk, Mt. St. John	1·11	66
,,	Pickering, Hungate	1·18	...
,,	Scarborough	1·32	79
,,	Middlesbrough	·55	42
,,	Baldersdale, Hury Res.	·72	...
Durh	Ushaw College	1·37	86
Nor	Newcastle, Town Moor	·72	45
,,	Bellingham, Highgreen	1·32	...
,,	Lilburn Tower Gdns.	1·96	...
Cumb	Geltsdale	·60	...
,,	Carlisle, Scaleby Hall	·68	31
,,	Borrowdale, Seathwaite	3·89	34
,,	Borrowdale, Rosthwaite	2.42	...
,,	Keswick, High Hill	·82	...
Glam	Cardiff, Ely P. Stn.	1·60	53
,,	Treherbert, Tynywaun	2·91	...
Carm	Carmarthen Friary	1·49	40
,,	Llanwrda	1·73	40
Pemb	Haverfordwest, School	·98	...
Card	Aberystwyth	2·74	79
,,	Cardigan, County Sch.	1·86	...
Brec	Crickhowell, Talymaes	·80	...
Rad	Birm W. W. Tyrmynydd	1·42	27
Mont	Lake Vyrnwy	1·30	29
Denb	Llangynhafal	1·15	...
Mer	Dolgelly, Bryntirion	1·85	42
Carn	Llandudno	1·00	48
,,	Snowdon, L. Llydaw 9	4·05	...
Ang	Holyhead, Salt Island	2·69	110
,,	Lligwy	·84	...
Isle of Man			
	Douglas, Boro' Cem.	1·99	62
Guernsey			
	St. Peter P't. Grange Rd.	1·80	73

Rainfall : February, 1929 : Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	2·27	87	*Suth* .	Loch More, Achfary ...	1·98	30
,, .	Pt. William, Monreith	2·72	...	*Caith* .	Wick	·67	29
Kirk .	Carsphairn, Shiel.	3·57	...	*Ork* .	Pomona, Deerness	1·07	35
,, .	Dumfries, Cargen	...	...	*Shet* .	Lerwick	1·96	62
Dumf.	Eskdalemuir Obs.	2·09	42	*Cork* .	Caheragh Rectory	8·70	...
Roxb .	Branxholm	1·36	52	,, .	Dunmanway Rectory...	9·91	170
Selk .	Ettrick Manse	...	...	,, .	Ballinacurra	6·72	179
Peeb .	West Linton	1·23	...	,, .	Glanmire, Lota Lo. ...	7·72	195
Berk .	Marchmont House......	1·84	89	*Kerry*.	Valentia Obsy.	7·06	136
Hadd.	North Berwick Res. ...	1·24	48	,, .	Gearahameen	8·10	...
Midl .	Edinburgh, Roy. Obs.	·85	53	,, .	Killarney Asylum	4·82	92
Ayr .	Kilmarnock, Agric. C.	2·16	75	,, .	Darrynane Abbey	6·62	143
,, .	Girvan, Pinmore	2·68	63	*Wat* .	Waterford, Brook Lo...	8·67	266
Renf .	Glasgow, Queen's Pk. .	1·61	55	*Tip* .	Nenagh, Cas. Lough...	3·22	103
,, .	Greenock, Prospect H.	2·77	49	,, .	Roscrea, Timoney Park	3·03	...
Bute .	Rothesay, Ardencraig.	3·59	90	,, .	Cashel, Ballinamona...	3·71	116
,, .	Dougarie Lodge	3·17	...	*Lim* .	Foynes, Coolnanes......	3·66	115
Arg .	Ardgour House	2·97	...	,, .	Castleconnel Rec.	3·02	...
,, .	Manse of Glenorchy ...	2·32	...	*Clare* .	Inagh, Mount Callan...	4·68	...
,, .	Oban	2·20	...	,, .	Broadford, Hurdlest'n.	3·62	...
,, .	Poltalloch	2·13	49	*Wexf*.	Newtownbarry	6·90	...
,, .	Inveraray Castle...	2·52	37	,, .	Gorey, Courtown Ho ..	6·07	216
,, .	Islay, Eallabus	2·78	66	*Kilk* .	Kilkenny Castle.........	3·22	127
,, .	Mull Benmore	...	...	*Wic* .	Rathnew, Clonmannon	4·00	...
,, .	Tiree	3·16	...	*Carl* .	Hacketstown Rectory..	4·22	140
Kinr .	Loch Leven Sluice......	2·05	73	*QCo* .	Blandsfort House	...	...
Perth .	Loch Dhu	3·50	47	,, .	Mountmellick............	3·73	...
,, .	Balquhidder, Stronvar	1·93	...	*KCo* .	Birr Castle	3·24	141
,, .	Crieff, Strathearn Hyd.	2·81	80	*Dubl* .	Dublin, FitzWm. Sq...	1·91	210
,, .	Blair Castle Gardens ...	1·75	63	,, .	Balbriggan, Ardgillan.	4·13	...
,, .	Dalnaspidal Lodge ...	3·34	61	*Me'th* .	Beauparc, St. Cloud...	3·06	...
Forf .	Kettins School	1·85	87	,, .	Kells, Headfort	...	...
,, .	Dundee, E. Necropolis	1·92	102	*W.M* .	Moate, Coolatore	4·04	141
,, .	Pearsie House...........	2·44	...	,, .	Mullingar, Belvedere..	3·50	126
,, .	Montrose, Sunnyside...	2·05	111	*Long* .	Castle Forbes Gdns......	3·89	136
Aber .	Braemar, Bank	1·09	38	*Gal* .	Ballynahinch Castle ...	6·64	130
,, .	Logie Coldstone Sch....	1·39	67	,, .	Galway, Grammar Sch.	3·41	...
,, .	Aberdeen, King's Coll.	1·72	84	*Mayo* .	Mallaranny..............	4·03	...
,, .	Fyvie Castle	3·20	...	,, .	Westport House.........	3·84	97
Mor .	Gordon Castle	·72	37	,, .	Delphi Lodge	7·67	...
,, .	Grantown-on-Spey ...	·35	17	*Sligo* .	Markree Obsy...........	3·15	90
Na .	Nairn, Delnies	·42	23	*Cav'n* .	Belturbet, Cloverhill...	2·98	114
Inv .	Kingussie, The Birches	·81	...	*Ferm* .	Enniskillen, Portora...	3·07	...
,, .	Loch Quoich, Loan ...	3·40	...	*Arm* .	Armagh Obsy............	2·26	102
,, .	Glenquoich..............	2·94	29	*Down* .	Fofanny Reservoir......	8·79	...
,, .	Inverness, Culduthel R.	·35	...	,, .	Seaforde	4·09	134
,, .	Arisaig, Faire-na-Squir	1·02	...	,, .	Donaghadee, C. Stn ...	2·61	113
,, .	Fort William	2·10	...	,, .	Banbridge, Milltown...	1·90	91
,, .	Skye, Dunvegan	2·04	...	*Antr* .	Belfast, Cavehill Rd ...	3·72	...
R & C.	Alness, Ardross Cas. ...	·65	20	,, .	Glenarm Castle	3·49	...
,, .	Ullapool..................	·88	...	,, .	Ballymena, Harryville	3·24	100
,, .	Torridon, Bendamph...	1·54	19	*Lon* .	Londonderry, Creggan	2·35	74
,, .	Achnashellach	1·40	...	*Tyr* .	Donaghmore	4·29	...
,, .	Stornoway	1·44	32	,, .	Omagh, Edenfel.........	3·04	102
Suth .	Lairg	·74	...	*Don* .	Malin Head..............	1·72	71
,, .	Tongue	·91	26	,, .	Dunfanaghy	2·59	...
,, .	Melvich	·76	25	,, .	Killybegs, Rockmount.	4·54	91

Climatological Table for the British Empire, September, 1928.

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.	1020·7	+ 3·3	80	35	65·5	46·6	56·1	− 1·0	48·5	92	6·4	1·03	− 0·84	6	6·7	53
Gibraltar	1015·6	− 1·7	88	62	81·1	68·1	74·6	+ 2·1	67·0	84	5·8	2·69	+ 1·30	8	..	..
Malta	1017·1	+ 0·2	87	65	82·0	71·3	76·7	+ 0·7	71·0	77	3·7	2·20	+ 0·93	6	9·4	76
St. Helena	1015·5	+ 2·2	62	51	60·0	53·6	56·8	− 1·1	54·3	93	9·8	2·13	− 0·89	19	..	..
Sierra Leone	1014·1	+ 1·9	87	69	83·1	72·4	77·7	− 1·4	74·9	83	8·3	30·43	+ 1·95	25	..	..
Lagos, Nigeria	1010·9	− 1·9	83	70	81·4	73·9	77·7	− 0·7	74·7	87	7·1	5·60	+ 0·34	17	..	..
Kaduna, Nigeria	1015·3	+ 2·5	90	..	84·7	..	..	..	71·3	84	..	9·71	− 1·78	18	..	..
Zomba, Nyasaland	1013·4	− 0·3	88	54	81·2	60·9	71·1	+ 1·6	..	54	2·6	0·00	− 0·34	0	..	..
Salisbury, Rhodesia	1010·0	− 1·6	94	45	82·0	54·9	68·5	+ 2·1	56·4	42	1·6	0·16	− 0·10	1	9·4	78
Cape Town	1019·7	+ 0·6	79	40	63·6	49·2	56·4	− 1·5	50·7	85	5·2	3·16	+ 0·89	15	..	..
Johannesburg	1016·7	− 1·6	79	31	69·1	46·3	57·7	− 1·7	46·7	54	3·3	0·80	− 0·16	8	8·9	75
Mauritius	1020·5	+ 0·3	79	58	75·7	63·0	69·3	− 0·8	65·3	68	6·8	1·42	+ 0·12	18	7·6	63
Bloemfontein	..	..	84	26	68·9	42·2	55·5	− 3·6	44·9	54	3·2	0·25	− 0·65	3	..	..
Calcutta, Alipore Obsy.	1004·6	+ 0·1	93	77	90·7	79·6	85·1	+ 2·1	80·2	89	7·2	8·72	− 1·15	13*	..	..
Bombay	1008·3	+ 0·3	87	72	84·9	75·1	80·0	− 0·8	75·8	88	7·6	9·91	− 0·77	22*	..	..
Madras	1006·0	− 0·5	100	93	93·4	77·4	85·4	+ 0·3	76·7	78	6·6	8·18	+ 3·19	16*	..	..
Colombo, Ceylon	1010·2	+ 0·2	89	75	87·2	77·8	82·5	+ 1·6	76·9	73	7·0	1·44	− 4·78	16	7·9	65
Hongkong	1006·4	− 2·0	91	72	86·2	77·9	82·1	+ 1·1	75·4	72	6·1	3·91	− 6·08	9	6·7	54
Sandakan	..	..	91	71	89·0	74·2	81·6	− 0·1	77·4	82	..	10·06	+ 0·67	15	..	..
Sydney	1010·9	− 5·1	89	48	73·6	53·1	63·3	+ 4·1	55·4	53	4·0	0·20	− 2·69	6	8·4	71
Melbourne	1008·8	− 7·0	89	40	67·1	49·1	58·1	+ 4·0	51·3	59	6·6	1·13	− 1·28	15	6·5	48
Adelaide	1011·8	− 5·5	90	44	70·1	50·3	60·2	+ 3·1	52·6	55	5·6	1·81	− 0·23	10	6·1	52
Perth, W. Australia	1015·5	− 2·4	73	44	64·8	51·9	58·3	0·0	54·6	70	7·2	5·04	+ 1·64	20	6·1	52
Coolgardie	1014·3	− 2·8	88	36	72·2	46·0	59·1	+ 0·5	50·3	49	3·2	0·38	− 0·23	5	..	..
Brisbane	1015·0	− 2·3	86	47	78·6	55·9	67·3	+ 2·0	60·0	60	1·9	0·78	− 1·27	2	9·8	82
Hobart, Tasmania	998·6	−12·1	76	33	58·4	44·0	51·2	+ 0·4	45·5	61	7·2	4·47	+ 2·34	26	6·1	52
Wellington, N.Z.	1004·7	− 9·9	63	38	55·8	44·6	50·2	− 1·4	47·2	70	6·0	3·31	− 0·66	15	5·8	49
Suva, Fiji	1014·0	− 0·3	90	65	81·6	70·5	76·1	+ 1·6	71·6	76	7·1	4·15	− 2·83	15	5·8	48
Apia, Samoa	1012·5	+ 0·4	86	71	84·3	74·3	79·3	+ 1·1	76·6	79	5·1	8·03	+ 2·91	20	7·2	60
Kingston, Jamaica	1011·9	− 0·3	90	69	87·8	73·4	80·6	− 0·9	73·1	88	5·2	3·12	− 0·91	10	7·0	57
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1016·2	− 1·6	80	33	66·6	48·8	57·7	− 1·5	51·5	80	4·3	2·85	− 0·33	13	7·0	56
Winnipeg	1014·3	− 0·5	81	29	64·8	42·7	53·7	+ 0·3	42·7	85	4·4	0·64	− 1·64	6	6·1	48
St. John, N.B.	1017·6	+ 0·1	73	37	61·4	48·2	54·8	− 1·1	52·0	81	6·4	4·90	+ 1·16	13	5·4	43
Victoria, B.C.	1017·1	+ 0·6	82	46	63·4	49·8	56·6	+ 1·0	52·4	76	3·7	0·45	− 1·56	5	7·5	60

* For Indian stations a rain day is a day on which 0.1 in. or more rain has fallen.

Pancake ice on the river Dee at Queensferry, Cheshire, February 14th, 1929. (*See Page* 66).

M.O. 313.

The Meteorological Magazine

Vol. 64
April 1929
No. 759

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

The maximum Heights which it is possible to reach by Sounding or Pilot Balloons

By L. H. G. Dines, M.A.

Very few authentic records of the temperature of the upper air claim to penetrate to heights much over 22 kilometres, and in view of the great interest which attaches to the conditions at still higher levels the question is sometimes asked why this limit exists. The height to which a free balloon can rise is limited by definite physical conditions, and the main elements of the problem are all known reasonably accurately. The aim of this note is to set them out in such a manner that the probable maximum height attainable under given conditions can be readily determined.

The following table is based on the average conditions of temperature and pressure over the British Isles. As we do not know the mean temperature at heights above 22km. it is necessary to make some assumptions. Accordingly, a constant temperature has been assumed between 20 and 30km., a steadily rising temperature between 30 and 40km., and a constant temperature of 280a. above 40km.

Balloons may be of two kinds; (1) Those made with a thin inextensible envelope, either from which the gas escapes as it expands, or which is sealed up with just sufficient gas enclosed to give the requisite vertical velocity. (2) Those made of sheet rubber, which is capable of very considerable extension before

(83756) P. S. 1602/81. 1,000 4/29 M. & S. Gp. 303.

it ruptures. In the latter case the balloon is always sealed up, and apart from leakage the mass of contained gas remains constant.

Height above Mean Sea Level	Mean pressure in millibars P.	Mean temperature, absolute T.	Mean ratio P/T.	Relative diameter of spherical balloon	Lift of the hydrogen contained in the balloon	
					Lbs. per cu. ft.	Grammes per cu. metre
km.						
0	1014	283	3·58	1·00	·072	1160
10	261	222	1·18	1·45	·024	383
20	55	220	0·250	2·43	·0051	81
25	25	220	0·114	3·15	·0023	37
30	11·6	220	0·0527	4·08	·00107	17
35	5·61	250	0·0224	5·42	·00045	7·2
40	2·95	280	0·0105	6·99	·000212	3·40
45	1·60	280	0·00571	8·56	·000115	1·85
50	0·87	280	0·00311	10·47	·000063	1·01

In the case of inextensible balloons from which surplus gas can escape the limiting height is determined by the condition that the weight of the envelope and attached apparatus shall be equal to the lift of the included gas. Suppose, for example, that a balloon of 1,000cu. ft. capacity weighs 4lbs., it is seen by interpolation from column 6 of the table that it would just float at a height of about 22km., and under average conditions could rise no higher. In practice it is essential that the balloon be made to burst, and therefore it must be sealed up. Suppose then that it be sealed up with enough hydrogen enclosed to give a free lift of 1lb., the total lift of the gas is then 5lbs., and from column 6 it will be seen that at 20km. the balloon will reach its full capacity of 1,000cu. ft. and will burst. Suppose, again, that a balloon be made of the same material but twice the diameter. Its capacity will be 8,000cu. ft., and weight 16lbs. By interpolation from column 6 it is seen that 8,000cu. ft. of hydrogen will lift 16lbs. at a height of about 26km., and this represents the absolute limit under average conditions. It is clear that only by employing very large balloons made of very light material can heights appreciably greater than 20km. be reached by this means.

In the second case of rubber balloons the limiting factor is the extent to which the rubber envelope will stretch before rupture. The writer has tested many small samples cut from rubber balloons, and has found that the best specimens will stretch before rupture until their superficial area is about 55 times as

Extract from letter received from
Mr. L.H.G.Dines by Dr. Scrase,
19.7.40.

.... In the last paragraph of p.59 I have clearly erred as you suggest. I make the correct figures to be as follows.

Diameter at surface 2.12 m instead of 2.38.
Initial stretch 1.165 " 1.31.
Height at which stretch is 5.... 30.9Km. instead of 28½.

great as it was originally. In the case of a spherical balloon of uniform quality this means that if its unstretched diameter is 1 metre it will expand to 7½ metres before bursting. A great deal of information is available from the data of balloon soundings, in which the density of the surrounding air at the instant of bursting was known, and though many different makes of balloon have been used none have been found capable of expanding to more than about 5½ diameters in actual flight. The majority burst much sooner, at about 4 diameters more or less.

The specific gravity of rubber is about 0·92, and from the known densities of air and hydrogen the following equations are readily deduced :—

Weight of balloon in grammes $= 2890.\ d^2.\ t.$ ... ... (1)

Lift of enclosed hydrogen at the surface in grammes $= 607.\ d^3$ (2)

where d is the diameter of the balloon in metres and t is the thickness of the envelope in millimetres. It follows immediately that under surface conditions a rubber balloon will just support itself when the relation between d and t is given by the equation

$$d = 4{\cdot}76\ t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (3)$$

also that if another balloon be made from rubber sheet of the same thickness but of twice the diameter it will just support itself at the surface when half filled with hydrogen.

In England the weight of the recording meteorograph used with sounding balloons is so small that in the present case when we are considering only the larger types of sounding balloons it may be neglected entirely. It must, however, be remembered that to ensure a sufficiently high rising velocity a balloon must be filled initially to a diameter at least 10 per cent. greater than is required for it just to support itself.

To work out a definite example, it is generally found that balloons in which t is less than 0·5mm. do not stretch so well as thicker ones. Suppose then a case in which $t = 0{\cdot}5$mm. and $d = 2$m. From equation (2) this balloon will support itself when its diameter at the surface is 2·38m. Multiplying by 1·10 to give the requisite vertical velocity we have a diameter of 2·62m. at the start, that is an initial stretch of 1·31. If the rubber be of very good quality it will endure a stretch of 5 before the balloon bursts. To find the height at which this will take place we have to interpolate in column 5 for the ratio 5/1·31, or 3·82; this is seen to be at about 28½km. From equation (1) the weight of this balloon will be 5·8 kilogrammes, which is about six times as heavy as the balloons commonly employed in England at the present time. If the thickness were 0·4mm. and the endurable stretch be taken as low as 4 a similar process shows that the height will again be about 28½km. As these values of the stretch are comparable with those actually obtained in the case of smaller balloons there is good ground for asserting that with balloons of 2m. diameter it is in general impossible to exceed heights of about 28½km.

It will be seen from the table that the density of the atmosphere roughly halves itself with every increase in height of 5km., and it readily follows from equations (1) and (2) that doubling d and keeping t constant can only result in a gain of about 5km. in the maximum height attainable.* At the same time the weight of the balloon is increased four times, and the cost in at least the same proportion.

In the above investigation several factors have been omitted in order to simplify the calculations, *e.g.*, the effect of the tension of the rubber envelope on the density of the included gas, the heating of the envelope and gas by solar radiation, the casual variations of the density of the air from its mean value and the possibility of a small and fortunate leakage reducing the strain on the rubber near the upper limit of the sounding. The last two are the only significant factors from the present point of view, and under special circumstances they are capable of adding perhaps 2 or 3km. to the maximum heights previously determined. There is also the element of uncertainty in the value of the temperature above 25km. to be considered; if, however, the table be recomputed to suit any other distribution of temperature which may be conceived of as possible, it will be found that the effect on the density at 30km. is comparatively very small, and that the order of magnitude of the results just obtained is unaffected by such changes.

It is evident that definite practical limitations exist which make the attainment of heights appreciably greater than 30km. almost prohibitive, but there is no reason why a good maker should not supply balloons which would sometimes reach about 30km.

As a further example of the use of the table the case is worked out below of the type of balloon commonly employed at Kew Observatory:—

Weight of balloon = 800 grammes.
Diameter unstretched = 70 cm.

From equation (1) we find that t = 0·58mm.

To obtain an adequate vertical velocity this balloon would be given a free lift of 680 grammes, and hence from (2) its diameter at the start would be $\frac{800 + 680}{607}$ m., that is 1·35m.

The balloon will therefore start with an initial stretch of $\frac{1 \cdot 35}{0 \cdot 70}$ or 1·93. If it endure a stretch of 5 before bursting the height reached will be from column 5 about 21km., or if it burst at a stretch of 4 it will reach about 18½km. Such heights are approximately those which good balloons of this size attain.

*In this case the balloon would be only partially inflated at the start.

Unusual Ranges of Temperature

By S. T. A. Mirrlees, M.A.

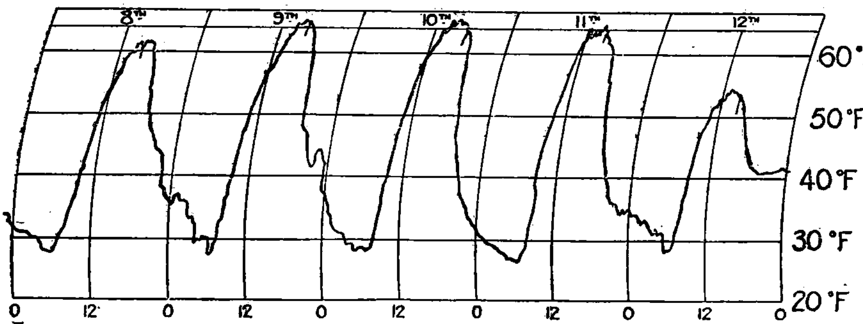
On the "average day" in March air temperature at inland stations in southeast England varies from about 36°F. near sunrise to about 49°F. in the afternoon. (These figures refer to temperatures measured under standard conditions.)

During this month both the sun's declination and the time during which the sun is above the horizon are increasing most rapidly, and when clear skies and absence of wind permit radiation effects to have free play it may happen that temperature after falling a few degrees below freezing point during the night rises rapidly after sunrise and reaches a maximum of 60° or over. The conditions in which a large temperature range occurs represent a nice balance of tendencies—if temperature falls low enough, a thick fog forms, and unless the fog clears quickly the rise of temperature will be restricted. The conditions are of course not confined to southeast England, but their effect is best seen where the climate is normally most extreme. If stable anticyclonic weather prevails a sequence of days with warm afternoons and cold nights may be experienced, and when conditions are favourable the daily range of temperature becomes exaggerated, and reaches 30° or more. Such a sequence was experienced over a large part of the country on March 8th—11th, when at several stations ranges in excess of 35° were recorded on each of the four days. The average daily ranges for this period at various stations as reported in the *Daily Weather Report* have been calculated, and are as follows:—Birr Castle 27°, Chester (Sealand) 32°, Shoeburyness 33°, Kew Observatory 34°, Ross-on-Wye 37°, Eskdalemuir 37°, South Farnborough 41°. During these days anticyclonic conditions prevailed over the British Isles, and at most of the stations mentioned cloud amounts were very small. Fog generally developed during the night, but cleared rather quickly, and relative humidity fell to low values during the afternoon hours, several stations reporting 30 per cent. or less at 13h.

A tracing of the South Farnborough thermograms for March 8th—12th is reproduced in the figure and shows the very rapid rise and fall of temperature before and after the hottest period of the day, approaching 10°F. per hour at times. The ranges shown by the thermograph are somewhat restricted, as compared with the ranges given by the maximum and minimum thermometers. By applying suitable corrections, however, it becomes possible to tabulate the curves for the four days. The resulting average curve shows a close resemblance to the actual curve for March 10th: the amplitudes of the coefficients of the first and second harmonic terms are 19·1° and 5·3° respectively, which may be compared with the average values for March of

4·4° and 1·1° at Kew Observatory. The irregular parts of the thermograms in the late evening hours are presumably the effects of local conditions, and cancel out in the average curve. The greatest daily range in the period was 43° on March 9th; on the same day the range of 41° experienced at Eskdalemuir (Dumfriesshire) is noteworthy.

SOUTH FARNBOROUGH. MARCH 1929.



From the results of temperature soundings by aeroplane published in the *Upper Air Supplement* to the *Daily Weather Report*, it appears that during a considerable part of the month temperatures in the upper air over southern England up to at least 20,000 feet were some 15° above normal. A temporary drop to the normal March level on the 23rd was followed by a return to warmer conditions again by the 27th. Considering the seven days on which the range reached or exceeded 40° at South Farnborough, one finds the following figures:—average surface temperature 49°, average temperature at 5,000 feet 44°, at 10,000 feet 28°. If convection had been sufficient to set up a dry adiabatic lapse rate of temperature between the ground and 5,000 feet in the warmest part of the day, the maximum temperature at the surface would have been about 71°; actually the average maximum for the seven days was 69°. The aeroplane ascents were carried out after 10h., by which time the surface temperature was rising above the mean for the day, and there is no direct measurement of the extent of the temperature inversion due to nocturnal cooling, but it was probably insignificant above the first two thousand feet.

Since the absolute daily range of shade temperature is not usually dealt with in meteorological statistics it would be a matter of considerable difficulty to find the actual highest daily range recorded in the British Isles. A few examples of large ranges may be cited without in any way attempting to define the record. Ranges of 40° were experienced on March 20th at South Farnborough and Croydon, and on March 28th at Eskdalemuir. At South Farnborough the range was 41° on 28th and 30th and 42° on 29th. At the same station on March 22nd—24th, 1918, the average range was 41°, the greatest range being 43° on 24th. On March 29th, 1893, a range of 44° was experienced at Cambridge.

Discussions at the Meteorological Office

March 11th.—*Contributions on the mechanism of waterspouts and tornadoes.* By A. Wegener (Met. Zs., Bd. 45, H.6, 1928) (in German). *Opener*—Mr. M. A. Giblett, M.Sc.

Dr. Wegener considers that a waterspout or tornado consists of a horizontal mother-whirl in the cloud, one end of which is bent downwards towards the ground, while the other end usually ends in the cloud. Various lines of evidence are adduced in support of this view, the strongest being the distribution of objects transported by the whirl. In the whirlwind of August 19th, 1890, at St. Claude for example, washing identified by the marks of the owners was carried from the right hand side of the track and dropped about 20km. to the left of the track, some distance forward. In another example the objects carried from the right of the track to the left were found to be encrusted with ice, showing that they must have passed through the cloud at a considerable height.

The rotation of the horizontal mother-whirl is clockwise when viewed from the right hand side. The hypothesis of the origin of these whirls assumes that initially a current of air moves horizontally across a layer of heated air with small horizontal motion, forming a discontinuity at a height of about three kilometres, along which a row of small whirls is developed, rotating clockwise when seen from the right. Where the lower air breaks through the upper layer, as shown by the formation of cumulonimbus clouds, two vertical discontinuities are formed, with similar rows of horizontal whirls, the forward whirls rotating in the same sense as the horizontal whirls. At the junction of this vertical row with the horizontal row a larger whirl is formed which, as it advances, absorbs the minor whirls. Instead of advancing directly forward, however, it tends to move obliquely towards the right, owing to the change of wind direction with height, so that the right hand end emerges from the cloud and is sometimes bent downwards to the ground.

There are several difficulties involved in this hypothesis, especially the difficulty of accounting for the intensity of the whirl and of the manner in which the one end becomes bent down to the ground. It also fails to account for the occurrence of three or more whirls along the same line-squall front as sometimes observed, though the author gives an explanation of the formation of multiple spouts. Mr. Giblett set out an alternative hypothesis, according to which waterspouts or tornadoes are developed at the front of an advancing wedge of cold air either at a long cold front associated with a depression or at the local cold front which often develops under a thunder-storm. The cold air at a height of a few hundred metres, but higher at times, over-runs the cold air at the surface, owing, for example, to friction with the ground, though sometimes also to other reasons, and some warm air is trapped beneath this advancing nose. It is the uprush of this warm air which forms the line of cloud in a line squall, as shown for example in the squall of October 14th, 1912, at Aberdeen. In this example three elementary waterspouts were seen to develop along this line. The strong horizontal convergence in such cases is adequate to produce a violent whirl about an axis leading upwards from the surface, by conservation of angular momentum, wherever the vertical uprush becomes at all localised. This alternative was suggested and illustrated in a paper on "Line Squalls" published in the *Journal of the Royal Aeronautical Society*, June, 1927.

Whatever may be the ultimately accepted theory, Wegener's paper will always be outstanding for the observational facts co-ordinated in it, and especially for the demonstration that, at least in a number of important cases in Europe, the tornado track lay on the right hand side of the track of the main cumulo-nimbus cloud and of the associated belt of heavy rain or hail, and also that there is evidence that such right-side tornadoes are cyclonic in rotation. The paper thus gives an important lead to future investigators, and, in particular, suggests that this characteristic should be examined specially for the case of American tornadoes.

Royal Meteorological Society

The meeting of the Society on Wednesday, March 20th, at 7.30 p.m. (Sir Richard Gregory, LL.D., President, in the chair) was devoted to the Symons Memorial Lecture. Mr. R. A. Watson Watt gave an account of "Weather and Wireless," of which the following is a summary.

Wireless as a means of communication is essential in modern meteorology because it alone is capable of giving sufficiently rapid interchange of data over wide areas. It is of special importance in British meteorology because it carries data from ships in the Atlantic giving the first indications of impending changes. In aerial navigation it provides the only means of carrying forecasts and the data necessary for the intelligent use of the forecasts. The broadcasting of weather reports and forecasts is educating a public opinion which will lead to greater attention to meteorology in education, and consequently to improvements in meteorological methods. The results of observations made all over Great Britain are in the hands of the central forecaster within an hour, the majority of the data for Europe are received within an hour and a half, and that for the whole Northern Hemisphere within six hours.

The demonstrations given showed the reception of the weather map for 1 p.m. transmitted on the Fultograph system across the room to show the complete process, and of the map for 6 p.m., together with a written forecast based on the latter prepared at the Meteorological Office at Royal Airship Works at Cardington, and transmitted by wireless from Cardington.

Wireless has a climate and a weather of its own. The weakening of signals over different kinds of country, according to time of day and season, and the dependence of atmospheric disturbance on latitude, place and time, are climatological in scope. The quick-period changes and the erratic phenomena of fading, are part of the weather of wireless; atmospherics are its rainfall. The history of civilisation is in the main the story of man's progress towards independence of the weather; the history of wireless is that of progress towards the mitigation of these disturbing factors. The nature of the broadcast service area, of the zone of severe fading and the reduced fading at greater distances, were discussed. Among the phenomena described was the reception of short-wave signals after they had travelled several times round the world, and also of "echoes" of this kind which would appear to have been reflected back to earth after being out beyond the moon. Atmospherics may be counted arriving at the rate of three or four thousand per second in a tropical night. The average atmospheric is a hundred thousand times as strong as a readable signal. Atmospherics have been known to disturb broadcast reception up to four thousand miles from their place of origin.

Atmospherics are found to originate in thunderstorms, and the predominate source of the world's supply of atmospherics at any moment usually lies in a land where it is summer afternoon. A map showing the travel across the world of these sources was exhibited. The average atmospheric received in England is of such strength as would be sent out by a thunderstorm 2,000 miles away. Visual direction finders of the type demonstrated in operation have accurately located thunderstorms in progress at places one or two thousand miles away.

Dr. Johnson has immortalised a brief chapter "concerning snakes," whose full text is, "There are no snakes to be met with throughout the whole island." Thus it is with the alleged effects of wireless on weather. The average rainfall of England requires for its production the expenditure of energy at the rate of a third of a million horsepower per square mile, night and day throughout the year. This is the rating of the largest electricity generating station in Great Britain. The total rate of emission of energy from all the broadcasting stations of Great Britain and northern Ireland, in the limited periods during which they work, is under 55 horsepower, the corresponding figure for Europe being about 400 horsepower. Any effect of broadcasting on weather would therefore be due to "sub-homeopathic doses" of less than one in a thousand million. Applying the same kind of arithmetic to the suburban home, one finds that to produce a year's rain for the tennis court by means of an electric kettle would cost £800 or more, while the home's contribution to the power bill of the local broadcasting transmitter is an eighth of a penny a year.

Extensions of the application of wireless telegraphy in meteorological communications may well include the transmission of three-colour weather charts. The detection and location of thunderstorms by wireless direction finding on atmospherics will probably become part of day-to-day meteorological practice. It is possible that some of the other measurements, and of the effects of weather on wireless described, may be used as aids to forecasting.

The lecture was illustrated by lantern slides and by the reception of current weather maps and written forecasts on the Fultograph system, and by demonstrations of the Cathode Ray Direction Finder, a visual direct-reading instrument used for locating wireless transmitters and thunderstorms.

Correspondence

To the Editor, *The Meteorological Magazine*

Drifting Ice on the Sea near Chester

During the severe frost of mid-February the unusual phenomenon of drifting ice was observed on the River Dee at Queensferry.

The river at this part has been banked up to form a canal about 300 feet wide and is subject to heavy tidal influence—on this particular date the range of tide was about 17 feet, with high water about 14h. 30m. The photograph forming the frontispiece of this number of the magazine was taken between 13h. 30m. and 14h., February 14th, 1929.

It was noticed on several days that the river became covered, as shown in the photograph, during the flow of the tide, and that most of the ice was deposited along the banks on the ebb. No doubt the bore, which is particularly evident in this estuary, prevented the river here from being completely frozen over. This is the opinion of a local river pilot of 20 years' experience. He referred to the phenomenon as "pack" ice. Does not this rather resemble what is known as "pancake" ice?

The grass minimum temperatures at Sealand from February 11th to 20th inclusive, were 24°, 18°, 13°, 8°, 9°, 24°, and 23°F. respectively.

The river at Chester was completely frozen over and skating was general.

The photograph was obtained by the Station photographer through the courtesy of Group Captain A. D. Cunningham, C.B.E., Commanding No. 5 Flying Training School, Royal Air Force.

F. DAVIES.

Sealand. March 18th, 1929.

Low February Temperatures

The following notable records of low temperature which Mr. R. Gray obtained at Oaklands, Dorstone, Herefordshire, were received too late for inclusion in " Notes on the Frost " in the March number of the *Meteorological Magazine.*

Screen temperatures

Feb.	Max.	Min.	" Grass " Min.	Feb.	Max.	Min.	" Grass " Min.
12th	24.5	18.0	16.0	16th	32.0	16.0	17.5
13th	25.5	—1.5	—4.5	17th	31.0	3.5	0.5
14th	26.0	—3.0	—7.0	18th	35.5	4.5	0.0
15th	22.0	—0.5	—4.5				

He also stated that " holly and ivy have been badly damaged by the frost and to-day present a scorched and brown appearance."

Sun Pillar

On March 9th at 17h. 55m. G.M.T. I observed a strange phenomenon of which I can find no record.

The sun was setting and appeared, when almost on the horizon, as a well-defined light-red ball with a sun pillar ascending from it. In the path of the pillar there was an image alike in all respects to the sun, the distance between the two balls being equal to the diameter of either. It was quite impossible at that time to say which was the object and which the image but this was decided when, two minutes later, the upper " sun " quite suddenly faded. Five minutes later the sun had set and only the pillar remained. There was very high and hazy cirrus in the vicinity of the phenomenon and no low cloud was present. The high cloud was travelling from southeast while the surface wind was east.

Mr. W. L. Andrew observed an excellent example of a sun pillar on February 22nd, but there were no other attendant phenomena.

T. H. APPLEGATE.

Cattewater, Plymouth, Devon. March 15th, 1929.

[Mr. Applegate's experience recalls a picture in Pernter and Exner's *Meteorologische Optik* (2nd Edn. p. 252). This picture represents observations made by Hevel as long ago as 1682. The significance of the duplication of the sun is not discussed by Pernter and Exner.

The accepted explanation of a sun pillar is the reflection of light from snow crystals fluttering down in the air with their flat surfaces nearly horizontal. Such reflection would not produce a sharp round image above the sun. From mountains or balloons a sharp reflection (as in the surface of calm water) is sometimes seen but this reflection is naturally below the sun.

If we try to explain the duplication of the sun in Applegate's observations by refraction of the light on account of a temperature inversion, we are met with the difficulty that there seems to have been no distortion. It is not at all unusual for the setting sun to assume bizarre shapes and to divide into two segments before it disappears but no one would describe such segments as well-defined balls. The cause of the Hevel-Applegate phenomenon must remain a mystery.

It may, however, be relevant to mention that on March 9th, the evening of Mr. Applegate's observations, a sun pillar was to be seen from Holmbury Hill in Surrey. The pillar was brightest where it intersected a belt of cloud (apparently cirro-stratus). The setting sun as seen from Holmbury Hill was distorted considerably.—F. J. W. WHIPPLE.]

Sun Pillar, March 29th

An exceptionally bright sun pillar, red in colour, was seen at 18h. 20m. on the above date . The base of the pillar was about 5° above the horizon rising to an altitude of about 25°, 1° in width. At 18h. 35m., nine minutes after sunset at an altitude of 10° in the pillar, the disc of the sun appeared indistinctly, radial arms developing extending 4° on either side. The complete phenomenon remained visible to 18h. 42m., the pillar alone being continued to 19h. The sun, deep red in colour, had disappeared in thick haze at 18h. 15m., no visible cloud being apparent to the west, cirrus, estimated at three-tenths, was present towards the east.

In its entirety the phenomenon must be assigned to that of a halo cross, uncommon with the sun above the horizon, more particularly so after sunset.

SPENCER RUSSELL.

Worcester Park, Surrey. April 2nd, 1929.

I observed a very vivid "sun pillar" this evening (Good Friday), here at Camberley. The sky in the west was clear except for some very fine cirrus cloud, which was only visible owing to the red rays of the set sun falling on it. There were also two streaks of more pronounced cirrus running at an apparent angle with the " pillar." Where the higher of these streaks crossed the pillar, it was somewhat brighter. From approx. 10° elevation to the horizon, the sky was dark with fog, whilst the ground was covered with ground fog in wreaths. Above 10°, the sky was reddish, and above this line, up to about 25°, the pillar was brilliant red, fading out just about 25° up. At about 10°, the pillar had a bright patch—doubtless a mock-sun, below which it faded into the fog. The sun had already set below the horizon, and I first noticed the pillar about 6.45 p.m. It had gone by 7.15 p.m. I did not look before, but there must have been some strong halo effects before sunset. I thought it worth while recording, owing to the extraordinary sharpness and brilliance of the pillar, especially during the absence of the sun itself.

E. W. GOODMAN.

Old Dean Hall, Camberley, Surrey. March 29th, 1929.

A sun pillar was observed here on Good Friday, March 29th, at 17h. 55m., extending about 20 degrees above the sun, rainbow-hued at first, then slowly turning a fiery red and finally fading away at 19h.

F. CLAUDE BANKS.

Market Gardens, Horndon-on-the Hill, Essex. April 3rd, 1929.

A remarkable phenomenon was seen here on Friday evening, March 29th, just after sunset, a sun pillar which took the form of a perfect luminous red cross which remained visible for some time.

G. E. DACEY.

6, *Clarendon Road, London, S.E.*13. *April 2nd*, 1929.

Ice Crystals

May I make some comments on the correspondence on ice crystals in the March number of the *Meteorological Magazine*?

The deposit which Mr. Weller observed on the Hog's Back on February 9th, 1929, must have been rime blown from the trees. There were great quantities of rime of similar character in Arundel Park on February 12th, 1927. On that occasion (as was reported in *Nature*, February 26th, 1927, p. 328) " the rime was heavy enough to bend the branches. In the light breeze the fragments of rime . . . . pelted the passer-by in no pleasant fashion. In places the fallen rime lay on the ground to the depth of one inch." The rime had formed on the twigs in plates such as Mr. Weller describes.

Ice crystals, of the type which Mr. Bigg observed, I saw on three occasions this winter. On January 26th on the Chiltern

Hills the crystals were falling whilst there was blue sky overhead but they might have come from clouds which had passed before the crystals reached the ground. On February 13th crystals were falling at Chiswick as well as at Richmond. At Richmond the crystals were of various patterns; in addition to the simple crystals such as Mr. Bigg mentions, the hub and six spokes, there were numerous crystals with hexagonal symmetry in lace-like designs. Most remarkable were two crystals in each of which there was a hub and twelve spokes. It is important to place the occurrence of this form on record as there is a note in Pernter and Exner's *Meteorologische Optik* (2nd Edn., 1922, p. 318) "Vom sternförmigen Dodekagon ist nun schon gar keine Rede; man findet dafür in den Mikrophotographien nicht einmal eine leise Andeutung." Almost simultaneously with my own observations, my son, who was examining ice crystals at Chiswick, also found a twelve-rayed specimen. One point which is not usually stated explicitly in descriptions of such crystals is that they are quite flat; they might have been cut from a very thin sheet of mica. Has anyone ever measured the thickness?

On February 13th, when the crystals were falling near Kew Observatory, the temperature was 21°F. The relative humidity was 83 per cent. with respect to vapour over water and therefore 88 per cent. with respect to vapour over ice. It is clear that the crystals must have come from a level where the relative humidity was greater. It is remarkable that such frail structures had not evaporated in their slow descent.

May I refer also to a very curious ice formation which occurred in a wood on the Chiltern Hills on January 26th? This formation was only found on two fallen trees a considerable distance apart. The ice was in threads and formed masses which looked like asbestos. The threads melted at a touch but they were so strong that a piece of wood covered with them could be carried in the hand for miles. In some cases, if not in all, the asbestos-like threads were between the wood of the tree and the bark. The fibres may possibly have been formed like the ice structure in Mr. Langley's bowl, each fibre being forced out of a pore in the saturated wood. I should be glad to learn of any published description of this phenomenon.

F. J. W. Whipple.

Kew Observatory, Richmond.

[With reference to the last paragraph I have observed a very similar formation of fibrous ice on the surface of saturated lumps of chalk and formed the same explanation, namely, that the ice was forced out of the pores of the chalk during the process of freezing. It resembled a layer of fibrous calcite, but melted on being handled.—C. E. P. Brooks.]

Smoke Cloud

On March 9th I was on Leith Hill when a great fire, which I ascertained afterwards must have been the one which destroyed the woods on the Fire Hills, near Hastings, was raging. The smoke cloud had a cumulus-like top. The elevation of the top was estimated as one-twentieth of the distance, *i.e.*, about 12,000 feet. The cloud stretched towards the northwest and the smoke from Hastings was being carried apparently beyond London to the Chiltern Hills.

It would be interesting to know whether these observations could be confirmed by the experience of aviators.

F. J. W. WHIPPLE.

Kew Observatory, Richmond, Surrey.

NOTES AND QUERIES

The Dry Period, January to March, 1929

The dry weather of January to March 1929 falls naturally into three phases, the main characteristics of which are shown by the monthly rainfall maps. During January the more prevalent west winds were replaced by drier northerly winds. Over Scotland as a whole the month was the driest January since that of 1881. Falls in excess of the average occurred along the east coast from the Cheviots to east Anglia, while there was less than half the average over the western half of Scotland, the north-west of England, most of Wales and the western half of Ireland. During the greater part of February south-easterly winds prevailed over Great Britain, while Ireland came under the influence of south-westerly winds. The rainfall exceeded the average for the month practically everywhere in Ireland and reached twice the average in the south-east. Over most of England there was only 30 to 50 per cent. of the average, while the northern half of Scotland was again very dry having large areas with less than 25 per cent. The weather of March was dominated by high-pressure systems centred over the British Isles, and the drought was intensified. The total for the month was everywhere less than half the usual amount and over a broad strip along the east coast from the Grampians to Margate and over much of south-eastern England there was less than 10 per cent. Over the country as a whole March 1929 was the driest March since before 1870 and ranks with February 1891 and June 1925 as the driest months in 60 years.

The general values for the rainfall of each month and for the whole period are set out below as percentages of the average amounts.

	January	February	March	Jan.-March
	%	%	%	%
England and Wales	71	49	13	45
Scotland	49	54	24	43
Ireland	57	129	24	70
British Isles	63	67	18	50

January to March 1929 was drier than any similar period in the last 60 years, the next driest being that of 1891 with 60 per cent. of the average. The rainfall of January to March 1929 reached half the average over practically the whole of Ireland as well as along parts of the east and south coasts of Great Britain. Over most of England and Wales and Scotland the totals were between 30 and 45 per cent. of the average, while in the neighbourhood of London, in the English Lake District and in Ross-shire there was less than 30 per cent. The falls at representative stations in these regions are given below:—

	Rainfall, Jan.-Mar., 1929.	
	in.	*% of average.*
London (Camden Square) ...	1·55	29
Borrowdale (Seathwaite) ...	9·75	27
Alness (Ardross Castle) ...	2·25	22

At Ardross Castle the period included both the driest January and the driest March of the last 60 years of comparable data, and the total rainfall was less than that of any other three consecutive months. The driest three consecutive months at these stations were:—

London, March-May, 1893, with 1·36in.,
Seathwaite, April-June, 1921, with 9·51in., and
Ardross Castle, April-June, 1887, with 3·42in.

At a number of stations near London, March was rainless and over most of the south-eastern half of England and to the east of the Pennines the fall was trifling, being about one-tenth of an inch. At Gloucester the total for January to March was only 1·27in. and at Shoeburyness only 1·18in., but conditions do not seem to have been as severe (up to the end of March) as during the famous spring drought of 1893 when in the south-east of England there was no rain for a period of 50 days and only about 1·1in. during 110 days. J. GLASSPOOLE.

The Alabama and the Mississippi Floods

Two years after the great disaster of the Mississippi floods in 1927 floods are again reported from the Mississippi area and from Alabama in March, 1929, though not to the same extent.

According to the *Weekly Weather and Crop Bulletin* of the United States Department of Agriculture extremely cold weather with unusually heavy snow was experienced in the States northwards of the Ohio and Missouri valleys during January, the heavy snow in the western Lake region and upper Mississippi valley constituting a record there for this month. Further south the precipitation varied little from the normal. In February the mean temperature was below normal generally over the United States, but for the eastern states the area of coldest weather was further south than in January. The precipitation was also differently distributed, being generally below normal in a belt from Lake Erie to Texas and above normal to the southeast of this. Alabama, Georgia and southern Mississippi lay well within the most notable wet region, where the amounts at some places were about twice the normal fall. Two periods of excessive rainfall occurred at the end of February and beginning of March, viz., February 26th-27th and March 3rd-4th, making the total rainfall for the week ending March 5th considerably in excess of the normal in Alabama, Georgia and southern Mississippi; the total at Macon being 12·5in. or 11·4in above normal and at Montgomery 12·0in. or 10·7in. above normal. Both these periods of excessive rainfall succeeded sharp rises in temperature and were associated with severe thunderstorms. Reports that flood stages had been reached in the rivers of the eastern cotton States followed quickly, as the rising temperatures had also caused the snow to melt on the upper reaches of the rivers. For the next few days there was scarcely any rain as a large anticyclone moved eastwards across the States accompanied by a rapid fall of temperature. By the 12th, however, this was replaced by a series of depressions which brought wet weather with southerly winds and rising temperatures again to the Gulf States. Heavy falls of rain were reported on the 12th, 13th and 14th, as much as 8·92in. falling at Mobile on the 14th, making the total there for the week ending March 19th, 15·5in. or 14·0in above normal. Floods were first reported on the early morning of the 14th, when Elba, Alabama, at the confluence of the Pea River with the Big and Whitewater Creeks was isolated from the surrounding country. During the next few days the town became completely submerged except for the upper storeys of some houses. The floods continued until about the 17th when the flooded area extended from Chattahoochee River on the Georgia border of Alabama to Tombigbee at the other side of the State, and from Montgomery southward to below the Florida border. Twenty thousand people were driven from their homes. On the 18th these rivers started to fall.

Owing to further heavy rains on the 21st and 22nd the Mississippi river, which was still in flood, burst the levee twice, at Point Pleasant, six miles north of Quincy, Illinois on the 21st, and at Quincy on the 22nd flooding rich farm land in the Indian Grave district. Fortunately these breaks had been anticipated and much of the livestock and personal belongings of the residents had been moved previously to higher ground. The Iowa River inundated 1,500 acres of land near Wapello, Iowa, on the 21st.

Torrential rains and tornadoes caused much loss of life and material damage in the States of Tennessee, Kentucky, Mississippi, Alabama and Georgia on the 23rd. No subsequent information is available but this absence of news suggests that conditions in the flooded areas have gradually improved.

The Adjustment of a Sunshine Recorder

It is customary, when examining sunshine cards from a recorder which has recently been installed or from a recorder which has not been securely fixed to its support, to see whether the burns which constitute the records run parallel to the central lines of the cards, and to assume that the recorder is correctly adjusted if that condition is satisfied.

It may therefore be useful to state that although this condition is necessary for the correct adjustment of a sunshine recorder, it does not form a sufficient guarantee that the recorder is correctly adjusted. It is possible to arrange that the level adjustment (in an east-west direction) and the azimuth adjustment are both incorrect (though related to one another) and still secure parallelism of burns to the central lines of the cards. When this occurs the recorder does not indicate local apparent time (L.A.T.) as it should, but L.A.T. increased or decreased by a constant interval of time.

A simple way of looking at the matter is to remember that parallelism of burns implies that the axis of the bowl of the recorder is parallel to the polar axis and that the sphere is in the centre of the bowl. Hence a rotation of the bowl about its axis will not disturb the parallelism of the burns. In practice, such rotation would correspond with mutually related errors of time, azimuth and east-west level.

If a is the angle in degrees through which the bowl is rotated beyond its correct position about its axis, the error in time is $\frac{a}{15}$ hours. It can be shown that if θ is the latitude, the corresponding error in level in the east-west direction is $a \cos \theta$, and the error in azimuth is $a \sin \theta$.

Thus, suppose the error in time is a quarter of an hour, then

$$\frac{a}{15} = \frac{1}{4}$$

$$\text{and} \quad a = 3\tfrac{3}{4}^{\circ}$$

The necessary tilt of the instrument in an east-west direction to secure parallelism of burns in latitude 55° is 3.75 × .57 = 2.1°, and the necessary error in azimuth is 3.75 × .82 = 3.1°.

This combination of errors will not occur if care is taken to ensure that any one of the three adjustments of time level and azimuth is correct. Probably the best course to follow is to verify that the instrument records local apparent time at noon. The other adjustments may, however, be tested instead.

Obituary

We regret to learn of the death on March 21st, in his 90th year, of Prof. Dr. August von Schmidt, formerly Head of the Meteorological Geophysical section of the Wurttembergisches Statistisches Landesamt, Stuttgart.

The Weather of March, 1929

Quiet, dry, sunny weather with a large diurnal range of temperature and much morning mist prevailed generally over the British Isles during March. On the 1st the northwestern districts were under the influence of a depression centred near Iceland and strong to high southerly winds were experienced there, but by the 3rd the anticyclonic conditions in the eastern districts extended over the country generally. During the first five or six days, day temperatures, though higher than those experienced at the end of February, were yet below the normal for the beginning of March except at a few places on odd days notably in southern Scotland. On the 7th and 8th there was a change to southeasterly winds in the west and the days became sunny and warm over the whole country. From the 8th to 11th 60°F. was exceeded in many places while 70°F. was reached at Norwich and Hull on the 9th, and the hours of bright sunshine exceeded 10 at many places in the south and 9 in the north of England, *e.g.*, Brighton had 10·7hrs. on the 9th and Durham 9·9hrs. on the 8th. Severe night frosts were experienced during all this time and indeed almost throughout the month though by far the lowest readings were at the beginning when 10°F. in the screen and 2°F. on the ground were recorded at Rhayader on the 1st. The diurnal range of temperature was greatest on the 8th-11th, 20th and 28th-30th when it exceeded 40°F. at a few places.* After the 11th light north to northeasterly winds brought cooler weather generally and the morning mist or fog persisted during the greater part of the day at several places. On the 16th the anticyclone moved away eastwards so that the British Isles again had southeasterly winds backing south. Temperature, however, only rose gradually, 65°F. not occurring

*See p. 81.

until the 19th and 20th when the winds had become southwest and Ireland and Scotland were under the influence of a depression near Iceland. Over 9hrs. sunshine occurred generally in the Midlands and southeastern England but along the East Anglian coast fog persisted occasionally throughout the day, preventing the temperature from rising, *e.g.*, the maximum was 34°F. at Gorleston on the 19th and 20th and 35°F. at Clacton on the 19th. On the 20th and 21st a shallow secondary passed across Ireland, Wales and Scotland and heavy rain fell locally, 1·35in. at Treherbert, Glamorgan, on the 21st and 0·91in. at Kilmacthomas, Waterford, on the 20th. For the next four or five days there were southwesterly winds, with slight to moderate rain in the west and north, and varying amounts of sunshine, the most occurring in southern England. On the 25th the anticyclone centred near the Azores spread over the British Isles and fine sunny weather with a gradually rising temperature was experienced until the 31st when the retreat of the anticyclone towards the southwest brought northwesterly winds and cooler weather. During the warm spell record temperatures were obtained, 70° and above being recorded at many stations over the whole of England and Ireland on all four days, the highest was 75°F. at Ilkley on the 28th and at Collumpton on the 30th. The total rainfall for the month over the whole country was very scanty, several places having less than 0·1in.* Sunshine totals for the month were far above normal, the distribution being as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	131	+26	Valentia	197	+74
Aberdeen	145	+28	Liverpool	180	+72
Dublin	201	+78	Falmouth	171	+33
Birr Castle	192	+82	Kew	146	+41

Pressure was above normal over the whole of western Europe, Iceland and Bermuda, the greatest excess being 16·5mb. at Malin Head; and below normal over northern Scandinavia, Spitsbergen and the North Atlantic from Madeira to Newfoundland, the greatest deficit being 6·6mb. at Horta. Except for central Europe, temperature was above normal especially in northern Sweden and Spitsbergen. At the latter place it was as much as 16°F. above normal. Precipitation was scanty in southern and central Europe and below normal even as far north as Vardo, except in western Norrland where it was abundant. At Spitsbergen it was slightly above normal. For the first time since 1893 ice floes were seen floating down the Bosporus during the first days of the month. Propelled by the current and a strong north wind they reached the Sea of Marmora. On the 3rd the weather in the neighbourhood again

* See p. 71.

became very cold with heavy snowfalls which interrupted the railway communications. On the 2nd and 3rd severe gales occurred in northern Italy, the northern Adriatic and Austria, and from the 1st—4th cold snowy weather was experienced in Berlin. For several days at the beginning of the month the ferry services connecting Denmark, Germany and Sweden had to be suspended on account of the ice; they were resumed generally about the 8th. Owing to the prolonged dry weather large stretches of forest were destroyed by fire in the Cher and Touraine regions of France on the 11th and in parts of Switzerland between the 12th and 17th. By the 12th the greater part of the Rhine had become free of ice, and on the 14th it was reported that the ice in the Yugoslav section of the Danube and in the Save was breaking up. Slight rain fell in all parts of Switzerland on the 23rd and 24th, thus bringing to an end the drought which had lasted there for 24 days. Cool weather with strong winds and much rain at times occurred in Germany during the last days of the month.

After an unusually long drought, rain fell in torrents in Madeira causing floods and a landslip on the northern coast of the island on the morning of the 6th. About 40 people were killed. Gales were experienced on the North Atlantic early in the month.

Heavy rains in the Otago Province of New Zealand caused extensive floods there, especially in Dunedin, about the 20th. Serious damage was done to the crops and property and the railway lines were breached.

Owing to heavy rains floods were experienced in Mississippi, Alabama, Georgia and Iowa.* A severe thunderstorm followed by heavy rain occurred at Ottawa on the 25th.

The special message from Brazil states that in the north and south rainfall was 3·66in. and 1·54in. respectively above normal, but in the centre it was 1·11in. below normal. Seven anticyclones passed over the country; during the last ten days the weather was abnormally cold and windy in the centre and south and very early frosts occurred in Parana. Coffee crops continued in exceptionally good condition. At Rio de Janeiro pressure was 0·2mb. below normal and temperature 0·2°F. below normal.

Rainfall, March, 1929.—General Distribution

England and Wales	13	per cent. of the average 1881-1915.
Scotland...	24	
Ireland	24	
British Isles	18	

*See p. 72.

Rainfall: March, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden. Square	·01	0	*Leics* .	Belvoir Castle	·07	4
Sur .	Reigate, The Knowle	·02	1	*Rut* .	Ridlington	·08	...
Kent .	Tenterden, Ashenden	·04	2	*Linc* .	Boston, Skirbeck	·28	18
,, .	Folkestone, Boro. San.	·18	...	,, .	Lincoln, Sessions House	·32	21
,, .	Margate, Cliftonville	·16	10	,, .	Skegness, Marine Gdns	·16	10
,, .	Sevenoaks, Speldhurst	·03	...	,, .	Louth, Westgate	·31	15
Sus .	Patching Farm	·12	6	,, .	Brigg, Wrawby St.	·16	...
,, .	Brighton, Old Steyne	·08	4	*Notts* .	Worksop, Hodsock	·06	4
,, .	Tottingworth Park	·15	6	*Derby* .	Derby, L. M. & S. Rly.	·21	12
Hants .	Ventnor, Roy. Nat. Hos.	·25	12	,, .	Buxton, Devon Hos.	·87	21
,, .	Fordingbridge, Oaklnds	·20	9	*Ches* .	Runcorn, Weston Pt.	·57	28
,, .	Ovington Rectory	·10	4	,, .	Nantwich, Dorfold Hall	·47	...
,, .	Sherborne St. John	·07	3	*Lancs* .	Manchester, Whit. Pk.	1·01	45
Berks .	Wellington College	·01	0	,, .	Stonyhurst College	1·67	45
,, .	Newbury, Greenham	·12	5	,, .	Southport, Hesketh Pk	·84	38
Herts .	Benington House	·04	2	,, .	Lancaster, Strathspey	·98	...
Bucks .	High Wycombe	·06	3	*Yorks* .	Wath-upon-Dearne	·05	3
Oxf .	Oxford, Mag. College	·08	5	,, .	Bradford, Lister Pk.	·28	12
Nor .	Pitsford, Sedgebrook	·19	10	,, .	Oughtershaw Hall	1·75	...
,, .	Oundle	·07	...	,, .	Wetherby, Ribston H.	·51	26
Beds .	Woburn, Crawley Mill	·10	6	,, .	Hull, Pearson Park	·12	7
Cam .	Cambridge, Bot. Gdns.	·03	2	,, .	Holme-on-Spalding	·15	...
Essex .	Chelmsford, County Lab	·06	3	,, .	West Witton, Ivy Ho.	·14	...
,, .	Lexden Hill House	·02	...	,, .	Felixkirk, Mt. St. John	·23	12
Suff .	Hawkedon Rectory	·03	2	,, .	Pickering, Hungate	·20	...
,, .	Haughley House	·04	...	,, .	Scarborough	·13	7
Norf .	Norwich Eaton	·07	4	,, .	Middlesbrough	·11	7
,, .	Wells, Holkham Hall	·16	10	,, .	Baldersdale, Hury Res.	·32	...
,, .	Little Dunham	·27	14	*Durh* .	Ushaw College	·13	6
Wilts .	Devizes, Highclere	·16	8	*Nor* .	Newcastle, Town Moor	·51	24
,, .	Bishops Cannings	·38	17	,, .	Bellingham, Highgreen	·26	...
Dor .	Evershot, Melbury Ho.	·43	14	,, .	Lilburn Tower Gdns.	·19	...
,, .	Creech Grange	·08	...	*Cumb* .	Geltsdale	·60	...
,, .	Shaftesbury, Abbey Ho.	·18	8	,, .	Carlisle, Scaleby Hall	·61	25
Devon .	Plymouth The Hoe	·75	26	,, .	Borrowdale, Seathwaite	2·15	20
,, .	Polapit Tamar	·40	13	,, .	Borrowdale, Rosthwaite	1·73	...
,, .	Ashburton, Druid Ho.	·46	10	,, .	Keswick, High Hill	·80	...
,, .	Cullompton	·25	9	*Glam* .	Cardiff, Ely P. Stn.	·59	18
,, .	Sidmouth, Sidmount	·23	9	,, .	Treherbert, Tynywaun	1·97	...
,, .	Filleigh, Castle Hill	·48	...	*Carm* .	Carmarthen Friary	2·03	53
,, .	Barnstaple, N. Dev. Ath.	·49	19	,, .	Llanwrda	1·28	28
Corn .	Redruth, Trewirgie	·72	20	*Pemb* .	Haverfordwest, School	1·55	...
,, .	Penzance, Morrab Gdn.	·54	17	*Card* .	Aberystwyth	·84	...
,, .	St. Austell, Trevarna	·45	13	,, .	Cardigan, County Sch.	·34	...
Soms .	Chewton Mendip	·23	6	*Brec* .	Crickhowell, Talymaes	·50	...
,, .	Long Ashton	·55	...	*Rad* .	Birm W. W. Tyrmynydd	·53	10
,, .	Street, Millfield	·20	...	*Mont* .	Lake Vyrnwy	1·24	29
Glos. .	Cirencester, Gwynfa	·24	10	*Denb* .	Llangynhafal	·08	...
Here .	Ross, Birchlea	·17	8	*Mer* .	Dolgelly, Bryntirion	1·76	36
,, .	Ledbury, Underdown	·11	6	*Carn* .	Llandudno	·17	8
Salop .	Church Stretton	·33	14	,, .	Snowdon, L. Llydaw 9	...	...
,, .	Shifnal, Hatton Grange	·22	12	*Ang* .	Holyhead, Salt Island	·55	21
Worc .	Ombersley, Holt Lock	·12	7	,, .	Lligwy	·81	...
,, .	Blockley	·07	...	*Isle of Man*			
War .	Farnborough	·08	4		Douglas, Boro' Cem.	1·29	44
,, .	Birminghm, Edgbaston	·16	8	*Guernsey*			
Leics .	Thornton Reservoir	·13	7		St. Peter P't. Grange Rd.	·06	24

Rainfall: March, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	·73	28	*Suth* .	Loch More, Achfary ...	1·97	31
,, .	Pt. William, Monreith	1·14	...	*Caith* .	Wick	·88	39
Kirk .	Carsphairn, Shiel.	1·46	...	*Ork* .	Pomona, Deerness	·89	32
,, .	Dumfries, Cargen	·77	21	*Shet* .	Lerwick	1·20	38
Dumf.	Eskdalemuir Obs.	1·10	22	*Cork* .	Caheragh Rectory	1·61	...
Roxb .	Branxholm	·46	16	,, .	Dunmanway Rectory...	2·05	42
Selk .	Ettrick Manse	...	...	,, .	Ballinacurra	·87	31
Peeb .	West Linton	·65	...	,, .	Glanmire, Lota Lo. ...	1·06	34
Berk .	Marchmont House......	·17	6	*Kerry*.	Valentia Obsy.	1·37	30
Hadd.	North Berwick Res. ...	·34	18	,, .	Gearahameen	2·90	...
Midl .	Edinburgh, Roy. Obs.	·20	11	,, .	Killarney Asylum	·78	17
Ayr .	Kilmarnock, Agric. C.	1·22	44	,, .	Darrynane Abbey	1·18	29
,, .	Girvan, Pinmore	1·13	30	*Wat* .	Waterford, Brook Lo...	1·01	37
Renf .	Glasgow, Queen's Pk. .	·90	35	*Tip* .	Nenagh, Cas. Lough...	1·04	34
,, .	Greenock, Prospect H.	1·47	30	,, .	Roscrea, Timoney Park	·95	...
Bute .	Rothesay, Ardencraig.	1·67	47	,, .	Cashel, Ballinamona...	·69	25
,, .	Dougarie Lodge	1·33	...	*Lim* .	Foynes, Coolnanes......	·81	27
Arg .	Ardgour House	1·90	...	,, .	Castleconnel Rec.	1·19	...
,, .	Manse of Glenorchy ...	1·73	...	*Clare* .	Inagh, Mount Callan...	1·54	...
,, .	Oban	1·62	...	,, .	Broadford, Hurdlest'n.	·11	...
,, .	Poltalloch	1·26	33	*Wexf*.	Newtownbarry	...	...
,, .	Inveraray Castle...	2·36	37	,, .	Gorey, Courtown Ho ..	·59	26
,, .	Islay, Eallabus	1·04	27	*Kilk* .	Kilkenny Castle.........	·81	35
,, .	Mull Benmore	8·10	...	*Wic* .	Rathnew, Clonmannon	·52	...
,, .	Tiree	·69	...	*Carl* .	Hacketstown Rectory..	1·10	39
Kinr .	Loch Leven Sluice......	·53	18	*QCo* .	Blandsfort House	·89	34
Perth .	Loch Dhu	1·65	25	,, .	Mountmellick...........	1·01	...
,, .	Balquhidder, Stronvar	·72	...	*KCo* .	Birr Castle	·53	22
,, .	Crieff, Strathearn Hyd.	·57	18	*Dubl* .	Dublin, FitzWm. Sq...	·22	11
,, .	Blair Castle Gardens ...	·66	25	,, .	Balbriggan, Ardgillan.	·42	...
,, .	Dalnaspidal Lodge ...	1·23	25	*Me'th* .	Beauparc, St. Cloud...	·51	...
Forf .	Kettins School	·56	25	,, .	Kells, Headfort	·71	26
,, .	Dundee, E. Necropolis	·42	20	*W.M* .	Moate, Coolatore	·52	...
,, .	Pearsie House...........	1·05	...	,, .	Mullingar, Belvedere..	·61	23
,, .	Montrose, Sunnyside...	·17	8	*Long* .	Castle Forbes Gdns......	·52	18
Aber .	Braemar, Bank	·31	10	*Gal* .	Ballynahinch Castle ...	·93	18
,, .	Logie Coldstone Sch....	·19	7	,, .	Galway, Grammar Sch.	1·15	...
,, .	Aberdeen, King's Coll.	·22	9	*Mayo* .	Mallaranny..............	·97	...
,, .	Fyvie Castle	·39	...	,, .	Westport House.........	·30	8
Mor .	Gordon Castle	·25	11	,, .	Delphi Lodge	1·52	...
,, .	Grantown-on-Spey ...	·24	9	*Sligo* .	Markree Obsy...........	·51	15
Na .	Nairn, Delnies	·33	18	*Cav'n*.	Belturbet, Cloverhill...	·55	20
Inv .	Kingussie, The Birches	·46	..	*Ferm* .	Enniskillen, Portora...	·20	...
,, .	Loch Quoich, Loan ...	4·30	...	*Arm* .	Armagh Obsy...........	·34	14
,, .	Glenquoich..............	3·96	41	*Down*.	Fofanny Reservoir......	·93	...
,, .	Inverness, Culduthel R.	·25	...	,, .	Seaforde	·62	21
,, .	Arisaig, Faire-na-Squir	1·01	...	,, .	Donaghadee, C. Stn ...	·56	25
,, .	Fort William	1·83	...	,, .	Banbridge, Milltown...	·29	...
,, .	Skye, Dunvegan	2·05	...	*Antr* .	Belfast, Cavehill Rd ...	·81	...
R & C.	Alness, Ardross Cas. ...	·61	19	,, .	Glenarm Castle	·66	...
,, .	Ullapool	1·96	...	,, .	Ballymena, Harryville	·51	16
,, .	Torridon, Bendamph...	1·94	26	*Lon* .	Londonderry, Creggan	·85	27
,, .	Achnashellach	3·20	...	*Tyr* .	Donaghmore	·43	...
,, .	Stornoway	1·23	30	,, .	Omagh, Edenfel.........	·48	15
Suth .	Lairg	1·59	...	*Don* .	Malin Head..............	·32	...
,, .	Tongue	·58	17	,, .	Dunfanaghy	25	...
,, .	Melvich	1·05	37	,, .	Killybegs, Rockmount.	·90	18

Climatological Table for the British Empire, October, 1928.

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	PRECIPITATION: Diff. from Normal	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
London, Kew Obsy.	1011·3	— 2·7	66	31	58·3	44·4	51·3	+ 1·4	46·5	91	7·0	3·61	+ 0·91	21	3·6	34
Gibraltar	1017·9	+ 0·7	81	52	72·8	60·5	66·7	+ 0·6	59·4	82	4·5	0·71	— 2·60	5	..	..
Malta	1017·5	+ 0·9	90	61	76·3	67·7	72·0	+ 1·1	66·9	78	5·6	1·28	— 1·59	7	7·7	68
St. Helena	1014·8	+ 2·6	65	52	61·4	54·0	57·7	— 1·1	55·1	93	9·6	0·98	— 0·93	14	..	..
Sierra Leone	1014·3	+ 2·7	88	68	84·1	71·6	77·9	— 2·2	75·3	85	5·0	16·41	+ 3·79	21	..	..
Lagos, Nigeria	1010·2	— 1·5	86	69	83·9	73·9	78·9	— 0·6	75·7	86	6·5	12·67	+ 4·91	20	..	..
Kaduna, Nigeria	1014·7	+ 2·4	93	..	88·2	..	..	..	72·1	74	..	3·03	+ 0·85	8	..	..
Zomba, Nyasaland	1009·7	— 1·2	92	57	87·2	64·8	76·0	+ 1·9	..	55	2·0	0·08	— 1·44	2	..	..
Salisbury, Rhodesia	1007·4	— 1·0	95	49	88·6	59·0	73·8	+ 3·1	58·1	29	1·0	0·35	— 0·79	2	10·7	86
Cape Town	1018·3	+ 0·9	88	46	70·2	52·9	61·5	+ 0·3	56·1	78	5·6	0·87	— 0·77	8	..	..
Johannesburg	1012·8	— 0·5	87	35	75·5	54·2	64·9	+ 2·2	53·4	53	3·1	2·35	— 0·21	9	9·3	73
Mauritius	1017·9	— 0·3	84	56	79·3	62·8	71·1	— 1·6	65·7	57	5·7	0·60	— 0·78	7	9·5	76
Bloemfontein	..	..	91	33	78·9	49·1	64·0	— 0·6	52·8	48	3·0	1·43	— 0·25	7	..	..
Calcutta, Alipore Obsy.	1009·5	+ 0·1	92	74	88·6	77·1	82·9	+ 2·2	78·1	91	6·3	2·83	— 1·36	6*	..	..
Bombay	1008·8	— 1·0	95	73	88·4	76·4	82·4	+ 0·1	76·5	85	4·0	0·43	— 1·24	2*	..	..
Madras	1007·9	— 1·0	94	74	88·5	76·3	82·4	+ 0·1	77·7	86	5·5	20·81	+ 9·09	14*	..	..
Colombo, Ceylon	1010·6	+ 0·3	88	72	84·0	75·5	79·7	— 0·6	76·3	79	8·7	24·70	+ 11·58	28	4·7	39
Hongkong	1015·2	+ 1·6	83	67	80·1	71·1	75·6	— 1·3	67·1	61	3·3	0·43	— 4·42	4	8·5	73
Sandakan	..	..	91	73	88·0	74·2	81·1	— 0·4	76·7	79	..	8·55	— 1·45	11	..	..
Sydney	1009·0	— 5·9	98	50	74·6	56·8	65·7	+ 2·2	56·5	47	4·1	1·65	— 1·56	10	7·9	63
Melbourne	1007·9	— 6·8	77	38	65·5	47·7	56·6	— 1·0	51·3	60	7·5	2·17	— 0·42	21	5·8	44
Adelaide	1010·5	— 5·5	91	43	69·1	51·0	60·1	— 1·8	52·3	53	6·2	2·43	+ 0·69	17	6·6	51
Perth, W. Australia	1015·2	— 1·6	75	42	66·7	49·9	58·3	— 2·7	54·1	60	5·7	1·78	— 0·40	16	8·1	63
Coolgardie	1011·8	— 3·4	92	35	76·6	47·8	62·2	— 1·4	51·6	39	2·8	0·88	+ 0·14	3	..	..
Brisbane	1012·1	— 4·1	93	52	81·7	63·0	72·3	+ 2·5	65·2	60	3·7	1·29	— 1·28	7	7·8	61
Hobart, Tasmania	1001·0	— 9·6	70	35	58·5	43·7	51·1	— 2.9	46·5	65	6·7	4·20	+ 1·94	25	6·3	48
Wellington, N.Z.	1006·3	— 6·8	68	38	58·8	48·7	53·7	— 0·6	51·0	78	7·6	5·32	+ 1·24	16	5·6	42
Suva, Fiji	1012·8	— 0·4	92	67	83·0	71·3	77·1	+ 1·1	72·0	71	5·8	1·57	— 6·23	13	7·0	56
Apia, Samoa	1011·0	— 0·5	87	70	85·5	74·1	79·8	+ 1·4	77·1	76	3·5	7·62	+ 1·56	14	8·3	67
Kingston, Jamaica	1012·0	+ 0·5	91	69	87·7	72·1	79·9	— 0·6	71·5	88	5·3	5·57	— 1·89	8	6·8	58
Grenada, W.I.	1008·6	— 2·0	90	71	87·5	74·4	80·9	+ 0·8	77·3	81	4·6	4·16	— 3·49	21	..	..
Toronto	1018·0	0·0	84	23	58·8	42·8	50·8	+ 3·9	44·4	80	5·2	2·94	+ 0·48	13	4·8	43
Winnipeg	1016·6	+ 1·3	68	16	50·0	32·5	41·3	+ 0·5	..	..	6·5	0·42	— 1·01	5	3·9	36
St. John, N.B.	1017·3	+ 0·8	67	22	53·8	39·9	46·9	+ 1·6	43·2	81	6·0	4·18	— 0·36	15	4·8	44
Victoria, B.C.	1017·8	+ 0·2	63	41	53·7	46·0	49·9	— 0·5	48·4	88	8·0	3·58	+ 1·03	17	2·7	25

* For Indian stations a rain day is a day on which 0.1 in. or more rain has fallen.

M.O. 313.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 64

May 1929

No. 760

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

Sir Gilbert Walker's formula for Ceara's droughts
Suggestions for its physical explanation

By SAMPAIO FERRAZ

Director of the Brazilian Meteorological Service

It was a grateful surprise for Brazilian meteorologists when Sir Gilbert Walker published his study of the famines of Ceará (Brazil) in the light of the general air circulation, and his masterly effort to draw up a forecasting formula for them, based on the relations between that State's rainfall and the conditions at the "centres" of the "southern oscillation."* The retrospective verification of the formula from 1926 to 1876 is certainly encouraging and represents another well-won fight for the correlation workers under the intense leadership of the

*GILBERT T. WALKER. Ceará (Brazil) famines and the general air movement. *Beitr. Phys. frei Atmosph., Leipzig*, 14, 1928, pp. 88-93.

The regression formula developed by Sir Gilbert Walker takes the form

[Ceará] = ·44 [Santiago] +·20 [Honolulu] —·10 [Cape] —·42 [S. Rhodesia] —·22 [St. Helena]

where the sign [ ] indicates that the unit of measurement is the standard deviation.

Ceará rainfall for Jan.-June is compared with the following data for the preceding year:

Santiago	pressure	June-August.
Honolulu	pressure	June-November.
Cape Town	pressure	September-November.
S. Rhodesia	rainfall	July-November.
St. Helena	wind	September-November.

(84196) P.S. 1602/81. 1,050 5/29 M. & S. Gp. 303.

author. The predicting equation is based on positive coefficients with Santiago's and Honolulu's pressure, and negative coefficients with Cape Town's pressure. Southern Rhodesia's rainfall and St. Helena's wind.

I would like to offer a few suggestions for possible physical explanations of such relations. In 1925 (*Causas provaveis das sêccas do Nordeste Brasileiro*), I attempted to show that the north-east droughts were coincident with a very reduced frequency of the migratory anticyclones or with their abnormally southern tracks, and that excessive precipitation was always connected with northerly tracks and more active circulation of the general eastward currents of lower and upper air. In the drought years the large continental area of low pressure is very persistent, and often the highs that are able to get into the Argentine are kept violently back or dissipated by it. Naturally, as would be expected, drought years are also notable for stronger winds in the famine regions, but there are exceptions. As I had before explained the enigmatic winter rainfall of Pernambuco and contiguous States by the action of the anticyclones, and considering they are felt as "friagens"—cold and dull spells—as far north as the Jurua in the Amazon Valley, and certainly do affect energetically the weather of Fernando Noronha, I thought they could perhaps influence the famine region through the upper air, altering substantially its vertical lapse rate of temperature. The lower currents of cold air are not able to reach the north-east overland as they do the Jurua on account of large orographic systems, but the higher air should be able to arrive there when the massive westerly currents that carry the anticyclones are abnormally active and run in lower parallels, too much so for the season.

I am under the impression that too little attention has been paid by meteorologists to the powerful influence of abnormally cold upper currents between the tropics. And yet our daily charts exhibit frequently this influence as the biggest rainmaker. I go even further, admitting that the more intense and less obstructed South Atlantic anticyclones are responsible for the northward shifting of the doldrums, and would be led to explain Durst's assertion regarding rainfall of that region coinciding more often with cooler air, by the frequent northern rushes of those systems. From Fernando Noronha to the doldrums the distance is not prohibitive. We must remember that nowhere else in the southern hemisphere do the moving highs have such regular north-easterly tracks as in the Atlantic.

Cuyaba's pressure and Ceará's rainfall have a contemporary correlation coefficient of 0·54 (Jan.-June). Santiago and Ceará have a similar coefficient of 0·49. I should say Sir Gilbert Walker's Santiago coefficient for June-August could be explained by persistence, because the two periods June-August and

January-June are fairly well correlated (0·43). Highs which run to the Atlantic without appreciable land track will to some extent increase the south-east trades, and may contemporaneously help to reduce Ceará's rainfall. South African highs, such as are formed between the two continents, not necessarily connected with the South American highs, may possibly and indirectly affect Ceará's rainfall. They would increase Cape Town's pressure, St. Helena's wind and, according to our views, Southern Rhodesia's rainfall, acting through the upper air. As a matter of fact Bliss has given us negative low coefficients for such a relation, but Sir Gilbert Walker's cross coefficient of 0·50 for July-November and September-November, between Southern Rhodesia and Cape Town, comes to our support, noting that Southern Rhodesia's precipitation in July and August is insignificant.

The three last factors of the predicting equation will represent a diminution of the temperature of the oceanic current which five months later (from St. Helena and south of it) will run offshore the famine region of Brazil. All of them really stand for conditions which reduce that temperature, and the potential humidity of the trades.

In proposing these suggestions my objective is to interpret Sir Gilbert Walker's formula in the light of such factors as can be indicated as responsible for the droughts of north-eastern Brazil. Putting aside such factors as upper air inversions, and absence of forced ascensions of air brought about by under and over-running of currents, things that may occur above without our knowledge, but are not likely in those regions, we may consider the three others—(*a*) breaking up of convective activity by abnormally strong trades; (*b*) absence of cold upper currents from higher latitudes; (*c*) diminution of humidity in the trades. All these conditions are supposed to be frequent in drought years. Of the first two there are many eloquent indications; of the third there are no observations to support or oppose. As would be expected the second factor is only contrary to rainfall in the famine region; further north, in Maranhao, Para and in the Amazon it is a favourable factor, where the uprush of air is increased by accumulation.

In years of excessive rainfall in the north-eastern semi-arid regions, the maps do not show the usual orographic effect, which seems to favour my views.

These are mere suggestions. In the forecasting treatise which I am writing, and where the South Atlantic and South American air circulations are dealt with in detail, at least as far as the data available will allow, all these points are more clearly put down and an effort is made to base them on observations rather than on suppositions.

An attempt was also made to introduce a slight improvement in Sir Gilbert Walker's equation, considering the two big droughts of 1915 and 1919 are not predicted satisfactorily by it. I believed it would be bettered if increased by a factor which represented the activity of the continental depression. It must be remembered that Santiago gives us the frequency and intensity of incoming highs, but fails to represent the contrary effect of the equatorial currents upon them. Unfortunately, we have no long series of pressure or temperature observations in a strategic point of Brazil near the equator. Cuyaba is too far south, but is better than Santiago. I thought Samoa or Batavia would give us the factor needed, and a preliminary inspection of their temperature data in abnormal years of Ceará's rainfall, led us to introduce Samoa in the new equation, where also Punta Galera was placed instead of Santiago, on account of its higher coefficient. We were seriously handicapped, not having St. Helena's observations to work with. The new equation—[Ceará] = 0·67 [Punta Galera] − 0·39 [S. Rhodesia] − 0·16 [Cape] − 0·13 [Samoa], with a total correlation factor of 0·88, although it improved the forecasts for 1915 and 1919 a drought is indicated in 1914 which did not occur and rainfall deficiency appears to be exaggerated right through in the retrospective curve. New studies must be made, preserving St. Helena.

Punta Galera was handled only for the reason given. I do not believe it reliable, however, in longer series. Its high coefficient is surprising considering the position of that station, subject to the influence of the high-latitude lows. There is no persistence in the data as we note in Santiago. Cuyaba does not show it either. If a predicting formula should represent individual factors and not combinations of them, Santiago is a better station for picturing the incoming anticyclones. Another should be sought to represent the continental resistance (equatorial currents) with the indispensable persistence coefficient to make it available in a forecast equation. Or perhaps the "oscillation" principle to which I have not given any attention in this rapid study, may prove a bigger helper.

At any rate Sir Gilbert Walker's equation is a remarkable advance, and will certainly assist other workers in searching for improvements.

Sun Pillars, Crosses in the Sky, and Mock Suns

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

The occurrence on a Good Friday of a beautiful cross in the western sky has appealed to the imagination of the public and has led to a good deal of discussion in the newspapers. The Editor of the *Meteorological Magazine* has asked me for an explanation of the phenomenon. I am sorry that I have no complete explanation to give, but I think it will be worth while to consider in some detail the questions raised by this rare appearance in the sky.

It is clear from the published descriptions that there were three distinct phenomena seen on the evening in question, the vertical column or sun pillar which attracted general attention, the cross arms which were seen by numerous observers and the bright patch or mock sun which was detected at the intersection by the practised observers, Messrs. Russell and Goodman. A sun pillar is by no means an unusual sight, though such a fine one as was seen on Good Friday must be rare. There is no doubt as to the explanation. It was given in vivid language in a letter written to *The Times* by Dr. Louis Cobbett.

"I once in Switzerland saw a sun pillar, similar to that which appeared here (in Cambridge) on Good Friday, but descending instead of ascending from the sun. The latter was high in the sky at the time, and the line of light stretched downwards across the dark background of the Weisshorn into the depth of the Rhone Valley below. So far as I remember it had no particular colour. The air was sparkling with crystals, and little feathery six-rayed plates of ice were falling sparsely out of a clear blue sky. These, being very thin, were unable to fall edgeways, but were kept gently wobbling about a mean horizontal position, and it was obvious that it was from their surfaces that the light which formed the sun pillar was being reflected in much the same way as moonlight forms a pathway of light on the sea."

Another interesting description is given by Prof. E. W. MacBride, who made his observation in the Windsor Terminus of the Canadian Pacific Railway in Montreal. The air was full of minute crystals condensed from the steam produced by one or two large locomotives just outside the station and the part of the sun was played by a powerful electric light. He writes to me: "I can not clearly recollect whether I saw any halo round the electric light or trace of horizontal arcs. What remains clearly and ineffaceably imprinted on my memory is the image of the strongly marked vertical pillar. The air in the station must have been in a state of comparative quiet."

Dr. Cobbett's description justifies the assumption that sun pillars are produced by the reflection of light from flat crystals. Prof. MacBride's evidence indicates that such crystals can be produced artificially.

A marvellous feature of sun pillars such as that of Good Friday is the large area over which they are seen. On this occasion the pillar could be seen by anyone who looked at the western sky from anywhere in the eastern counties from Lincoln to Kent. It was also seen in Surrey, Berkshire, Hampshire and

Wiltshire. There were still more widely spread observations on March 13th, 1924, when the area covered included the half of England east of a line from Scarborough to Paignton. On Good Friday there was little visible cloud to catch the eye of a meteorological observer. The presence of the crystals was revealed only by the light which they reflected towards the spectators far to the east of them. How and why this enormous swarm of crystals was produced we cannot tell. The fact that the pillar was still visible half an hour after sunset is evidence for the great height of the swarm. It was too diffuse to be noticed as cloud however and it may have been at a lower level than the cirrus which was visible to some of the observers.

We have now to consider the horizontal arms of the cross. The crosses in the sky which have been recorded before nearly all occurred with the sun above the horizon and in most cases the sun or moon was at the intersection of the arms. That sort of cross can be regarded as the simultaneous appearance of a sun pillar and a part of the mock sun ring. The mock sun ring is believed to be produced by the reflection of light from the surfaces of little prisms floating in the air with their axes vertical. Why prisms do float sometimes in the upright position is still uncertain. It may be that each prism has a flat cap which acts as a parachute, it may be that each contains an air bubble near one end or it may be that needle-like prisms point up and down in a strong electric field, just as iron filings all point the same way in a strong magnetic field.

The Good Friday cross was not in this category. There is however a famous parallel. We quote from a letter written to *The Times* by Miss Barbara Carter: "A flaming cross such as that seen on Good Friday is described by Digno Compagni, the Florentine chronicler, as having appeared in the November of 1301. 'That evening,' he writes, 'there appeared in the sky a marvellous sign, to wit, a vermilion cross, over the palace of the Priors. Its stem was a palm and a half in width; its upright appeared to be 20 braccia long, the cross-piece a little less. It lasted for the time it would take a horse to run twice round the lists. Hence the people who saw it, and I who saw it clearly, understood that God was greatly angered with our city.' Dante, for whom the date marked the beginning of his 20 years' exile, refers to the same phenomenon in his *Convivio*; in Florence, at the outset of her destruction, a great quantity of those vapours that are of the following of Mars, were seen in the air in the shape of a cross."

The short duration of the cross-piece "the time it would take a horse to run twice round the lists," may be compared with the seven minutes recorded by Spencer Russell on Good Friday.

In Russell's observation there was a mock sun at the intersection of the cross-piece with the sun pillar. This intersection was at an elevation of 10°. Goodman, who saw no cross-piece, though he records streaks of cirrus crossing the pillar, also records a mock sun at the same elevation, 10°. The distance of the mock sun from the true sun which was a little below the horizon, must have been about 11°, much less than the angle of 22°, which is the radius of the common halo. The hypothesis that the mock sun was the intersection of a halo with the sun pillar is ruled out. That hypothesis is in any case very improbable, for there was no halo reported that afternoon.

A very remarkable instance of a mock sun seen with the sun well below the horizon is to be found in Vol. I of the *Proceedings of the British Meteorological Society*. The phenomenon was seen at Wrotham in Kent by the Rev. Charles Lane on January 27th, 1862.

"The sun appeared to have already risen, and to be about 3° above the horizon, showing a sickly face through a bank of fog; and from the northern limb of the sun there streamed upwards a broad ray of creamy light. . . . . . Mr. Lane noticed the time, which was 7.15 a.m.—too soon by 33 minutes . . . . for the sunrise of the almanac. . . . . The ball of the mock sun was well defined (its form distinctly globular) for fully fifteen minutes; it then began gradually to disappear; and it entirely vanished in the first beams of the real luminary of day."

At the time of Lane's first observation the sun was 5° below the horizon, so that the mock sun was initially 8° from the true sun. Just before sunrise, if we can trust the sketch in the *Proceedings*, the interval was reduced to about 2°. With the sun 5° below the horizon clouds about 11km. above ground and 170km. away would have had the right elevation, 3°, and would have been lit by the sun. As to how the round image of the sun was formed I have no suggestion to make. This early observation must be placed in the same class as those made by Applegate on March 9th and by Russell and Goodman on Good Friday. The explanation of the occasional occurrence of mock suns in association with sun pillars must be left as a problem for the devotees of Meteorological Optics.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, April 17th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, D.Sc., President, in the Chair.

W. H. Dines and L. H. G. Dines.—Monthly mean values of radiation from various parts of the sky at Benson, Oxfordshire. (Memoirs Vol. 2, *No.* 11, *May,* 1927.)

This paper summarises and discusses the observations of radiation from the sky made at Benson from 1922 to 1926. The luminous rays and long-wave radiation are each tabulated separately for clear and overcast skies for different zones, and several interesting conclusions are drawn.

L. H. G. Dines.—An analysis of the changes of temperature with height in the stratosphere over the British Isles. (*Memoirs Vol.* 2, *No.* 18, *April*, 1928.)

The Dines meteorograph, when employed with balloons giving a velocity of ascent of 200 to 250 metres per minute, is not sufficiently well ventilated to give accurate readings of the temperature of the upper part of the stratosphere during the hours of daylight. Using Hc for the height of the base of the stratosphere, the results appear to be about 3°C. too high at (Hc + 6)km., and the error increases upwards. The corresponding error in the descent is believed to be insignificant. The average temperature in the stratosphere over the British Isles is accordingly found from night observations, and consists of a pronounced inversion of 3°C. at the bottom, followed by a gradual upward decrease at the rate of about 0.5°C. per km. from (Hc + 3) to (Hc + 8) km. As the height increases there is a definite tendency for the temperature to become independent of that at the base of the stratosphere, and at (Hc + 17) km. the temperature may be independent of that at Hc. The available evidence is against the existence of a diurnal variation of temperature in the stratosphere.

In the discussion the method of tabulation was questioned, but was justified by the statement that the great majority of ascents which reach the stratosphere do show a sharp inversion.

H. A. Hunt, Commonwealth Meteorologist.—A basis for seasonal forecasting in Australia.

The author's investigations into the sequence of wet and dry seasons in Australia indicate a fairly definite four-year cycle. This period usually consists of two dry years followed by two wet years, requiring two years to be allotted to the drying and heating phase and two to the wetting and cooling. In the tables given the years are shown coupled in pairs, of which the aggregates for the 24 months make alternate wet and dry periods, although the single years do not always display higher or lower totals than each of the years in the opposing pair. The four-year period in the rainfall is also fairly well marked in the percentage of the continental area over which the rainfall is above the average each year.

A good discussion followed, in which it was pointed out that in Ceylon there are two periods of about 3·7 and 4·5 years respectively which combine to give a four-year cycle similar to that found in Australia. Analysis of the Australian cycle shows it to consist of a similar periodicity of 3·7 years with indications of a longer periodicity of between four and five years.

Correspondence

To the Editor, *The Meteorological Magazine*

Exceptional Dryness

With regard to the comments in your magazine on the exceptional dryness and extremes of temperature experienced in February and March, I might say that here on two days in March, early in the afternoon, the humidity in the screen was down to 30 per cent. The weather was very fine and warm. Also about 2 p.m. one afternoon in February, the weather being very fine and cold with east wind, the dry bulb temperature was 29° while the wet was 25° [humidity 52 per cent].

G. WESTON.

Munsted Heath, Godalming, April 28th, 1929.

Shortage of Snow on Ben Nevis

I have been informed by members of the Scottish Mountaineering Club that the amount of snow this spring on Ben Nevis and other mountains is the smallest that can be remembered. This is of course what one would expect in view of the drought which has prevailed all this year.

C. K. M. DOUGLAS.

April 25th, 1929.

Snow Falling through Drizzle

In the *Meteorological Magazine* for September, 1927, results concerning the investigation of rain falling through drizzle are given, but no mention is made as to the occurrence of snow falling through drizzle, and I wonder, therefore, whether it is comparatively rare. The following account of this phenomenon at Dover preceded by glazed frost may prove of interest.

The weather of February 26th was dull and frosty with a strong easterly wind (Force 6 at 9h.). The screen temperature remained unusually steady throughout the day, varying from 29.8°F. at 8h. to 30.2°F. at 20h. Heavy drizzle commenced at 9h. 50m. and fell continuously until 11h. 15m. covering most objects with a coating of smooth transparent ice which rendered many roads and pavements dangerous to traffic and pedestrians. At 11h. 10m. large well-frozen snow flakes began to fall through the drizzle and these conditions continued for several minutes, ending with the gradual cessation of the drizzle but a rapid increase in the snowfall. I hasten to emphasise the fact that the snow flakes were very large and well frozen because under the circumstances one might easily be led to think the occurrence was that of drizzle turning to fine snow. Conditions became somewhat similar again at 17h. 15m., but in this case the drizzle was very slight, and the soft hail and snow which followed fell through the drizzle for a very short period only, and, indeed, might easily have passed unnoticed but for careful observation.

Close examination of my barogram reveals a slight rise of pressure just before 10h. followed by a gradual fall until after 11h. when a further slight rise is discernible. Careful study of the thermogram fails to show any change of temperature during the phenomenon.

CYRIL G. W. LEWIS.

69, *Barton Road, Dover.* *March 9th,* 1929.

Brilliant Parhelia

Between 9h. and 9h. 30m. this morning the parhelia of the halo of 22° were observed in a cirrus cloud. The halo was not visible. Both parhelia showed prismatic colours, especially the left-hand one, which for a few minutes was very brilliant and had a white "tail" pointing away from the sun estimated at 1° long.

CICELY M. BOTLEY.

17, *Holmesdale Gardens, Hastings.* *March 3rd,* 1929.

Wet Bulb Temperatures as "Thaw Temperatures"

A propos of Col. Gold's letter on the above subject in your issue of February, 1929, the following set of readings of the wet and dry bulb thermometers, which I took at Wengen in Switzerland in January last, confirms his observation that the ground will not thaw when the wet bulb is below 32°F. The following readings were taken by means of a whirling psychrometer in the shade :—

Day January	Hour (C.E.T.)	Dry Bulb	Wet Bulb	Relative Humidity	Temperature in sun against a cream coloured wall facing SSE.
	h. m.	°F	°F	%	°F
10th	14 15	34·8	29·0	48	62
13th	14 00	32·4	27·2	40	62
19th	14 15	34·2	28·2	46	64
20th	14 00	35·8	30·4	52	72
21st	14 00	38·2	30·2	35	— (overcast)

Except on the 21st the sun shone brightly at the time of observation. There was no thaw in the shade even on much frequented paths, the snow being dry to the touch. Only in direct sunshine was there any thaw, and this was least in open spaces. Thus the ice on the skating rink was damp to the touch, but there was no water. In more sheltered corners the thaw was much more pronounced. There can be no doubt, therefore, as Col. Gold points out, that the continued frost on the surface of the ground (or snow) is to a large extent due to evaporation

—in the table above the humidities are very low—and to a less extent to radiation or to the low temperature of the snow or ground immediately underneath the surface.

Nevertheless the following figures are puzzling. The temperature of the air is below 32°F.; yet even after whirling the psychrometer for more than 15 minutes it was found impossible to get ice on the wet bulb. In the last two examples it seems

Day January	Hour (C.E.T.)	Dry Bulb	Wet Bulb	Humidity	Weather and cloud
	h. m.	°F	°F	%	
11th	14 10	31·5	26·4	48	c (high cloud)
12th	14 10	31·2	26·2	48	$b_o v$
22nd	23 50	31·9	31·1	91	ov after ors.
23rd	10 20	30·4	29·2	87	b_o

possible to give some explanation. The non-freezing of the water may, in part, be due to the high humidity. Some confirmation of this is offered from the following observations at South Kensington on February 19th at 17h. (G.M.T.). The roads were in a damp condition and the snow in Hyde Park was decidedly wet to the touch though the temperature of the air was 30·8°F. The humidity was, however, 90 per cent. Here, then, in spite of the air temperature being well below 32°F. no freezing occurred. The wind at the time was E. force 3. The above examples are clear cases of super-cooling.

Again, in no instance, except one, was I able to get the wet bulb to freeze when the air temperature was slightly above 32°, and that of the wet bulb well below this figure. Here are some examples from Wengen:—

Day January	Hour (C.E.T.)	Dry Bulb	Wet Bulb	Humidity	Weather and cloud
	h. m.	°F	°F	%	
7th	14 00	33·0	27·5	46	o
13th	14 00	32·4	27·2	40	b, ci 2
19th	14 15	34·2	28·2	46	bv, ci 1
21st	18 00	34·0	29·0	53	o, st. cu. 10
21st	23 30	32·9	27·9	52	o, st. cu. 9
The exception was					
22nd	08 25	32·2	29·4	72	$os_o s_o +$

Perhaps in this case a flake of snow may have touched the wet muslin and have started the freezing. It seems, therefore, that while it is possible to preserve freezing, at any rate in open spaces, when the air temperature is above the 32°F. if the wet bulb is below that figure and the humidity low, it is not possible to freeze water when the temperature of the air is at or a little above or below 32°F. be the humidity high or low, at any rate over a small surface such as a thermometer bulb.

As regards a snow layer being an effective agent in reducing the temperature of the air of the surface layers of air, I found, from several observations, that in clear weather the mean difference of temperature of the air at 2in. and 4ft. above the snow to be 5.5°F., while in overcast weather the difference was only 1.7°F., the temperature at the lower level being the lower of the two. J. E. BELASCO.

21, Gunter Grove, Chelsea, S.W.10. February 20th, 1929.

Mr. Belasco's observations on the super-cooling of water on the wet bulb are very instructive. This super-cooling occurs, not only when the dry bulb is above 32° but also on occasions when the dry bulb is below 32°. It would be interesting to have records of other occasions than the single one mentioned by Mr. Belasco, when ice was formed on the wet bulb with the dry bulb above 32°. Mr. Belasco's suggestion that on the occasion he mentions, January 22nd, formation of ice was due to contact with a snowflake appears probable. It is supported by the facts which Aitken mentioned some years ago in connexion with the super-cooling of water.* E. GOLD.

Further to my letter of February 20th arising out of Col. Gold's remarks, it occurred to me that super-cooling of water on the wet bulb thermometer might be arrested or, if not arrested completely, at any rate much reduced by artificial means. Messrs. Harrods were kind enough to allow me to carry out some experiments on this point by permitting me the use of their cold storage chambers. For this work I used an Assmann Psychrometer, the muslin of the wet bulb being moistened with distilled water. In one chamber the temperature of the air was 31·0°F., while the wet bulb, when steady state had been reached, gave 29·9°F., but the water on it had not frozen. I then endeavoured to promote freezing by applying a little sawdust to the muslin by means of a long thin piece of wood, thus hoping to provide the necessary nucleus at which the change of state could begin. The result was not successful, and the temperature of the wet bulb rose to 30·3°F. I repeated the experiment but was still unable to promote freezing. There being some ice on a nearby window, I procured a little of this on my stick and applied it to the muslin. The temperature of the wet bulb immediately rose to 32·0°F., freezing having begun. At the end of the experiment, when the steady state had been reached, the dry bulb was 30·0°F., the ice bulb 28·9°F. I then repeated this experiment in a much colder chamber, the dry bulb being 24·0°F. The chamber was

*Collected Scientific Papers of John Aitken, LL.D., F.R.S. By C. G. Knott, 1923, No. 37, Ground Ice.

small, one-half of it being fitted with pipes which were thickly coated (an inch or more) with hoar frost, though the floor was damp. As water the wet bulb fell to 23·7°F. Immediately on reaching this figure the mercury of the wet bulb thermometer rapidly rose to 32·0°F., where it remained for about two minutes after which it fell to 23·6°F. Still remaining in the same chamber and after completely thawing the ice bulb to well above 40°F., I allowed it to cool to 30·0°F. I then, as before, applied the sawdust. The cooling of the wet bulb immediately ceased and the temperature rose slowly to 32·0°F. It remained at that figure for quite a considerable time and then fell to 23·6°F. Once more I thawed the ice bulb and when later the wet bulb had cooled to 30·0°F. I applied a little ice to the muslin. This time the temperature rose rapidly to 32·0°F. and then later fell to 23·7°F. where it remained steady. (In all cases—both at Harrods and in Switzerland—I have noticed that the descent from 32°F., after freezing has occurred, is at first extremely slow to about 30·5°F. after which the descent is quite rapid. In Switzerland I never observed super-cooling when the temperature of the air was below 20°F., the descent of the mercury of the wet bulb, say, from 50°F. being stopped at 32°F. while freezing was taking place.) From the above experiments it would appear that when the temperature of the air is well below the freezing point, super-cooling can be arrested and a nucleus at which to begin freezing can be provided for in the form of ice or wood being applied to the bulb. This is a great saving of time. On the other hand when the air temperature is only a little below the freezing point super-cooling can only be arrested by the application of ice.

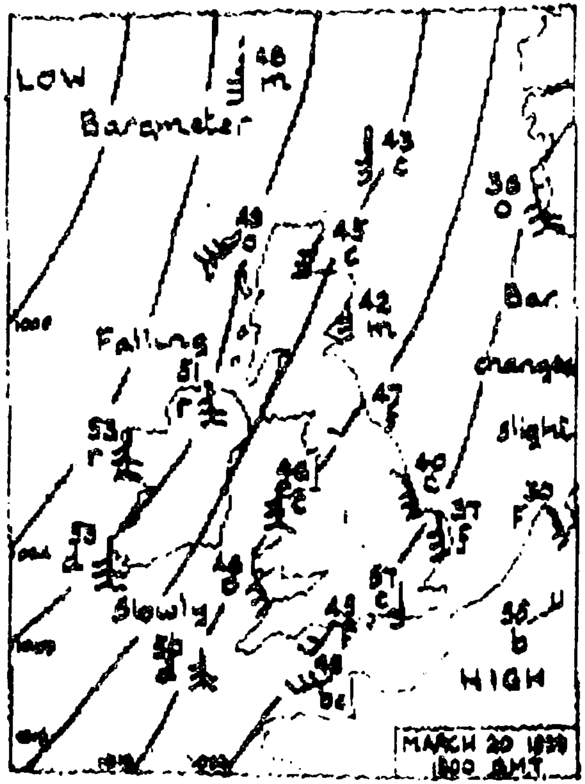
J. E. Belasco.

NOTES AND QUERIES

Underground Water Level in the Thames Valley

Owing to the prolonged drought the flow of the Thames has been reduced much below normal, and the level of the underground water in the riverside gravel-beds is exceptionally low.

The level of underground water is recorded at Kew Observatory where there is a small well provided for the purpose. No water is drawn from this well, so that the changes in level are due entirely to natural causes. Normally during the months January to March the water is at its highest level, about 300cm. above sea level and 250cm. lower than the Observatory lawn. From March onwards the water falls more or less steadily to September in which month the level is on the average about 200cm. above sea level. This winter the highest level, 263cm., was attained on January 4th. By the end of the month the water had fallen to 220cm. On March 8th the measurement was



GENERAL INFERENCE FROM OBSERVATIONS AT 1800 GMT., MARCH 20 1929.

THE CONTINENTAL ANTICYCLONE IS PASSING AWAY SOUTHEASTWARD AND A LARGE DEPRESSION IS SPREADING IN FROM THE ATLANTIC. SOME RAIN OR DRIZZLE WILL OCCUR IN WESTERN AND NORTHERN DISTRICTS BUT IN THE SOUTHEAST THERE WILL BE LITTLE OR NONE FOR ANOTHER 24 HOURS.

FORECAST FOR SE ENGLAND TOMORROW.

WIND SOUTH TO SOUTHWEST, LIGHT OR MODERATE. CLOUDY, LOCAL COASTAL FOG AND DRIZZLE. VERY MILD.

WEATHER CHART AND FORECAST TRANSMITTED BY THE FULTOGRAPH SYSTEM.

200cm., and the fall has continued almost without intermission. For May 5th the minimum reading is 178cm. The only periods during which the water has been so low as 178cm. above M.S.L. since the systematic record began in January, 1916, were:— from the middle of 1921 to February, 1922, the greater part of December, 1922, and four weeks in the autumn of 1923. The lowest level of all was recorded on four days in January, 1922, viz., 157cm. above M.S.L.

As has been mentioned the water level is controlled by the state of the river rather than by local rainfall. It may be noted, however, that the rainfall for the first four months of 1929 is the lowest ever recorded at Kew Observatory for this period of the year, only 59·4mm. having fallen. The difference from the minimum for any four consecutive months, 59·0mm. in May to August, 1921, is insignificant.

F. J. W. Whipple.

The Wireless Transmission of Weather Maps

By the courtesy of Messrs. Travers Cleaver Ltd., we are enabled to reproduce on the opposite page the specimen weather chart for 6 p.m. on March 20th, and the accompanying forecast, transmitted by the Fultograph system at the lecture on "Weather and Wireless" given by Mr. R. A. Watson Watt at the Royal Meteorological Society on that date. A full summary of the lecture appeared on p. 64 of the *Meteorological Magazine* for April.

A Destructive Thunderstorm in December

On December 30th, 1928, a thunderstorm passed over the Falmouth district about 8 a.m.

Mr. George Knowles, of Penmorva, Budock, Falmouth, reported that the lightning was extraordinarily vivid and was accompanied by a very heavy squall of wind and hail. Some damage was done to property about ¾ mile from his house. "There was only one flash of lightning and that struck a large fir tree which it completely wrecked, scattering the pieces for a distance (it was said, though I wonder if it was accurate) of about 200 yards. At the same time it struck the telephone." Later, Mr. Knowles interviewed the owner of the damaged property and he now sends the following report: "The owner said that her telephone was struck and there was a brilliant flash; the receiver, which was by her bed, was thrown violently against her chest, inflicting a severe bruise, which had to be treated by her doctor. The flash left a smell of sulphur in her room. The tree was about ½ mile from the house and the telephone wires were about 80 or 100 yards from the tree, which was a very tall fir over 100 feet high. The gardener who saw the lightning flash told me that it seemed to fall like a large ball of fire which burst just above the tree with a tremendous report. The tree was smashed and the pieces scattered over a wide area. He said that there was a man in a shed about 100 yards from the tree and he was knocked down by the shock. The house, called "The Cragg," is situated on a high rock about 200 yards from Maen Porth, an inlet of the sea about 2½ miles southwest from Falmouth. Unfortunately, I did not see the tree till all the debris was cleared away and cut up, but the gardener said that some of the pieces were very large."

On the morning of the 30th a depression over southeast England, an offshoot of a depression south of Iceland, was moving southwards and deepening. In the rear of this depression showers of rain or hail fell locally in the southern parts of England, while a few stations recorded thunder and lightning. According to the *Daily Weather Report* heavy rain and hail showers and lightning were observed at Falmouth (Pendennis) between 7h. and 13h. on the 30th.

In this connexion it is of interest to note that the inquiry into winter thunderstorms over the British Isles, conducted in recent years by Mr. S. Morris Bower, under the auspices of the Royal Meteorological Society, has shown that there is a tendency towards a secondary maximum of frequency of winter thunderstorms over parts of Devon and Cornwall. Winter thunderstorms are most frequent on the west coasts of Scotland and Ireland.

The Effect of Exposure on Climate

In the summer of 1926 the Bavarian Forest Research Department carried out an investigation of very great interest, which is described by Dr. R. Geiger.*

On a plateau in the Swabian Jura, in eastern Wurttemberg, rests an isolated hill of a regular conical shape, known as the "Hohenkarpfen," rising at an average slope of about 20° from a general level of some 800 metres to 912 metres at its highest point. Symmetrically disposed on its slopes and on the summit, a number of meteorological stations were erected, the principal ring, at a height of 860 metres, averaging only 45 metres apart. The observations included temperature and humidity, rainfall, wind-velocity (with electric self-recording cup anemometers) and intensity of light.

The phenomena are naturally distributed in relation to the direction of the wind at the time, and the feature of most interest is the rainfall. The heaviest falls, averaging 4 to 7 per cent. above the average for the whole hill, were found on the flanks, with a slight minimum on the leeside and a pronounced

*Messung des Expositionsklimas. *Forstwiss. Centralbl. Berlin.* 49, 1927, pp. 665-675, 853-859, 914-923; 50, 1928, pp. 73-85, 437-448, 633-644; 51, 1929, pp. 37-51.

minimum to windward; the gauge in the centre of the summit received nearly the average fall for the whole area. This is not the whole story however, for the rain-gauges were exposed with their apertures horizontal, while it is obvious that a slope facing towards the wind must receive more rain than a horizontal surface. At one point on the south-west slope two gauges were accordingly exposed, one upright, and the other with its aperture parallel with the ground surface; the latter received altogether 2 per cent. more rain than the former, but with winds from south-west exceeding 5 m./s. in velocity the excess rose to 27 per cent. On such steep slopes the orthodox exposure of rain-gauges with their apertures horizontal gives rise to a curious paradox. On a windward slope the rain falls obliquely into the gauge, but meets the ground almost at right angles and the gauge receives less rain than an equal area of ground. To leeward, where the rain falls almost vertically, it meets the gauge at right angles but is inclined to the ground, and the gauge receives more rain than an equal area of ground. Hence, as Dr. Geiger points out, although the gauges on the leeward slopes of the Hohenkarpfen caught about 4 per cent. more rain than those on the windward slopes, the actual fall per unit area of ground was very nearly the same both to windward and leeward. It seems desirable to add, moreover, that on such exposed sites the "catch" of the rain-gauge is not always a measure of the true fall, and that the deficit recorded on the windward side may be more apparent than real. Some experiments in this connexion are being made by Mr. Hudleston at Hutton John, near Penrith; preliminary accounts are published in *British Rainfall* for 1926 and 1927.

Engineering and Industrial Instruments (List E.5) Negretti & Zambra, London

It might, perhaps, be thought that a catalogue possessing the above title would contain little of interest to the meteorologist. A very brief perusal of its beautifully printed pages is sufficient to correct this impression, for we find that the book is devoted almost entirely to instruments for the measurement of air speed, pressure and temperature. It is true that the compilers have had in mind the requirements of industry, first and foremost, and that the needs of the ordinary meteorologist are dealt with more adequately in other lists issued by the same firm. Nevertheless, space has been found for a good deal of matter which concerns ourselves as much as anybody. Apart from descriptions and illustrations of airmeters, anemobiagraphs, thermometers, thermographs, barometers, barographs, hydrometers and hygrographs, we cannot but be interested in the notes on pitot tubes (pp. 10-11), recording pens (p. 274), glass thermometers (pp. 288-291) and other explanatory matter. The book is much more than a mere price list and no one interested in instruments could fail to profit from a perusal of it.

The expansion of meteorology into fresh channels involves an ever-increasing demand for new types of instruments and it is interesting to find that such needs can frequently be met by instruments developed for industrial purposes. We may take, for example, Negretti & Zambra's mercury-in-steel thermometers and thermographs. In these instruments the thermometer bulb, made of steel and filled with mercury, is connected by fine capillary tubing, also of steel, to the dial or recorder which may be up to 150ft. from the bulb. Many pages of the catalogue are devoted to various patterns of this instrument, and it is certain, therefore, that it has found a wide market in the industrial world. At the same time, the meteorologist finds it useful for such purposes as recording earth temperature, indicating air temperature on aeroplanes, &c. On the other hand, it is of interest to note that industrial applications have been found for so typical a meteorological instrument as the Symons earth thermometer.

In designing instruments for industrial purposes, manufacturers have been compelled to give special attention to such features as robustness, clear and permanent figuring, protection of working parts from dirt and corrosion and reliability (in the sense of freedom from liability to breakdown). These desiderata are equally important to the meteorologist, who is likely to profit, therefore, from the experience gained by the manufacturer in the industrial sphere. An accurate instrument need not necessarily be a "delicate" instrument. Under modern conditions, costly instruments of elaborate construction must often be designed in such a way that expert attention is only necessary at rare intervals. Messrs. Negretti & Zambra are to be congratulated on the success with which they have endeavoured to meet this need and also on their enterprise in producing so helpful and elegant a list of their products.

News in Brief

We are informed that Commandant Alvaro de Freitas Morna has been appointed Director of the Marine Meteorological Service of Portugal, in succession to Commandant Joao Batista de Barros.

According to *The Times* "work has begun on the building of an observatory for meteorological and scientific research on the Jungfraujoch (11,340ft.). The promoter of the scheme is the Swiss meteorologist Prof. A. de Quervain, and the £20,000 needed for the carrying out of the enterprise has been raised.

The Adams Prize for 1927-8 (value about £246) has been awarded to Prof. Sydney Chapman, F.R.S., of Trinity College, Cambridge. The subject was "The variations in the earth's magnetic field in relation to electric phenomena in the upper atmosphere and on the earth.''

Staff News.—The final round of the Air Ministry Interdepartmental Association Football Cup Competition was played at Waddon on Thursday, April 18th, against a team representing the Aeronautical Inspection Department. The Meteorological Office team after a very keen game won by 5 goals to 1. At the close of the match the cup was presented to the Office team by Lieut.-Col. H. W. S. Outram, C.B.E., Director of Aeronautical Inspection. This is the first time the Meteorological Office has held the cup since 1923.

Errata

The review of Müller-Pouillet's *Lehrbuch der Physik* on p. 50 of the *Meteorological Magazine* for March contains a reference to the death of Prof. Dr. B. Gutenberg. Happily that reference was an error; Prof. Dr. Gutenberg is in fact the principal author of the section on "Thermodynamics of the Earth."

March, 1929, p. 30, Table I, *for* "Newcastle" *read* "Tynemouth", *for* "Oxford, 10° on the 15th, 0° on the 16th" *read* Leafield 10° on the 14th, 0° on the 15th," and *for* "Manchester" *read* "Winchester."

The Weather of April, 1929

The weather of April was generally dry and in Great Britain cold with a preponderance of northerly winds. During the opening days pressure was high to the westward of the British Isles, while shallow depressions moved southwards across the North Sea. Snow and sleet showers occurred in Scotland and sleet and hail showers in the Midlands from the 1st-4th and snow as far south as Norfolk on the 3rd; further south and west the rainfall was slight. Considerable periods of bright sunshine occurred during this time. On the 5th an anticyclone coming from the west covered the British Isles, and the 6th was a sunny day over the whole kingdom with between 11 and 12½hrs. bright sunshine at numerous places, *e.g.*, 12·2hrs. at Hastings, and 11·8hrs. at Edinburgh. This fair weather continued in England on the 7th and 8th, while overcast skies and slight rain occurred in Ireland and Scotland during the passage of a shallow depression. On the 9th there was a general change, an anticyclone to the north of the British Isles brought fine weather to Ireland from the 9th-13th and to Scotland from the 9th-16th, an average of 8-10hrs. bright sunshine daily being recorded at several places. Meanwhile cold cloudy unsettled weather with easterly winds prevailed in England generally; snow and sleet fell at many places from the 10th-12th, and on the 12th temperature did not rise above 38°F. at Harrogate, Birmingham and

Huddersfield. On the 16th and 17th the weather became unsettled with westerly winds in the west and north, but anticyclonic in the south. It was at this time that the one really warm spell in the month was enjoyed, especially in southern England where temperature rose above 70°F. generally on the 19th from Devonshire to Norfolk and 74°F. was reached at Greenwich. A cold northerly wind, however, in the rear of a depression over Norway was spreading southward over Scotland on the 19th and reached southern England on the 20th. The weather continued sunny though cold on the 21st and 22nd. From then until the end of the month it was generally cold and unsettled except in the north with showers in most places but many bright intervals. Moderate rain occurred on the 27th-29th, among the heaviest falls being 0·84in. at Killybegs (Donegal) on the 27th and 0·86in. at Guernsey on the 29th. Snow fell in many parts of Scotland and north England from the 24th-28th, but from the 28th-30th the weather was fine and sunny in north and west Scotland; Tiree had 14·7hrs. bright sunshine on the 30th and 13·0hrs. on the 28th. Temperature was low during the greater part of the month; the lowest minimum in the screen being 22°F. at Marlborough on the 6th and at Durham and Marlborough on the 22nd and the lowest on the grass, 10°F. at Marlborough on the 22nd and 11°F. at Rhayader on the 4th. Rainfall totals for the month were again below normal except for a small area in southeast Scotland. The distribution of sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	197	+43	Valentia	177	+17
Aberdeen	154	— 4	Liverpool	192	+34
Dublin	145	—20	Falmouth	190	+ 6
Birr Castle	130	—24	Kew	146	—11

Pressure was above normal from Spitsbergen to northern France, over the northern North Atlantic and at Bermuda, the greatest excess being 11·1mb. at Isafjord, and below normal over Scandinavia, central and southern Europe, the Azores and Newfoundland, the greatest deficits being 3·9mb. at Bornholm and 3·6mb. at Horta. Temperature was generally below normal except in the extreme south, and rainfall was below normal in most parts of northern and western Europe but above normal in central Europe. In western Svealand and northwestern Gothaland however it was 150 per cent. of the normal.

The warm sunny weather experienced generally at the end of March broke in Switzerland and France on the 2nd and 3rd respectively, when there was a sudden drop in temperature accompanied by heavy falls of snow. Heavy snow and cold weather were also experienced in Germany, Austria, northern Italy, and the Balkan Peninsula from about the 1st-8th. A severe storm, said to be the most violent for fifty years, occurred along the

Spanish coast between Cadiz and Gibraltar from the 17th to 19th, causing much damage. Intense cold weather set in again in Turkey on the 19th when snow fell generally, and snowstorms were experienced in Germany as late as the 25th. On the 30th a strong Föhn wind blowing over Switzerland caused the snow up to a height of 6,000ft. to melt rapidly.

In Kenya the spring rains, which were about a month late, began definitely in most districts during the week ending the 27th. The drought had caused injury to the crops.

Owing to floods and gales a portion of the bridge of boats at Mosul broke from its moorings on the 14th.

Torrential rains occurred in the northern part of Tasmania on the 3rd and 4th with subsequent severe floods during which 27 people were drowned, and roads, bridges and property were destroyed to the value of £1,000,000. The floods were abating on the 8th.

Storms of snow, sleet and cold winds swept across the central provinces of Canada on the 1st, and across Ontario on the 5th followed by thunderstorms on the 6th-8th. The prairie provinces also experienced wintry conditions early in the month. Temperature was considerably above normal in the United States, except for the Pacific States, during the first part of the month, 90°F was recorded in parts of the Atlantic States and 94°F. at Washington, D.C., and Richmond, Va., on the 7th. Later the temperature fell considerably. The rainfall was above normal in most districts. Storms were experienced on the Atlantic Coast on the 16th, torrential rain in the Mississippi Valley about the 21st and 22nd followed by floods, a tornado in Texas and the Rocky Mountain States on the 22nd, and a tornado in Georgia and South Carolina on the 25th. A hurricane which struck the banana region of Santa Marta (Colombia) on the 4th destroyed about a million banana plants.

Icebergs and vast icefields in the North Atlantic were much more southerly than usual.

The special message from Brazil states that the distribution of rainfall in the northern and central regions was irregular with 0·35in. and ·04in. below normal respectively, and that the rainfall was scarce in the southern regions with 2·60in. below normal. Eight anticyclones passed across the country. The crops were generally in good condition despite the rainfall deficit. At Rio de Janeiro pressure was 1·4mb. above normal and temperature 2·2°F. below normal.

Rainfall, April, 1929.—General Distribution

England and Wales	57	per cent. of the average 1811-1915
Scotland	76	
Ireland	51	
British Isles	61	

Rainfall: April, 1929: England and Wales

Co.	STATION	In.	Per-cent of Av.	Co.	STATION	In.	Per-cent. of Av.
Lond .	Camden Square	1·33	86	*Leics* .	Belvoir Castle	1·09	71
Sur .	Reigate, The Knowle	·96	62	*Rut* .	Ridlington	1·26	...
Kent .	Tenterden, Ashenden	·99	61	*Linc* .	Boston, Skirbeck	·61	45
,, .	Folkestone, Boro. San.	1·14	...	,, .	Lincoln	·70	50
,, .	Margate, Cliftonville	·63	47	,, .	Skegness, Marine Gdns	·41	31
,, .	Sevenoaks, Speldhurst	1·06	...	,, .	Louth, Westgate	·65	39
Sus .	Patching Farm	·77	44	,, .	Brigg, Wrawby St.	·65	...
,, .	Brighton, Old Steyne	·70	43	*Notts* .	Worksop, Hodsock	·88	60
,, .	Heathfield, Barklye*	1·00	59	*Derby* .	Derby, L. M. & S. Rly.	·94	58
Hants .	Ventnor, Roy. Nat. Hos.	1·28	76	,, .	Buxton, Devon Hos.	1·53	52
,, .	Fordingbridge, Oaklnds	·85	46	*Ches* .	Runcorn, Weston Pt.	·88	51
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	·96	...
,, .	Sherborne St. John	·96	54	*Lancs* .	Manchester, Whit. Pk.	1·07	56
Berks .	Wellington College	·70	43	,, .	Stonyhurst College	1·28	66
,, .	Newbury, Greenham	·93	51	,, .	Southport, Hesketh Pk	·88	48
Herts .	Benington House	...	...	,, .	Lancaster, Strathspey	1·59	...
Bucks .	High Wycombe	1·25	80	*Yorks* .	Wath-upon-Dearne	·81	51
Oxf .	Oxford, Mag. College	1·39	90	,, .	Bradford, Lister Pk.	·96	48
Nor .	Pitsford, Sedgebrook	1·64	107	,, .	Oughtershaw Hall	2·74	...
,, .	Oundle	·82	...	,, .	Wetherby, Ribston H.	·96	55
Beds .	Woburn, Crawley Mill	1·85	123	,, .	Hull, Pearson Park	1·06	68
Cam .	Cambridge, Bot. Gdns.	...	...	,, .	Holme-on-Spalding	·91	...
Essex .	Chelmsford, County Lab	...	...	,, .	West Witton, Ivy Ho.	1·28	...
,, .	Lexden Hill House	1·77	...	,, .	Felixkirk, Mt. St. John	1·30	78
Suff .	Hawkedon Rectory	1·70	110	,, .	Pickering, Hungate	1·26	...
,, .	Haughley House	1·06	...	,, .	Scarborough	1·13	72
Norf .	Norwich Eaton	1·18	69	,, .	Middlesbrough	·99	72
,, .	Wells, Holkham Hall	·86	61	,, .	Baldersdale, Hury Res.	1·28	...
,, .	Little Dunham	·99	61	*Durh* .	Ushaw College	1·39	74
Wilts .	Devizes, Highclere	·58	31	*Nor* .	Newcastle, Town Moor	1·42	87
,, .	Bishops Cannings	·91	45	,, .	Bellingham, Highgreen	1·68	...
Dor .	Evershot, Melbury Ho.	1·23	52	,, .	Lilburn Tower Gdns.	1·19	...
,, .	Creech Grange	1·03	...	*Cumb* .	Geltsdale	1·99	...
,, .	Shaftesbury, Abbey Ho.	·74	35	,, .	Carlisle, Scaleby Hall	1·31	67
Devon .	Plymouth The Hoe	·87	38	,, .	Borrowdale, Seathwaite	5·90	80
,, .	Polapit Tamar	1·28	55	,, .	Borrowdale, Rosthwaite	2·65	...
,, .	Ashburton, Druid Ho.	...	...	,, .	Keswick, High Hill	1·55	...
,, .	Cullompton	1·03	45	*Glam* .	Cardiff, Ely P. Stn.	·65	26
,, .	Sidmouth, Sidmount	·48	23	,, .	Treherbert, Tynywaun	1·00	...
,, .	Filleigh, Castle Hill	·60	...	*Carm* .	Carmarthen Friary	1·03	38
,, .	Barnstaple. N. Dev. Ath.	·81	38	,, .	Llanwrda	1·47	45
Corn .	Redruth, Trewirgie	1·33	46	*Pemb* .	Haverfordwest, School	·93	...
,, .	Penzance, Morrab Gdn.	1·38	57	*Card* .	Aberystwyth	·90	...
,, .	St. Austell, Trevarna	1·48	52	,, .	Cardigan, County Sch.	·80	...
Soms .	Chewton Mendip	·99	33	*Brec* .	Crickhowell, Talymaes	1·20	...
,, .	Long Ashton	·90	...	*Rad* .	Birm W. W. Tyrmynydd	1·36	37
,, .	Street, Millfield	·72	...	*Mont* .	Lake Vyrnwy	1·78	59
Glos. .	Cirencester, Gwynfa	·97	52	*Denb* .	Llangynhafal	1·01	...
Here .	Ross, Birchlea	·88	46	*Mer* .	Dolgelly, Bryntirion	1·60	44
,, .	Ledbury, Underdown	·75	41	*Carn* .	Llandudno	1·45	80
Salop .	Church Stretton	·81	38	,, .	Snowdon, L. Llydaw 9	4·39	...
,, .	Shifnal, Hatton Grange	·72	43	*Ang* .	Holyhead, Salt Island	·98	47
Worc .	Ombersley, Holt Lock	·63	41	,, .	Lligwy	1·04	...
,, .	Blockley	1·48	...	*Isle of Man*			
War .	Farnborough	1·59	81		Douglas, Boro' Cem.	1·39	57
,, .	Birminghm, Edgbaston	·78	45	*Guernsey*			
Leics .	Thornton Reservoir	1·14	67		St. PeterP't. GrangeRd.	2·41	120

* Gauge formerly at Tottingworth Park.

Rainfall: April, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt.	Stoneykirk, Ardwell Ho	...	...	*Suth.*	Loch More, Achfary	4·54	94
,,	Pt. William, Monreith	·91	...	*Caith.*	Wick	1·69	85
Kirk.	Carsphairn, Shiel.	2·06	...	*Ork.*	Pomona, Deerness	1·49	72
,,	Dumfries, Cargen	..	...	*Shet.*	Lerwick	1·48	65
Dumf.	Eskdalemuir Obs.	1·81	53	*Cork*	Caheragh Rectory	1·83	...
Roxb.	Branxholm	1·51	80	,,	Dunmanway Rectory	2·10	51
Selk.	Ettrick Manse	...	...	,,	Ballinacurra	·93	36
Peeb.	West Linton	1·21	...	,,	Glanmire, Lota Lo.	1·38	49
Berk.	Marchmont House	1·54	76	*Kerry.*	Valentia Obsy.	1·70	46
Hadd.	North Berwick Res.	1·91	136	,,	Gearahameen	3·90	...
Midl.	Edinburgh, Roy. Obs.	1·59	115	,,	Killarney Asylum	1·61	49
Ayr.	Kilmarnock, Agric. C.	1·25	61	,,	Darrynane Abbey	1·62	47
,,	Girvan, Pinmore	1·33	45	*Wat.*	Waterford, Brook Lo.	1·59	63
Renf.	Glasgow, Queen's Pk.	1·44	73	*Tip.*	Nenagh, Cas. Lough	1·31	52
,,	Greenock, Prospect H.	1·26	35	,,	Roscrea, Timoney Park	·66	...
Bute.	Rothesay, Ardencraig.	1·46	49	,,	Cashel, Ballinamona	2·18	87
,,	Dougarie Lodge	1·81	...	*Lim.*	Foynes, Coolnanes	1·18	48
Arg.	Ardgour House	3·73	...	,,	Castleconnel Rec.	·88	...
,,	Manse of Glenorchy	3·31	...	*Clare.*	Inagh, Mount Callan	1·23	...
,,	Oban	2·74	...	,,	Broadford, Hurdlest'n.	1·37	...
,,	Poltalloch	2·17	72	*Wexf.*	Newtownbarry	..	...
,,	Inveraray Castle	3·68	80	,,	Gorey, Courtown Ho	·79	36
,,	Islay, Eallabus	2·43	85	*Kilk.*	Kilkenny Castle	1·40	64
,,	Mull Benmore	5·30	...	*Wic.*	Rathnew, Clonmannon	·87	...
,,	Tiree	1·96	...	*Carl.*	Hacketstown Rectory	·86	32
Kinr.	Loch Leven Sluice	1·39	72	*QCo.*	Blandsfort House	1·40	54
Perth.	Loch Dhu	1·95	41	,,	Mountmellick	...	...
,,	Balquhidder, Stronvar	1·40	...	*KCo.*	Birr Castle	·91	42
,,	Crieff, Strathearn Hyd.	·99	45	*Dubl.*	Dublin, FitzWm. Sq.	1·44	76
,,	Blair Castle Gardens	1·41	67	,,	Balbriggan, Ardgillan.	1·32	67
,,	Dalnaspidal Lodge	1·25	34	*Me'th.*	Beauparc, St. Cloud	1·19	...
Forf.	Kettins School	·70	42	,,	Kells, Headfort	1·16	46
,,	Dundee, E. Necropolis	1·15	68	*W.M.*	Moate, Coolatore	·92	...
,,	Pearsie House	1·43	...	,,	Mullingar, Belvedere	·68	29
,,	Montrose, Sunnyside	1·33	73	*Long.*	Castle Forbes Gdns.	1·11	46
Aber.	Braemar, Bank	1·65	70	*Gal.*	Ballynahinch Castle	1·57	44
,,	Logie Coldstone Sch.	2·32	115	,,	Galway, Grammar Sch.	·92	...
,,	Aberdeen, King's Coll.	1·75	94	*Mayo.*	Mallaranny	1·45	...
,,	Fyvie Castle	2·09	...	,,	Westport House	·87	32
Mor.	Gordon Castle	1·82	104	,,	Delphi Lodge	2·65	...
,,	Grantown-on-Spey	2·58	131	*Sligo.*	Markree Obsy	1·32	50
Na.	Nairn, Delnies	1·48	99	*Cav'n.*	Belturbet, Cloverhill	·79	35
Inv.	Kingussie, The Birches	1·66	...	*Ferm.*	Enniskillen, Portora	1·01	...
,,	Loch Quoich, Loan	4·10	...	*Arm.*	Armagh Obsy	·85	40
,,	Glenquoich	6·08	94	*Down.*	Fofanny Reservoir	1·56	...
,,	Inverness, Culduthel R.	1·08	...	,,	Seaforde	1·41	54
,,	Arisaig, Faire-na-Squir	2·89	...	,,	Donaghadee, C. Stn	1·21	60
,,	Fort William	3·52	...	,,	Banbridge, Milltown	1·15	...
,,	Skye, Dunvegan	1·36	...	*Antr.*	Belfast, Cavehill Rd	1·58	...
R & C.	Alness, Ardross Cas.	1·89	78	,,	Glenarm Castle	1·29	...
,,	Ullapool	3·31	...	,,	Ballymena, Harryville	1·68	64
,,	Torridon, Bendamph	3·90	75	*Lon.*	Londonderry, Creggan	1·96	76
,,	Achnashellach	5·10	...	*Tyr.*	Donaghmore	1·66	...
,,	Stornoway	1·59	52	,,	Omagh, Edenfel	1·42	54
Suth.	Lairg	2·16	...	*Don.*	Malin Head	1·21	...
,,	Tongue	2·14	82	,,	Dunfanaghy	...	...
,,	Melvich	2·55	110	,,	Killybegs, Rockmount.	1·80	50

Climatological Table for the British Empire, November, 1928.

STATIONS	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	Relative Humidity.	Mean Cloud Am'nt	Am'nt	Diff. from Normal	Days	SUNSHINE Hours per day	SUNSHINE Percentage of possible
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10					
London, Kew Obsy.	1009.3	− 5.3	59	28	52.3	42.1	47.2	+ 3.2	43.7	89	7.8	1.81	− 0.41	15	1.9	21
Gibraltar	1020.4	+ 2.4	73	48	65.5	53.0	59.3	− 1.2	52.5	81	4.4	7.06	+ 0.67	6	..	..
Malta	1014.4	− 2.1	78	45	66.9	58.0	62.5	− 1.4	57.3	72	6.2	7.28	+ 3.71	16	5.9	58
St. Helena	1013.5	+ 2.1	67	53	62.7	55.0	58.9	− 1.2	56.0	96	9.9	0.35	− 1.33	7	..	..
Sierra Leone	1012.9	+ 2.0	90	68	86.9	72.7	79.8	− 1.4	75.6	81	2.7	3.62	− 1.50	7	..	..
Lagos, Nigeria	1008.6	− 2.2	90	73	87.9	77.3	82.6	+ 1.2	77.7	82	5.1	0.54	− 2.04	4	..	..
Kaduna, Nigeria	1014.7	+ 3.4	96	..	90.5	..	..	..	..	..	..	0.00	− 0.12	0	..	..
Zomba, Nyasaland	1009.3	+ 0.4	95	58	87.8	66.8	77.3	+ 1.7	..	57	4.5	1.01	− 4.07	8	..	..
Salisbury, Rhodesia	1008.3	+ 0.1	92	52	83.6	60.4	72.0	+ 1.3	61.1	47	4.4	3.06	− 0.64	9	7.7	60
Cape Town	1018.0	+ 2.2	85	43	73.1	55.2	64.1	− 0.3	57.9	71	5.4	0.89	− 0.19	8	..	..
Johannesburg	1012.0	+ 0.5	88	45	76.1	54.8	65.5	+ 2.0	57.7	68	3.7	5.79	+ 0.83	13	7.8	58
Mauritius	1018.6	+ 2.5	88	63	80.4	67.3	73.9	− 1.6	67.8	60	6.3	1.05	− 0.53	23	9.0	69
Bloemfontein	..	..	95	44	80.6	55.3	67.9	− 0.5	56.5	50	3.7	2.79	+ 0.52	7	..	..
Calcutta, Alipore Obsy.	1014.2	+ 0.9	90	59	85.0	66.5	75.7	+ 2.6	67.5	87	1.6	0.00	− 0.66	0*	..	..
Bombay	1012.0	0.0	95	71	90.9	73.8	82.3	+ 1.8	71.9	76	1.4	0.09	− 0.36	0*	..	..
Madras	1012.0	+ 0.7	89	69	86.0	74.0	80.0	+ 1.1	74.7	79	5.7	6.64	− 7.61	6*	..	..
Colombo, Ceylon	1011.1	+ 1.0	88	71	85.7	74.0	79.9	+ 0.2	76.3	79	7.1	17.59	+ 5.80	25	6.7	57
Hongkong	1017.4	− 0.2	82	57	74.0	65.7	69.9	+ 0.3	62.3	63	5.9	0.81	− 0.86	4	5.9	54
Sandakan	..	..	89	72	86.7	74.8	80.7	− 0.1	77.5	81	..	13.41	− 1.25	18	..	..
Sydney	1015.0	+ 1.3	100	50	75.3	58.6	66.9	− 0.2	60.0	53	5.7	0.26	− 2.55	3	8.4	60
Melbourne	1015.1	+ 0.9	94	44	72.4	51.3	61.9	+ 0.6	54.7	58	5.9	1.20	− 1.02	12	7.7	54
Adelaide	1016.6	+ 1.5	100	45	79.9	55.6	67.7	+ 0.8	56.0	36	4.4	0.49	− 0.67	3	10.8	78
Perth, W. Australia	1017.0	+ 1.7	99	49	76.5	56.8	66.7	+ 0.7	59.4	52	3.3	0.41	− 0.38	5	10.8	79
Coolgardie	1014.3	+ 1.2	102	48	88.1	55.3	71.7	+ 0.9	57.3	36	2.4	0.01	− 0.67	1	..	..
Brisbane	1016.0	+ 1.5	103	59	83.1	64.7	73.9	+ 0.3	66.3	55	5.1	2.90	− 0.76	9	9.0	67
Hobart, Tasmania	1010.2	+ 0.8	86	41	64.8	48.0	56.4	− 0.8	50.7	59	6.6	1.59	− 0.93	19	7.2	50
Wellington, N.Z.	1014.0	+ 1.9	67	40	60.5	48.7	54.6	− 2.3	52.5	77	7.0	5.16	+ 1.64	9	7.7	53
Suva, Fiji	1012.1	+ 1.0	85	65	81.3	71.2	76.3	− 0.9	71.2	72	7.0	6.14	− 3.37	16	5.8	45
Apia, Samoa	1010.0	+ 0.5	90	71	84.7	74.5	79.6	+ 0.9	77.6	79	6.0	14.31	+ 5.02	22	5.4	43
Kingston, Jamaica	1012.5	+ 0.1	89	70	86.5	71.9	79.2	− 0.1	72.1	95	4.4	2.83	− 0.20	12	7.2	64
Grenada, W.I.	1008.0	− 2.3	90	69	85.6	73.5	79.5	+ 0.2	76.7	83	5.2	9.78	+ 1.39	19	..	..
Toronto	1015.6	− 1.2	65	16	45.2	34.2	39.7	+ 3.4	35.6	82	7.6	4.22	+ 1.27	15	2.3	24
Winnipeg	1017.2	+ 0.5	55	8	36.9	23.8	30.3	+ 9.5	..	..	5.7	1.66	+ 0.70	3	3.0	33
St. John, N.B.	1012.9	− 1.0	55	13	40.9	28.7	34.8	− 1.9	30.4	73	7.0	3.02	− 1.39	14	3.6	37
Victoria, B.C.	1018.1	+ 2.6	59	38	49.9	43.0	46.5	+ 2.1	44.0	86	7.5	1.91	− 4.55	16	2.4	26

* For Indian stations a rain day is a day on which 0.1 in. or more rain has fallen.

M.O. 313.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 64

June 1929

No. 761

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

Some Perplexities of the Winter of 1928-9

By L. C. W. BONACINA.

Before the winter of 1928-9, duly ticketed and labelled, is consigned to the meteorological archives, one or two anomalies about it, real or apparent, that run the risk of being forgotten, should be noted. The first anomalous feature relates to the snowfall which for its extreme irregularity of distribution is unique, at least among severe winters since 1875. In the supplementary manuscript to my paper "Snowfall in the British Isles" in *British Rainfall*, 1927, I am reluctantly classing 1928-9 as a snowy winter because, especially in Wales, but also in parts of south-western England, northern England and Scotland, the snowfall was actually heavy all through; moreover by English standards every cold winter means such precipitation as there is in the form of snow rather than rain. But in the Scottish Highlands it was relatively slight and in central and eastern England, except possibly on the Kent coast, the frequent falls of dry snow were so trivial that the ground was never once really covered, the total amount which fell being much smaller than in many a mild winter. In 1895 when the snowfall in the west was also much heavier than in the east the disproportionality was less than in 1929, London being well-covered in February 1895.

The result of this insignificant snowfall in 1929 was that, notwithstanding the freezing of the Thames and the Arctic appearance of the Essex tidal creeks, the winter was nothing like so climatically impressive as it might have been, and the result also was that the frost had a tamer ending in March than would have been the case had the anticyclone established itself

(84689) P. S. 1602/81. 1,050 6/29 M. & S. Gp. 303.

over a land everywhere deep in snow. Who could have believed that after a February so cold, with the frost—just because of the lack of snow—deep in the soil, the equinoctial sunshine of March would yet have sufficed to raise the temperature locally nearly to 80°? And that in a bleak northern county like Yorkshire where sleet and snow in spring, when not actually present, seem always lurking round the corner! Our experiences in March, of skating with afternoon temperatures between 50° and 60°, should have brought home to us that under real anticyclonic weather, heat and cold are closely interwoven. But to us in the British Isles, true "children of the mist" as we are, such dry continental conditions are so rare as to become quite astonishing.

Another interesting anomaly that requires looking into relates to the relative duration of deep-water skating in the north-west and south-east of England. I have heard from more than one source that skating was in full swing on the great lakes of Cumberland and Westmorland for many weeks, and that on Derwentwater it lasted, even over a depth of 70 feet, from early in January to mid-March, the ice being 6 inches thick. Around London skating lasted on small shallow ponds for a similar length of time, but not till the onset of the acute cold in February did it begin on the lakes and reservoirs and never at all on the Serpentine (as distinct from the Long Water) which became the haunt of wild fowl of many kinds. The Serpentine, be it remembered, is of trifling depth in comparison with Derwentwater, and though it may have strong currents, one's natural explanation of the fact that the ice did not apparently quite reach regulation thickness was that the duration of the intense cold was much shorter than in the north. Yet on referring to the charts published in the *Monthly Weather Reports* we find that both in January and February the Lake District lay on a higher sea-level isotherm than London, whilst in December, the first month of the frost, there was little difference. Now the explanation of the relative brevity of deep-water skating in the south would seem to be either that the northern reports are exaggerated, or else that the published isotherms are not based on a sufficient number of stations to reveal the apparently intense local cold that led to such prolonged skating in the deep basins of Lakeland with cold air streaming into them from the heavily snow-clad mountains. But the critical factor may be hydrological rather than meteorological, viz., that the Lakes are more susceptible to freezing through being fed by water from cold mountain levels. In this connexion may I point out that although Cumberland lies on a rather milder normal winter isotherm than Middlesex there have been more winters in the last 50 years which have seen crowds of skaters on Windermere and Derwentwater than on the Serpentine in London.

The Means adopted to obtain satisfactory Illumination of our Barometers

By G. A. Clarke, Aberdeen Observatory.

In the summer of 1928 it was decided, as the result of a discussion with Col. Gold, to enclose the Aberdeen barometers in protective casings, in order to shield them from the direct light and heat of the sun, which at certain periods of the year shines through the eastward window of the Observatory, at the sides of which window the barometers are mounted.

Consequent upon this decision the necessity arose for artificial illumination of the cistern level, vernier, and scales of the instruments, and the following is a description of the plan adopted.

The barometers are completely enclosed in box-like cases with glazed doors. In the right-hand rear corner of the casing, small electric bulbs of the type known as "tubular" are fitted, one at the vernier level and the other at the cistern level, and are so arranged as to be switched on simultaneously. No direct light from these bulbs falls on the instrument, but, instead, a system of reflecting and shielding surfaces was evolved and arranged as shown in the drawings which in Figs. 1 and 2 show horizontal cross-sections at the vernier and cistern levels respectively.

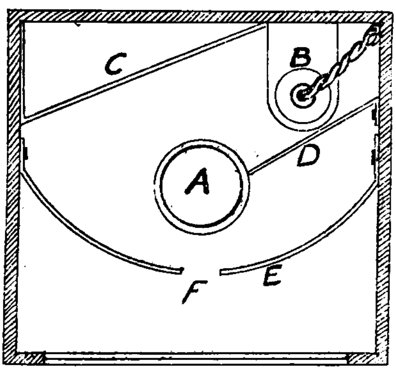


Fig. 1.

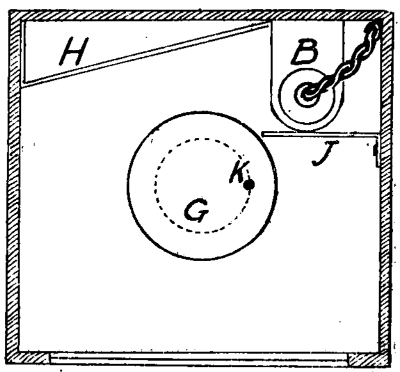


Fig. 2.

In Fig. 1 the circle A represents the cross-section of the barometer tube and scale. At B the tubular bulb is fitted to a brass flange, the bulb hanging vertically. The light from the bulb is reflected from a surface of white Bristol-board C, which is inclined at an angle as shown in the drawing. At D is a blackened Bristol-board shield, covering the bulb and cutting off direct light from the observer's view. In front of the barometer scale, at a suitable distance, and having a suitable curvature, both determined by experiment, is a curved Bristol-board shield E. This shield is white on the inside and blackened on the side towards the observer. In it is cut a slit F, of sufficient length and width to enable only the mercury column and the scale and vernier to be seen conveniently.

When the light is switched on, the observer, looking through the slit F, sees the brilliantly illuminated white card C above the mercury column, and the scale and vernier less brightly illuminated by the reflection of light from the white inner surface of the shield E. When the vernier is brought down to the level of the mercury meniscus, the brighter illumination practically disappears, and only the illuminated scales are visible; they can then be read with ease and precision.

At the cistern level, the cross-section of which is shown in Fig. 2, G indicates the cistern, H is the inclined reflector, and J the dark shield. K shows the position of the fiducial point or index, which, when the light is switched on, shows clearly against the white reflecting background.

The chief advantages of the arrangements described are those of uniformity and effectiveness of illumination. The employment of light reflected from matt white surfaces entirely eliminates the effects of irradiation, while the presence of the shields ensures that only the necessary parts of the instrument are illuminated. The cases enclosing the barometers should obviate any sudden or rapid variations of temperature, the intensity of the illumination is fairly constant, and the readings are taken always under uniform conditions; they should therefore be very consistent and dependable.

Royal Meteorological Society

The usual monthly meeting of this Society was held on Wednesday, the 15th inst., in the Society's Rooms, 49, Cromwell Road, South Kensington, Sir Richard Gregory, D.Sc., President, in the Chair.

Mr. J. E. Clark gave a brief account of the effects of the frost and drought in the early months of 1929 in delaying the appearance of plants.

The following papers were discussed :—

1. *J. Edmund Clark, I. D. Margary, R. Marshall and C. J. P. Cave.—Report on the phenological observations in the British Isles, December,* 1927, *to November,* 1928.

It may surprise many to find on examining the Report, that 1928 considered as a whole differed so slightly from the average for 35 years. We think of the year as sunny, but the dull spring balanced brilliancy in January, July and September; so too the bitter December and chilly June were off-set by the wonderful warmth from January to April, with only occasional slices of cold sandwiched in. The response of flowers, birds and insects, each in their own way has been interesting. December checked the hazel, despite January, making it flower at the average date. But coltsfoot and the next five plants to appear, up to the hawthorn, came early. Still the April cold snap nearly made the horse-chestnut late, so that it only flowered two days instead of six earlier than the hawthorn. In north Scotland it was actually later. Migrants, despite some remarkable premature records of swallow, chiffchaff and cuckoo, averaged only a couple of days early. But this fully suffices to make the lines of equal appearance dates (Isophenes) shift markedly northwards compared with 1927. Interesting are special areas of approach mostly up estuaries, especially the Bristol Channel. A reason for this may be the sea temperatures south and south-east of Ireland. The agreement of the flowers with the average date has produced a " zero " line, unbroken but very sinuous, 2,750 miles long, unprecedented in the previous 37 years. Both farm and garden notes are decidedly on the cheerful side, especially compared with 1927, excepting fruit crops and large areas in north Scotland.

2. *D. Brunt, M.A., B.Sc.—The index of refraction of damp air, and the optical determination of lapse-rate.*

This paper gives the correction to the index of refraction μ, to allow for the presence of water vapour, and shows that variations of humidity give results which cannot be distinguished optically from variations of temperature. It is shown that damp air of temperature T, and virtual temperature T^1 has the same index of refraction as dry air at a temperature $\frac{2}{3}T + \frac{1}{3}T^1$.

3. *J. Reginald Ashworth, D.Sc.—The influence of smoke and hot gases from factory chimneys on rainfall.*

In a manufacturing town such as Rochdale the combustion of large quantities of coal must produce an upward current of hot air which is probably sufficient to influence the rainfall. This effect is not likely to be a large one but it seems to be a real one from these considerations. (1) The average rainfall on week-days over the long period of 30 years is found to be six per cent more than the average on Sundays. At Stonyhurst, where factories do not predominate, the rainfall on Sundays and week-days is more nearly alike than at Rochdale. (2) A continuous record of rainfall hour by hour shows that there are more hours of rain during the working hours of the day on week-days than on Sundays. Also on week-days the rainy hours are more in the daytime than in the night the reverse of which occurs on Sundays, and at Stonyhurst on all days, as is generally the case at western stations. (3) The rate at which rain falls is decidedly greater on week-days than on Sundays. It is small on Sundays and increases until mid-week, after which it slightly diminishes. This variation of the rate at which rain falls agrees very closely with the fluctuation of smoke emission as tested by the average number of soot particles deposited from the air each day of the week. The fact that there is any difference at all points to the influence of human agencies, of which the only reasonable one is the emission of smoke and hot gases in large quantities into the air. The alternative to this that there is a natural 7-day period in rainfall which accidently has its minimum on Sundays is too unlikely to be seriously considered.

A good discussion followed, in which two opposite views were expressed. Some speakers thought that all the effects ascribed to the emission of hot gases could equally well be the result of chance variations; it was pointed out for example that the deficiency in the quantity of rain on Sunday was less marked than the excess on Monday, for which no cause was assigned, and that the deficiency in the number of hours between 6h. and 18h. on Sunday was not uniformly distributed but was almost confined to a few hours at midday. Other speakers, including Sir Napier Shaw, thought that although each separate piece of evidence could be otherwise explained, taken all together their general concordance was a strong argument for the reality of the effect. The general view taken by these speakers was that the increase was probably due to the chemical effect of the hygroscopic nuclei emitted rather than to any mechanical effect caused by the high temperature of the gases emitted.

Correspondence

To the Editor, *The Meteorological Magazine*

Inversions and Grass Minimum Temperatures

In the *Meteorological Magazine* for January, 1929, p. 283, Colonel Gold discusses the difference in the readings of minimum thermometers exposed according to specifications two inches above the ground, where one is over short grass and moss and another over grass with bare earth between blades. The latter gives consistently lower readings. In studies of "Frost Protection" it has been shown that a miniature tropopause exists a few centimeters above the soil, especially noticeable on quiet, clear nights. Thus, if the surface reading is $-2°C$. the reading at a height of 5 centimeters may be $-4°C$., above which level the temperature rises slowly, reaching $-2°C$. at about one meter.

The nature of the cover is important. Contrary to the findings at South Farnborough, thickly matted soils are not always warmer than open, sandy soils. In fact sanding is one of the methods used in cranberry bogs to mitigate low temperatures.

Colonel Gold suggests that radiation is more energetic at the top of the carpet of short grass and moss, and that the layer of air entangled beneath the grass top remains warmer. Minute turbulence follows from the unstable state. With bare ground a more stable condition exists and the air cools progressively. It is largely a question of air drainage and a slow transvection of air, which moving over a bare or sanded surface, leads to mixing and decreases stratification.

In various papers on Frost Fighting, curves of these and other inversions (see Fig. 1, Temperature Inversions in Relations to Frosts) are given.* Inversions on a larger scale are quite common, from the ground up to 200 meters. Thus at Blue Hill

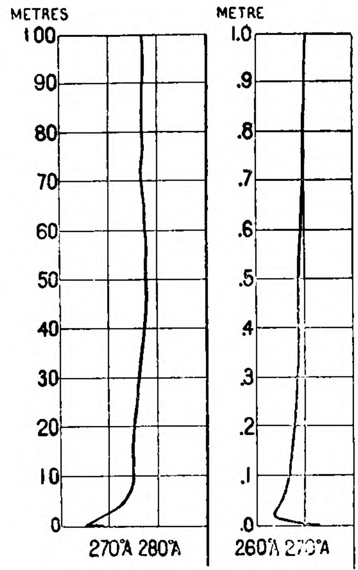


FIG. 1.
(Reproduced from Ann. Astr. Obs. Harvard Coll., LXXIII., 1915.)

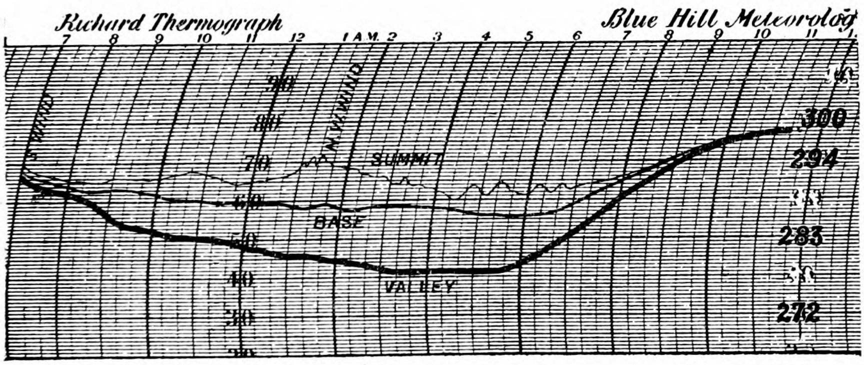


FIG. 2.
(Reproduced from Ann. Astr. Obs. Harvard Coll., LXXIII., 1915.)

an inversion of 11°C. has been recorded; and we are able to check the lapse by intermediate records, the three levels being: summit 200 meters, base 66 meters, and valley 18 meters above sea-level. (Fig. 2, Illustration of Typical Late Spring Frost.) Wind seems to be the effective factor. It is also well known that there are inversions or marked changes in lapse rate just above cumulus clouds. And finally, there is the great discontinuity at the top of the troposphere. If we accept the conclusions of Lindemann and Dobson there is another major inversion

* *Ann. Astr. Obs. Harvard Coll.* LXXIII, 1915. Part II. Temperature inversions in relation to Frosts, by A. McAdie.

at 65 kilometers. Not only from the study of meteors and auroras, but from the behaviour of radio signals in, through and possibly beyond, the Kennelly-Heaviside ionized layer, we are now able to explore the upper reaches of air. Meanwhile at the other extreme, under our feet, is a tropopause in miniature.

ALEXANDER MCADIE.

Harvard University, Blue Hill Observatory, Mass. U.S.A. February 4th, 1929.

A further series of comparison readings of grass minimum temperatures on the two instrument sites at South Farnborough have recently been completed, and it is thought that a discussion of the results might prove interesting in view of the suggestions made by Colonel Gold in the *Meteorological Magazine* for January, 1929.

In the first of the present series (November 17th to December 16th, 1928) the average difference for 30 nights was 1°F., the first site (covered with short grass and moss) reading higher than the second, in which bare earth is visible between the blades of grass. In the second set of readings (December 17th, 1928, to January 15th, 1929) with the thermometers interchanged, the average difference was 0.2°F., the first site reading lower. This appeared to indicate a thermometric error of 0.6°F. and led to the conclusion that the real difference between the two sites during the period studied was only of the order of 0.4°F., the first site reading higher. The interesting result is that for 50 nights in late summer and autumn the average difference is 5°F. but that for 60 nights in late autumn and winter it is only 0.4°F. These figures lead to the suggestion that the seasonal change in the vegetation around the first site plays the major part in the divergence.

It is to be noted, however, that the moss-covered site is still reading slightly higher during winter when neighbouring trees, etc., are bare, and at first sight it would appear that this (0.4°F.) is the order of the differences, an explanation of which was suggested by Colonel Gold. Some recent observations of grass minima on the second site have given very different results. A site covered with a carpet of moss was selected as near as possible to the standard site (grass and earth covered). Only nine readings have been obtained to date. Five of these on cloudy nights gave similar readings, the other four on radiation nights gave a lower minima over moss of the order of 2°F. and not a higher reading. It would appear that conduction of heat upwards from the earth beneath does in this case play an important part, and that the minute turbulence is only of a secondary nature. In the case of the moss the heat radiated would not be made good by conduction, the air entangled in the moss acting as a bad conductor.

There is a further complication on the first site in the fact that it is more often permeated with water owing to the proximity of a small stream and to bad drainage. This would increase the conductivity of the soil and moss and with a dry night air lead also to cooling by evaporation. In the case of the first site we have, therefore, to consider four possible effects:—(*a*) surrounding vegetation and the reflection of heat radiated from the ground, (*b*) the moss carpet and its prevention of conduction of heat from the earth, coupled with any difference in the nature, and hence the conductivity, of the soil on the two sites, (*c*) the effect of water in increasing the conductivity of the soil and moss, and (*d*) the effect of evaporation during night in cooling the moss carpet. A measure of the difference in the readings between the two sites is consequently given by an expression of the form $(a)-(b)+(c)-(d)$. Several variations of this expression might occur, *e.g.* (1) during a night with high relative humidity, effect (*d*) would be negligible; (2) after a spell of dry weather, effect (*c*) would be negligible; (3) during wet weather, effects (*b*) and (*c*) would tend to neutralise one another, etc. It is thought that these variations might afford an explanation of the day to day changes in the differences between the two sites as well as to the change in the average differences. From the figures available, effect (*a*) appears to predominate whilst surrounding trees are in leaf; in winter, effects $(a)+(c)$ are in general balanced by effects $(b)+(d)$, so that on the average there is little difference between the sites.

Some such specification as suggested by Colonel Gold certainly appears desirable, but in view of the results obtained at this station it is felt that a specification of the solid angle subtended by surrounding objects should also be included.

W. H. Bigg.

R.A.E., S. Farnborough. January 29th, 1929.

Smoke Cloud

In regard to the letter re the above in the current issue of the *Meteorological Magazine*, may I point out that the blaze on the Fire Hills at Hastings occurred on Monday, March 11th, therefore the smoke seen by Dr. Whipple on the 9th could not have originated at Hastings.

Cicely M. Botley.

Guildables, 17, *Holmesdale Gardens, Hastings. April 22nd,* 1929.

I am much obliged to Miss Botley for pointing out my mistake. The smoke which I saw had the right bearing for Hastings but it must have originated at a nearer place, perhaps in Ashdown Forest. That being so my estimate of the height of the cloud should be considerably reduced.

F. J. W. W.

The Scanty Rainfall of 1929

A search through the rainfall records here extending over 110 years fails to reveal a four-month period of low rainfall such as has been experienced this year. The total fall to April 30th was only 3·06 inches made up as follows:—

	inch.	
January	0·98	(The average fall during this period is 8·35 inches.)
February	1·12	
March	0·18	
April	0·78	
	3·06	

March was the driest on record here.

By selecting a three-month period of drought in various years some extraordinary "coincidences" result:—

1893. March to May: total 2·07 inches.
1898. January to March: total 2·07 inches.
1921. February to April: total 2·07 inches.
1929. February to April: total 2·08 inches.

However, the timely arrival of early May rains has thwarted the beating of yet another record. I refer to the dry season of 1896 when the five-months' rainfall (January to May) amounted to only 3·84 inches—of which May claimed but 0·18 inch. In that very dry year the total rainfall to the end of August (eight months!) had reached only 8·15 inches.

The dryness of the spring of 1929 is well illustrated by the relative humidity values, *e.g.*, during April two values under 30 per cent were registered at 13h. whilst the hygrograph showed one instance under 20 per cent. The *mean* relative humidity during April was well under 60 per cent both at 13h. and 18h. Such a state of things does not normally occur until June or July.

F. J. PARSONS.

The Observatory, Ross-on-Wye. May 6th, 1929.

Approximate Equations for the Determination of Screen Minimum Temperatures during Radiation Nights

In the *Meteorological Magazine* for February, 1928 (p. 20), one of us, in conjunction with Mr. J. Paton, gave approximate equations for the determination at Cranwell of screen minimum temperatures during radiation nights in winter (October to March inclusive) from a consideration of data of the preceding 15h. It has since been thought that a similar piece of work for a seacoast station was called for, for the purposes of comparison. Calshot was the station selected. The period examined stretched from October 1st, 1923, to March 31st, 1928, a

" radiation night " was defined as in the previous note as one in which the mean cloud amount at 18h., 1h., and 7h. G.M.T. was four-tenths or less, and the screen minimum temperature was that measured at the last mentioned 7h.

In determining the equations representing the relationships by the usual graphical methods, a differentiation as before was adopted with regard to wind force during the night, as measured by a Dines anemometer whose head is 43ft. above ground, taking the average of the readings at 18h., 1h., and 7h., as the deciding factor. Two wind groups were taken : (*a*) a mean of 8 miles an hour or less, (*b*) a mean of more than 8 miles an hour. Each of these two groups was further sub-divided according as to whether the relative humidity at 15h. was greater or less than 85.

The equations obtained were as follows, where T = expected night screen minimum; D = dew point at 15h., H = relative humidity at 15h. :—

Mean wind speed	Value of H	Equation	No. of cases available
8 m.p.h. or less	$H = \text{or} > 85$	$T = 1.06D - 8.0$	9
	$H < 85$	$T = 0.88D + 2.1$	59
Greater than 8 m.p.h.	$H = \text{or} > 85$	$T = 0.83D + 1.8$	32
	$H < 85$	$T = 0.80D + 9.0$	143

As in the previous note these equations are only put forward as holding for values of D greater than 32°F. Those given fit the actual results very well, there being no marked divergencies.

W. H. PICK.
D. F. BOWERING.

September 24th, 1928.

Moonbeams analogous to Crepuscular Rays

On April 25th at 11 p.m. (B.S.T.) a dim streak of light was seen stretching across the sky, from near the eastern horizon to the zenith. The night was cool and still, and the sky dark, apparently covered by light unbroken clouds. Some of the brighter stars (1st and 2nd Mag.) of high altitude were visible, but near the horizon all were obscured by haze. From a position distant from street lamps, other similar straight streaks were visible. These were about 2° in angular breadth, and in general appearance and visibility resembled lunar halos, except that they were straight. These streaks apparently converged towards the east (and therefore were presumed to be parallel) and were most distinct between about 30° above the horison and a few degrees west of the zenith; they were stationary except for a slow drift southwards. A little after 11 p.m. the moon suddenly appeared, some 8° above the south-south-east horizon, over a dense bank of cloud.

L. G. VEDY.

Downing College, Cambridge. May 4th, 1929.

NOTES AND QUERIES

The early History of the South-west Monsoon

Marco Polo, the Venetian, travelled in Asia between the years 1271 and 1295. On his return journey in 1293, or more probably in 1294, he visited the island of Ceylon. The following notes of what he observed or learned there are taken from the translation published in the magnificent annotated edition of Colonel H. Yule, issued by Murray in 1871. "You must know that the sea here forms a gulf between the Island of Seilan (Ceylon) and the main land . . . . . The pearl-fishers take their vessels, great and small, and proceed into this gulf, where they stop from the beginning of April till the middle of May . . . . . As soon as the middle of May is past no more of those pearl shells are found there." A note by Colonel Yule points out that the fishery in modern times takes place at an earlier season, in March and April. The time appears to be fixed so that the fishery occurs between the cessation of the north-east and the beginning of the south-west monsoons.

The next European traveller to visit Ceylon and to record the date of this fishery seems to have been another Venetian, named Cæsar Frederick, who lived in the East from 1563 to 1581. An account of his travels was published in Hakluyt's Voyages (II.1.224). This narrative, however, gives the same dates for the season of the pearl-fishery as does Colonel Yule for modern times.

The difference between these two early records raises the interesting question whether there was actually a change in the date of arrival of the south-west monsoon between the beginning of the fourteenth and the middle of the sixteenth centuries. An alternative solution is very simple; Marco Polo may have made a mistake. If so it can hardly have been a casual error of dictation, because the statement of the date of the end of the fishing season is repeated.

A change was made in the calendar by Pope Gregory XIII in the year 1582 when ten days were omitted, making that particular year, in Italy, one of only 355 days. The corresponding change in England was not introduced until 1752, the bill to affect this alteration in 1584 having been withdrawn after the second reading. Clearly this fact must be taken into account in estimating the true change in the date of the beginning of the south-west monsoon. Correcting Marco Polo's account for the change in the calendar increases by nearly ten days, the difference between his record and present-day dates of the monsoon. It is doubtful whether Cæsar Frederick used the old style or the new in the story of his travels. If he used the old style then it is possible that the fishery in his day came to an end early in May rather than at the end of April. The change in the date of the monsoon may not have been quite completed by 1580.

Another district, of which Marco Polo gave some account, was called by him Maabar, and this is believed to correspond closely with the modern Coromandel Coast. He describes the climate in the following passage:—"You must know that the heat here is sometimes so great that 'tis something wonderful. And rain falls only for three months in the year, viz., in June, July and August. Indeed, but for the rain that falls in these three months, refreshing the earth and cooling the air, the drought would be so great that no one could exist." Colonel Yule wrote a note on this passage stating his belief that Polo wrongly applied to this coast a description that was true of the districts both to the west and to the east of it. Coromandel, he informs us, gets rain from the north-east monsoon in October. It would be a dangerous matter to contradict such a high authority as Colonel Yule, but the evidence of a change of climate in Eurasia since the Middle Ages, which has been collected in recent years, rouses the suspicion that Marco Polo may have been correct after all. If so an interesting problem is propounded, for some very drastic change in the circulation seems to be indicated, reminiscent of the history of the climate of Central America.

It may well be asked whether there are any other records of climate in the latter part of the thirteenth century which point to the later arrival of summer conditions. There is just one meagre piece of dubious evidence that in England, or rather in the south of England, spring came late in the Middle Ages. It is notoriously difficult to prove a negative. A considerable body of evidence has, however, been collected which points to the conclusion that the cultivated cherry was scarcely grown at all in England between the days of the Romans and the reign of Henry VIII. Now vines were certainly widely cultivated during that period, as was pointed out by Sir Richard Gregory* and many earlier authorities. The cause for this anomaly must be sought in the different climatic requirements of these two fruits. Usually the vine is regarded as a more southern type than the cherry. But even under glass, unless much forced,

*See *Geographical Teacher*, XII, part 4, p. 249.

grapes ripen at a much later season than cherries, and the flowering period in the open will be found to be somewhat later. It seems probable that cherries in the south of England were not a paying crop in the Middle Ages, just as they are not in the north country to-day, because the conditions in April and May did not allow of successful flowering and setting of the fruit. Possibly the vine, in protected situations, may have succeeded in forming its fruit and ripening it later in the year sufficiently to be made into a substitute for decent wine—with the help of those tell-tale blackberries that some of the cottagers were bound to pick for their landlords. The flower of the cherry came too early and met the frost of the last part of the mediæval winter. By the end of the fifteenth century the date of the change to summer conditions had become early enough to allow the cherry to set its fruit in the south of England. Its culture spread very rapidly in Kent in the reign of Henry VIII.

The picture of the mediæval climate of England which is suggested by the strange history of the culture of cherries would seem to approximate to the present climate of Burgos in Spain, which is vividly sketched as *Nueve meses de invierno y tres de infierno*, Nine months winter and three months hell.

Everything in this article must be regarded as tentative and provisional. Confirmation is badly needed of the record of Marco Polo. The true cause of the neglect of cherry culture in earlier times may have been merely the ignorance of the men of those days of the dietetic value of plenty of fruit. The coincidence of the two lines of evidence is left to the consideration of the reader.

G. M. MEYER.

Insplashing into and outsplashing from the funnel of a rain-gauge

The remarkably heavy rainfall in London during Monday evening, October 22nd, provided a particularly good example of insplashing into the funnel of a gauge from the surrounding ground. At Streatham two rain-gauges were in use, one a gauge with a Snowdon funnel with 4-inch vertical sides and its rim 1 foot above short grass, the other a check gauge with a shallow funnel and with its rim only 4 inches above recently dug earth. When the gauges were inspected the next morning splashes of earth were apparent on the outside of the funnel of the check gauge right up to the rim. The observer had also noted that the rain-water in the gauge was very muddy. In the case of the standard gauge and in the case of other gauges inspected that morning in the district, where the same quantity of rain fell, the catch had been clear water even where the surrounding ground seemed very dirty. All these gauges were of the Snowdon pattern with the rims at 1 foot.

It is unfortunate that the check gauge had a shallow funnel. Actually, the check gauge only gave ·72in., compared with ·77in in the Snowdon gauge. Apparently the check gauge with the shallow funnel failed to retain all the heavy rain falling into the funnel.

It appears, therefore, that during this unusually heavy rain—

(1) while there was a material amount of insplashing into the gauge with the rim only 4 inches above the ground, it was negligible in the case of that at 1 foot;

(2) the amount of outsplashing from the gauge with the shallow funnel exceeded the insplashing by about 7 per cent. of the total fall.

J. GLASSPOOLE.

Meteorological Charts of Egypt and the Nile Valley

The Survey of Egypt has recently issued a very fine series of climatological charts, part of a larger atlas. These charts are based on information supplied by the Physical Department, covering the whole Nile Valley from the Mediterranean to latitude 5° south, and represent the longest period of observations available, generally covering 25 years. They show mean temperature, mean daily maximum, and mean daily minimum for the months of January, April, July and October, and absolute maxima and minima of temperature for the year. The highest maximum shown exceeds 52°C. (126°F.) at Wadi Halfa. Then follow isobars, prevailing winds and isohyets for the same four months. The last chart shows annual isohyets and daily weather charts illustrating various weather types, including the Khamsin. These are accompanied by explanatory text, and the whole is preceded by two sheets of text and diagrams, which also illustrate the variations of humidity and cloudiness.

Meteorological Instruments of the late Mr. J. G. Waller

The late Mr. J. G. Waller, who carried on meteorological observations at Plumstead for a number of years, had a good equipment of meteorological instruments including two barometers, sunshine recorder and thermometers, and Mrs. Waller now wishes to dispose of these. Offers to purchase should be made to her at 51, Hinstock Road, Plumstead, London, S.E.18.

Erratum

October, 1928, p. 224. Heading of table *should read* "Climatological Table for the British Empire, April, 1928."

Ten-Day Period Temperatures

An examination of the mean maximum and mean minimum temperatures for ten-day periods at the four stations, Kew, Falmouth, Valentia and Aberdeen for the thirty years, 1871 to 1900 inclusive, obtained from the Meteorological Office publication, *Temperature Tables for the British Isles*, shows a run of temperatures for the periods August 1st to 10th, and August 11th to 20th, which does not appear consistent with a smooth annual variation.

From the table of temperatures appended it will be seen that, before the general fall takes place during August 21st to 30th—

(1) The mean maxima and minima for Falmouth and Kew for August 1st to 10th decrease from the preceding period and increase in the subsequent period.

(2) The mean minima for the four stations show an average increase of 0·45°F. for the period August 11th to 20th after an average decrease of 0·33°F.

(3) Although Aberdeen shows a slight fall of 0·2°F., there is an average increase of 0·27°F. in the case of the mean maxima for the four stations for the period August 11th to 20th.

A point of interest is that Buchan fixed the period August 6th to 11th for a "cold" spell, and the period August 12th to 15th for a "warm" spell. This "cold" spell falls approximately into the first ten-day period in question, and the "warm" spell into the second ten-day period.

MEAN DAILY MAXIMUM TEMPERATURE, 1871—1900				
	July 21st-31st	Aug. 1st-10th	Aug. 11th-20th	Aug. 21st-30th
	°F.	°F.	°F.	°F.
Kew ...	71·0	70·4	71·1	68·4
Falmouth...	66·1	65·7	65·9	64·8
Valentia ...	64·3	64·5	64·9	63·1
Aberdeen ...	61·6	62·1	61·9	60·1
MEAN DAILY MINIMUM TEMPERATURES				
Kew ...	55·1	53·8	54·5	53·0
Falmouth...	55·8	55·5	56·0	54·8
Valentia ...	54·7	55·0	55·1	54·0
Aberdeen ...	50·6	50·6	51·1	49·4

D. F. BOWERING.

Reviews

Die bebenauslösende Wirkung der Sonnenflecken, gezeight an der sogenannten elfjährigen Periode. By Otto Myrbach. Brunswick, Zs. Geophys. 4, 1928, Heft 7/8, pp. 413-416.

In this paper an hypothesis is put forward that solar activity has a direct influence on the generation of earthquakes. The view is that an earthquake is caused when stresses in the earth's crust exceed some critical value, but that by some solar action the rate of growth of the stresses can be accelerated. The author anticipates that increased solar activity will enable earthquakes to occur before the stresses have reached their critical values and, therefore, that disturbances will be more frequent and less violent during sunspot maximum than during sunspot minimum.

The hypothesis is tested by comparing the variation of earthquake frequency with variation of solar activity, but in the absence of reliable information as to the total number of earthquakes occurring all over the world, the author uses data relating to disturbances recorded at one station only (Vienna). Unfortunately the number of distant earthquakes which are registered at one station depends rather on their strength than on the frequency of occurrence, whereas the number of near earthquakes depends mainly on frequency of occurrence. However, the author makes use of this difference and separates the near earthquakes from the distant ones, expecting to find at sunspot maximum a minimum frequency of distant earthquakes and a maximum frequency of near earthquakes. The frequency curve for near shocks, which is reproduced in the paper, can scarcely be considered to bear any close relation to the sunspot curve, while the method of deriving the corresponding curve for distant earthquakes is very unconvincing.

F. J. Scrase.

Climate of New Zealand. By Dr. E. Kidson. Extract from the *New Zealand Official Year-Book*, 1929, pp. 1-18.

This booklet gives in sixteen pages of letterpress and diagrams a considerable amount of information. Eleven pages are devoted to a general description of New Zealand's climate, supplemented by a map of the mean annual rainfall and by tables of normal values for six stations in the North Island and eight in the South Island. For comparison similar tables are given for Kew Observatory and Aberdeen.

The remaining part is devoted to results of observations in 1927. Diagrams are given showing the departures from normal of mean monthly temperature and rainfall at eight stations; areas over which rainfall in 1927 was above the average are shown by a map, a tabular summary is given of the observations at 28 stations distributed over the two islands, and short notes indicate the general character of the weather in the various months. Regarding the year as a whole, it is stated that " the prevailing westerly winds were very much below average strength, a feature most probably associated with the approach of a maximum of solar activity. Rainfall was above normal over most of the North Island, and although there was a deficit in the South Island this was offset by the absence of drying winds. . . . . The year was, on the whole, a cold one."

S. T. A. MIRRLEES.

Obituary

We regret to learn of the death, on April 9th, 1929, at Washington, D.C., of Colonel E. Lester Jones in his 53rd year. Colonel Jones had been Director of the United States Coast and Geodetic Survey since April, 1915.

The Weather of May, 1929

May was again a dry month on the whole, though there were many local variations, some stations in the west, and particularly the south-west, having more than the average rainfall. The first half of the month was rather cool and unsettled, pressure was high to the north-west and south-west of the British Isles, leaving a track for depressions across the country. Some heavy local falls of rain were recorded during this period, notably :— on the 4th, 1·91in. at Festiniog, Merioneth, and 2·23in. at Llyn Fawr Reservoir, Glamorgan; on the 5th, 1·88in. at Holme, S. Devon; and on the 14th, 2·06in. at Borrowdale, in Cumberland. Thunder was reported locally on the 7th, 8th, 14th and 15th. Many good sunshine records were obtained during the first three days of the month, and again from the 8th to the 10th.

On the 16th anticyclonic conditions became established, and practically no rain fell throughout the country until the 21st, when a depression on the Atlantic spread eastwards, causing rain in the west and north. At Fofanny Reservoir, in County Down, 3·52in. fell on the 22nd. In the east of England, however, it remained fine and sunny with rather high temperature until the 24th. On the 24th a shallow trough of low pressure crossed Great Britain causing local thunderstorms; Mr. G. E. Dacey reported a severe storm with damage by lightning at Lewisham, and 1·72in. fell at Cambridge. Further thunderstorms, due to shallow depressions over France and off south-west Ireland, occurred on the 26th and 27th. Temperature continued high locally until the 28th.

During the last few days of the month an anticyclone off the north-west coasts gave north-easterly winds over most of the country and dry, cool weather with a good deal of cloud in the east but bright in the west. In the extreme south-west, however, almost continuous rain was experienced for two days.

Sunshine was well above the normal in many places and some good individual records were obtained, notably:—14·9hrs. at Croydon on the 21st, 15·2hrs. at Harrogate on the 25th, and 16hrs. at Inverness on the 30th. During the week from the 19th-25th Gorleston recorded 93hrs., an average of 13·3hrs. per day; and during the whole month Calshot recorded 270hrs., an average of 8·7hrs. a day and 56 per cent of the duration of daylight. The distribution of sunshine is shown by the following table:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	236	+45	Valentia	178	—25
Aberdeen	179	— 8	Liverpool	241	+42
Dublin	240	+35	Falmouth	207	—24
Birr Castle	201	+19	Kew	244	+43

Pressure was slightly below normal over the British Isles and Iceland and slightly above normal over the rest of Europe except southern Italy and Greece; it was well above normal over the Atlantic from the Azores to Bermuda. Temperature was above normal in Sweden and slightly so in eastern England; it was below normal in Spain and Central Europe. Rainfall was below normal in northern Norway, eastern England and Central Europe and above normal at Spitsbergen, in northern and in central Sweden where the excess reached 50 per cent; in southern Sweden the rainfall was normal.

Owing to the severe winter there were icebergs in the Kerch Strait (Sea of Azov) in the middle of May; the shallower part of the sea had frozen right to the bottom, and although the surface layers thawed some time ago, the ice layer at the sea bed was only then thawing and rising to the surface. Ships were forced to alter their courses. In consequence of a sudden drop in temperature snow fell on the Swiss Alps on the 15th as low as 4,500 feet; in some places the fresh snow was 10in. deep. Storms and continuous rain in Yugoslavia caused floods in many districts; on the 17th the main railway line between Belgrade and Nish was cut in two places by floods of the River Morava, and the Simplon Express had to return to Belgrade. A cloud-burst occurred at Valievo destroying many houses.

Widespread floods occurred in Iraq in the early part of May. The Tigris is said to have reached a height unknown for 50 years, and the Euphrates rose 23 feet above its normal summer level at Jerablus, submerging all its islets. Thousands of acres of winter crops ready for harvesting were destroyed.

Rainfall: May, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	1·39	79	*Leics* .	Belvoir Castle	1·20	57
Sur .	Reigate, The Knowle	2·45	144	*Rut* .	Ridlington	1·68	...
Kent .	Tenterden, Ashenden	1·58	100	*Linc* .	Boston, Skirbeck	1·15	65
,, .	Folkestone, Boro. San.	1·38	...	,, .	Lincoln	·83	44
,, .	Margate, Cliftonville	·69	44	,, .	Skegness, Marine Gdns	·89	52
,, .	Sevenoaks, Speldhurst	2·05	...	,, .	Louth, Westgate	1·19	59
Sus .	Patching Farm	2·67	144	,, .	Brigg, Wrawby St.	1·08	...
,, .	Brighton, Old Steyne	1·70	105	*Notts* .	Worksop, Hodsock	·73	37
,, .	Heathfield, Barklye*	2·54	141	*Derby* .	Derby, L. M. & S. Rly.	2·31	121
Hants .	Ventnor, Roy. Nat. Hos.	2·73	161	,, .	Buxton, Devon Hos.	3·12	101
,, .	Fordingbridge, Oaklnds	2·42	116	*Ches* .	Runcorn, Weston Pt.	1·87	81
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	1·74	...
,, .	Sherborne St. John	1·46	75	*Lancs* .	Manchester, Whit. Pk.	2·61	123
Berks .	Wellington College	3·29	177	,, .	Stonyhurst College	3·18	112
,, .	Newbury, Greenham	1·89	100	,, .	Southport, Hesketh Pk	1·96	94
Herts .	Benington House	...	...	,, .	Lancaster, Strathspey	2·23	...
Bucks .	High Wycombe	2·81	159	*Yorks* .	Wath-upon-Dearne	1·10	54
Oxf .	Oxford, Mag. College	·83	46	,, .	Bradford, Lister Pk.	1·57	75
Nor .	Pitsford, Sedgebrook	1·83	96	,, .	Oughtershaw Hall	1·72	...
,, .	Oundle	·83	...	,, .	Wetherby, Ribston H.	1·50	72
Beds .	Woburn, Crawley Mill	1·68	87	,, .	Hull, Pearson Park	1·26	65
Cam .	Cambridge, Bot. Gdns.	2·81	160	,, .	Holme-on-Spalding	1·36	...
Essex .	Chelmsford, County Lab	1·78	124	,, .	West Witton, Ivy Ho.	1·47	...
,, .	Lexden Hill House	1·50	...	,, .	Felixkirk, Mt. St. John	1·66	88
Suff .	Hawkedon Rectory	1·29	70	,, .	Pickering, Hungate	1·18	...
,, .	Haughley House	·94	...	,, .	Scarborough	1·42	74
Norf .	Norwich Eaton	·94	49	,, .	Middlesbrough	1·16	60
,, .	Wells, Holkham Hall	1·26	78	,, .	Baldersdale, Hury Res.	1·53	...
,, .	Little Dunham	1·73	89	*Durh* .	Ushaw College	1·21	56
Wilts .	Devizes, Highclere	1·75	97	*Nor* .	Newcastle, Town Moor	·78	38
,, .	Bishops Cannings	1·99	102	,, .	Bellingham, Highgreen	1·60	...
Dor .	Evershot, Melbury Ho.	3·56	175	,, .	Lilburn Tower Gdns.	1·04	...
,, .	Creech Grange	2·53	...	*Cumb* .	Geltsdale	1·59	...
,, .	Shaftesbury, Abbey Ho.	2·46	116	,, .	Carlisle, Scaleby Hall	1·29	54
Devon .	Plymouth The Hoe	3·18	154	,, .	Borrowdale, Seathwaite	8·50	115
,, .	Polapit Tamar	3·99	198	,, .	Borrowdale, Rosthwaite	6·98	...
,, .	Ashburton, Druid Ho.	4·76	178	,, .	Keswick, High Hill	3·46	...
,, .	Cullompton	2·67	124	*Glam* .	Cardiff, Ely P. Stn.	3·44	137
,, .	Sidmouth, Sidmount	2·34	119	,, .	Treherbert, Tynywaun	7·55	...
,, .	Filleigh, Castle Hill	3·20	...	*Carm* .	Carmarthen Friary	4·41	160
,, .	Barnstaple N. Dev. Ath.	3·18	154	,, .	Llanwrda	4·30	127
Corn .	Redruth, Trewirgie	5·46	236	*Pemb* .	Haverfordwest, School	4·95	...
,, .	Penzance, Morrab Gdn.	4·85	220	*Card* .	Aberystwyth	3·02	...
,, .	St. Austell, Trevarna	4·25	176	,, .	Cardigan, County Sch.	3·48	...
Soms .	Chewton Mendip	2·60	94	*Brec* .	Crickhowell, Talymaes	4·00	...
,, .	Long Ashton	2·48	...	*Rad* .	Birm W. W. Tyrmynydd	4·34	127
,, .	Street, Millfield	1·78	..	*Mont* .	Lake Vyrnwy	3·02	96
Glos. .	Cirencester, Gwynfa	2·95	143	*Denb* .	Llangynhafal	1·61	...
Here .	Ross, Birchlea	2·14	101	*Mer* .	Dolgelly, Bryntirion	3·81	115
,, .	Ledbury, Underdown	1·90	93	*Carn* .	Llandudno	1·77	93
Salop .	Church Stretton	2·62	102	,, .	Snowdon, L. Llydaw 9	4·85	...
,, .	Shifnal, Hatton Grange	1·83	89	*Ang* .	Holyhead, Salt Island	2·59	133
Worc .	Ombersley, Holt Lock	1·75	85	,, .	Lligwy	2·26	...
,, .	Blockley	1·87	...	*Isle of Man*			
War .	Farnborough	1·88	84		Douglas, Boro' Cem.	2·79	112
,, .	Birminghm, Edgbaston	1·80	84	*Guernsey*			
Leics .	Thornton Reservoir	1·81	90		St. Peter P't. Grange Rd.	2·55	150

* Gauge formerly at Tottingworth Park.

Rainfall: May, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Wigt .	Stoneykirk, Ardwell Ho	3.57	142	*Suth* .	Loch More, Achfary ...	2·56	58
,, .	Pt. William, Monreith	...	...	*Caith* .	Wick	1·94	94
Kirk .	Carsphairn, Shiel.	6·38	...	*Ork* .	Pomona, Deerness	1·69	85
,, .	Dumfries, Cargen	..	...	*Shet* .	Lerwick	1·88	90
Dumf.	Eskdalemuir Obs.	4·23	128	*Cork* .	Caheragh Rectory	3·63	...
Roxb .	Branxholm	2·28	101	,, .	Dunmanway Rectory...	4·88	144
Selk .	Ettrick Manse	...	...	,, .	Ballinacurra	3·24	137
Peeb .	West Linton	1·58	...	,, .	Glanmire, Lota Lo. ...	4·13	169
Berk .	Marchmont House......	1·71	69	*Kerry*.	Valentia Obsy.	3·53	112
Hadd.	North Berwick Res. ...	2·05	103	,, .	Gearahameen	6·00	...
Midl .	Edinburgh, Roy. Obs.	1·34	72	,, .	Killarney Asylum	2·79	91
Ayr .	Kilmarnock, Agric. C.	2·92	126	,, .	Darrynane Abbey	2·91	98
,, .	Girvan, Pinmore	4·43	149	*Wat* .	Waterford, Brook Lo...	3·61	156
Renf .	Glasgow, Queen's Pk. .	2·71	111	*Tip* .	Nenagh, Cas. Lough...	2·43	98
,, .	Greenock, Prospect H.	5·25	152	,, .	Roscrea, Timoney Park	1·83	...
Bute .	Rothesay, Ardencraig.	3·68	122	,, .	Cashel, Ballinamona...	2·82	117
,, .	Dougarie Lodge	4·57	...	*Lim* .	Foynes, Coolnanes......	1·74	75
Arg .	Ardgour House	5·99	...	,, .	Castleconnel Rec.	2·08	...
,, .	Manse of Glenorchy ...	4·68	...	*Clare* .	Inagh, Mount Callan...	3·14	...
,, .	Oban	4·44	...	,, .	Broadford, Hurdlest'n.	2·61	...
,, .	Poltalloch	5·20	180	*Wexf*.	Newtownbarry	4·01	...
,, .	Inveraray Castle...	5·07	129	,, .	Gorey, Courtown Ho ..	3·32	150
,, .	Islay, Eallabus	4·24	156	*Kilk* .	Kilkenny Castle.........	2·65	120
,, .	Mull Benmore	9·30	...	*Wic* .	Rathnew, Clonmannon	2·58	...
,, .	Tiree	4·17	...	*Carl* .	Hacketstown Rectory..	2·84	109
Kinr .	Loch Leven Sluice......	2·43	100	*QCo* .	Blandsfort House	2·64	109
Perth .	Loch Dhu	5·60	125	,, .	Mountmellick...........	...	...
,, .	Balquhidder, Stronvar	...	...	*KCo* .	Birr Castle	2·57	115
,, .	Crieff, Strathearn Hyd.	2·70	68	*Dubl* .	Dublin, FitzWm. Sq...	1·26	61
,, .	Blair Castle Gardens ...	2·58	127	,, .	Balbriggan, Ardgillan.	1·76	...
,, .	Dalnaspidal Lodge ...	4·27	118	*Me'th* .	Beauparc, St. Cloud...	1·99	...
Angus.	Kettins School	2·82	116	,, .	Kells, Headfort	2·61	97
,, .	Dundee, E. Necropolis	2·39	114	*W.M* .	Moate, Coolatore	2·20	...
,, .	Pearsie House...........	2·75	...	,, .	Mullingar, Belvedere..	2·70	110
,, .	Montrose, Sunnyside...	1·95	96	*Long* .	Castle Forbes Gdns......	2·08	81
Aber .	Braemar, Bank	2·82	118	*Gal* .	Ballynahinch Castle ...	3·71	103
,, .	Logie Coldstone Sch....	1·49	60	,, .	Galway, Grammar Sch.	1·50	...
,, .	Aberdeen, King's Coll.	2·28	98	*Mayo* .	Mallaranny..............	3·32	...
,, .	Fyvie Castle	1·99	...	,, .	Westport House.........	1·87	66
Mor .	Gordon Castle	1·34	63	,, .	Delphi Lodge	5·81	...
,, .	Grantown-on-Spey ...	2·66	114	*Sligo* .	Markree Obsy............	2·71	97
Na .	Nairn, Delnies	2·62	145	*Cav'n* .	Belturbet, Cloverhill...	2·30	93
Inv .	Kingussie, The Birches	1·56	...	*Ferm* .	Enniskillen, Portora...	2·05	...
,, .	Loch Quoich, Loan ...	7·30	...	*Arm* .	Armagh Obsy...........	2·74	115
,, .	Glenquoich..............	5·60	102	*Down* .	Fofanny Reservoir......	7·23	...
,, .	Inverness, Culduthel R.	1·99	...	,, .	Scaforde	2·59	99
,, .	Arisaig, Faire-na-Squir	3·78	...	,, .	Donaghadee, C. Stn ...	2·95	130
,, .	Fort William	5·38	...	,, .	Banbridge, Milltown...	1·97	...
,, .	Skye, Dunvegan	4·03	...	*Antr* .	Belfast, Cavehill Rd ...	2·98	...
R & C.	Alness, Ardross Cas. ...	2·08	80	,, .	Glenarm Castle	3·41	...
,, .	Ullapool	1·59	...	,, .	Ballymena, Harryville	3·38	118
,, .	Torridon, Bendamph...	3·60	79	*Lon* .	Londonderry, Creggan	2·45	94
,, .	Achnashellach	3·52	...	*Tyr* .	Donaghmore	3·04	...
,, .	Stornoway	2·22	87	,, .	Omagh, Edenfel.........	2·41	93
Suth .	Lairg	2·07	...	*Don* .	Malin Head..............	1·92	...
,, .	Tongue	2·34	98	,, .	Dunfanaghy	2·34	...
,, .	Melvich	2·57	125	,, .	Killybegs, Rockmount.	2·34	65

Climatological Table for the British Empire, December, 1928.

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.	1017·7	+ 4·0	54	25	43·5	33·8	38·7	− 1·6	36·5	92	7·3	2·35	+ 0·06	15	1·5	19
Gibraltar	1021·0	+ 0·9	68	44	60·7	49·3	55·0	− 1·0	49·8	82	5·2	3·06	− 2·55	8	..	..
Malta	1016·0	− 0·6	65	44	58·3	50·4	54·3	− 3·6	49·7	72	6·6	4·33	+ 0·62	18	4·6	48
St. Helena	1012·7	+ 1·8	65	54	62·7	56·2	59·5	− 2·7	57·4	96	9·5	1·85	− 0·11	19	..	..
Sierra Leone	1012·0	+ 1·1	90	68	86·8	73·8	80·3	− 1·1	76·1	79	2·1	2·34	+ 0·92	2	..	..
Lagos, Nigeria	1010·3	− 0·2	91	69	88·2	74·9	81·5	0·0	74·6	80	5·1	0·13	− 0·67	2	..	..
Kaduna, Nigeria	1015·6	+ 2·8	97	..	88·9	..	..	..	57·8	31	..	0·00	0·00	0	..	..
Zomba, Nyasaland	1008·4	+ 0·1	89	60	82·5	65·4	73·9	+ 0·8	..	77	7·5	8·90	− 1·97	20	..	..
Salisbury, Rhodesia	1007·2	− 1·4	86	53	78·3	60·5	69·4	− 0·2	63·3	67	6·6	5·24	− 0·54	16	5·8	44
Cape Town	1014·4	+ 0·1	98	50	77·1	59·0	68·1	+ 0·2	61·0	70	4·3	0·98	+ 0·16	4	..	..
Johannesburg	1009·7	− 0·3	89	49	79·0	56·9	67·9	+ 2·8	59·0	66	3·7	3·86	− 1·57	16	9·6	70
Mauritius	1014·1	+ 0·1	87	67	82·8	70·3	76·5	− 1·8	71·4	68	7·8	2·84	− 1·89	20	7·3	55
Bloemfontein	..	..	97	52	87·4	60·2	73·8	+ 2·0	60·9	49	5·0	1·48	− 0·97	7	..	..
Calcutta, Alipore Obsy.	1015·3	− 0·4	84	53	79·4	58·5	68·9	+ 2·4	58·8	83	1·8	0·00	− 0·20	0*	..	..
Bombay	1012·6	− 0·9	93	61	86·9	69·5	78·2	+ 0·7	66·5	71	0·8	0·00	− 0·05	0*	..	..
Madras	1012·0	− 1·5	88	65	84·2	71·6	77·9	+ 1·2	72·0	81	6·4	4·24	− 1·57	8*	..	..
Colombo, Ceylon	1010·2	− 0·5	89	71	85·5	73·2	79·3	+ 0·3	74·9	76	6·4	8·78	+ 3·41	16	7·6	65
Hongkong	1019·4	− 0·3	79	54	70·5	61·9	66·2	+ 3·2	60·5	68	4·9	0·02	− 1·11	1	7·0	65
Sandakan	..	..	90	72	85·9	73·9	79·9	− 0·2	76·8	84	..	34·32	+ 16·66	21	..	..
Sydney	1011·9	0·0	85	59	74·8	63·6	69·2	− 0·9	64·5	66	6·1	0·94	− 1·97	6	7·4	51
Melbourne	1012·4	− 0·1	99	47	77·2	55·9	66·5	+ 2·2	59·0	62	6·6	0·78	− 1·56	7	6·8	46
Adelaide	1012·5	− 0·7	105	49	84·8	60·0	72·4	+ 1·3	59·1	33	4·3	0·24	− 0·76	5	10·9	76
Perth, W. Australia	1011·1	− 2·1	101	53	81·1	61·4	71·3	+ 0·6	62·4	49	3·4	1·12	+ 0·54	8	10·5	74
Coolgardie	1009·5	− 1·7	107	52	90·4	60·0	75·2	− 0·6	60·9	42	2·8	0·70	0·00	6	..	..
Brisbane	1011·7	− 0·3	92	62	83·9	67·4	75·7	− 0·7	68·2	58	6·3	2·56	− 2·28	10	8·7	63
Hobart, Tasmania	1010·2	+ 0·5	83	45	68·4	51·6	60·0	− 0·4	54·1	60	7·0	1·99	+ 0·03	15	8·4	55
Wellington, N.Z.	1013·2	+ 1·0	72	45	63·9	52·3	58·1	− 2·3	56·1	79	7·0	8·19	+ 4·97	15	6·9	46
Suva, Fiji	1009·1	+ 0·5	91	71	86·5	74·7	80·6	+ 1·7	76·4	79	7·5	17·41	+ 5·30	20	5·6	42
Apia, Samoa	1009·3	+ 0·9	89	72	86·6	74·9	80·8	+ 1·5	77·5	75	5·3	10·69	− 2·93	22	7·3	57
Kingston, Jamaica	1014·1	+ 0·1	88	65	85·7	68·6	77·1	− 0·6	66·9	87	2·6	0·08	− 1·51	2	7·1	64
Grenada, W.I.	1009·0	− 2·5	88	70	84·7	72·7	78·7	+ 0·6	74·6	79	3·5	7·17	− 0·10	20	..	..
Toronto	1018·9	+ 1·5	47	13	37·5	28·2	32·9	+ 6·7	29·1	81	7·6	1·25	− 1·58	11	2·4	27
Winnipeg	1017·2	− 0·7	44	−16	24·2	11·1	17·7	+12·0	11·5	78	5·5	0·35	− 0·63	8	2·8	34
St. John, N.B.	1015·7	+ 1·5	52	7	35·8	23·9	29·9	+ 5·5	26·6	75	5·4	4·22	+ 0·05	15	3·9	44
Victoria, B.C.	1018·8	+ 2·0	49	29	44·1	38·2	41·1	− 0·4	39·1	87	7·4	2·63	− 3·28	14	2·0	24

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

July, 1928, p. 152. Sandakan—mean min., ½ (M + m), and differences from normal *should read* 75·0 ; 81·3 ; + 1·5 respectively.

Dec., 1928, p. 276. Sandakan—precipitation, difference from normal *should read* — 2·69.

Climatological Table for the British Empire, Year, 1928.

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.	1014·1	− 1·3	87	25	57·7	43·7	50·7	+ 1·0	45·2	86	6·8	23·90	+ 0·10	169	4·5	34
Gibraltar	1018·1	+ 0·2	99	42	70·4	58·1	64·2	− 0·1	57·1	81	4·5	25·39	− 10·43	88	..	..
Malta	1015·9	0·0	95	44	70·6	61·1	65·9	− 0·2	60·7	77	4·7	33·44	+ 13·58	108	8·3	68
St. Helena	1014·0	+ 2·4	73	50	64·6	57·0	60·8	− 1·2	58·2	95	9·0	24·21	− 15·91	195	..	..
Sierra Leone	1012·7	+ 1·3	93	67	85·8	73·0	79·4	− 1·3	74·7	79	5·9	148·54	− 8·69	175	..	..
Lagos, Nigeria	1010·0	− 1·4	92	69	85·4	75·4	80·4	− 0·1	75·7	83	6·9	79·05	+ 7·42	140	..	..
Kaduna, Nigeria	1015·1	+ 2·7	99	..	88·4	..	..	..	..	..	..	50·62	+ 1·39	113	..	..
Zomba, Nyasaland	1012·9	+ 0·6	95	47	79·5	60·8	70·1	+ 0·7	..	69	5·2	40·08	− 14·46	104	..	..
Salisbury, Rhodesia	1012·1	− 0·2	95	34	78·5	53·5	66·0	+ 0·7	57·2	55	3·3	23·27	− 8·67	78	8·8	73
Cape Town	1018·3	+ 1·3	100	34	71·6	54·3	63·0	+ 0·7	55·6	79	4·7	16·66	− 8·64	89	..	..
Johannesburg	1016·9	+ 0·5	89	27	71·0	50·3	60·6	+ 1·1	50·4	57	2·9	29·51	− 3·71	94	8·8	73
Mauritius	1016·4	+ 0·3	92	54	79·8	67·6	73·7	− 0·3	69·8	71	5·7	55·35	+ 5·69	228	8·1	67
Bloemfontein	..	..	97	22	74·6	47·4	61·0	− 0·4	50·0	58	2·9	16·45	− 6·92	64	..	..
Calcutta, Alipore Obsy.	1007·7	+ 0·1	105	49	88·6	71·9	80·3	+ 1·6	72·3	85	5·0	78·57	+ 16·03	111*	..	..
Bombay	1008·9	− 0·3	95	60	87·2	74·6	80·9	+ 0·4	73·2	78	3·9	85·73	+ 13·54	100*	..	..
Madras	1008·3	− 0·5	110	63	92·1	76·3	84·2	+ 1·2	74·9	73	5·2	50·36	− 0·38	90*	..	..
Colombo, Ceylon	1010·2	+ 0·2	92	66	86·3	75·3	80·8	+ 0·1	76·5	76	7·0	98·81	+ 13·56	203	7·2	60
Hongkong	1012·1	− 0·5	93	45	77·1	68·9	73·0	+ 0·7	68·0	77	6·9	71·15	− 12·67	132	5·5	46
Sandakan	..	..	92	71	87·9	74·9	81·4	+ 0·1	77·4	83	..	167·78	+ 48·06	178	..	..
Sydney	1014·9	− 1·0	101	41	72·3	57·2	64·8	+ 1·6	58·6	68	5·1	40·07	− 7·83	130	6·9	57
Melbourne	1015·5	− 0·8	104	32	68·5	50·9	59·7	+ 1·3	53·6	68	6·2	24·09	− 1·46	151	5·9	49
Adelaide	1016·3	− 0·7	109	35	73·2	53·5	63·4	+ 0·4	54·3	53	5·1	19·43	− 1·77	107	7·5	62
Perth, W. Australia	1016·0	− 0·4	101	40	73·3	55·2	64·3	+ 0·1	57·5	61	5·0	44·88	+ 10·85	140	7·8	64
Coolgardie	1015·4	− 0·6	113	31	78·0	50·7	64·4	− 0·1	53·7	51	2.9	6·96	− 3·20	53	..	..
Brisbane	1015·9	+ 0·1	103	40	78·1	60·2	69·1	+ 0·2	62·8	68	4·7	52·64	+ 7·98	139	7·7	64
Hobart, Tasmania	1011·7	− 0·9	101	33	62·7	48·3	55·5	+ 1·2	49·5	67	6·5	30·23	+ 6·49	205	6·0	50
Wellington, N.Z.	1014·7	0·0	79	36	60·7	49·3	55·0	− 0·3	52·3	77	6·6	55·21	+ 7·17	146	5·8	48
Suva, Fiji	1011·6	+ 0·2	94	62	82·8	72·2	77·5	+ 0·5	73·4	79	6·9	113·83	+ 1·45	233	5·6	46
Apia, Samoa	1010·7	+ 0·4	90	68	85·1	75·0	80·1	+ 1·6	77·1	79	4·9	133·27	+ 26·42	207	6·8	56
Kingston, Jamaica	1013·7	0·0	94	64	86·9	71·1	79·0	− 0·3	69·8	84	3·7	28·89	− 4·70	66	..	..
Grenada, W.I.	1009·7	− 2·5	90	60	86·1	73·6	79·9	+ 1·1	75·2	77	4·9	63·77	− 12·31	215	..	..
Toronto	1014·9	− 1·5	90	− 4	54·3	38·8	46·6	+ 2·2	41·0	75	5·5	35·35	+ 1·88	160	5·6	46
Winnipeg	1015·6	− 0·6	96	−25	48·1	29·6	38·9	+ 4·6	..	..	5·1	20·91	− 0·16	97	6·0	49
St. John, N.B.	1014·4	− 0·3	85	−10	50·6	36·1	43·4	+ 2·2	39·7	74	6·3	43·10	− 4·98	172	5·1	42
Victoria, B.C.	1017·7	+ 1·3	90	24	56·0	45·0	50·5	+ 1·0	47·2	81	6·0	19·90	− 12·59	124	6·0	49

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

Note:—Malta—Station moved from from Valletta, 35°53'N, 14°30'E, 185ft. to Pieta, 35°54'N, 14°31'E, 233.6ft. from April 20th, 1928. Differences from normal refer to Valletta throughout.

and about 200 residences were washed away. By the middle of the month the Tigris had subsided but the Euphrates was still rising; the railway from Baghdad to Basra was cut in two places and about a mile of track was washed away. The presence of so much water in the desert made flying very difficult as the mists rising from the surface caused very bad visibility. The Euphrates began to fall at Ramadi on the 21st.

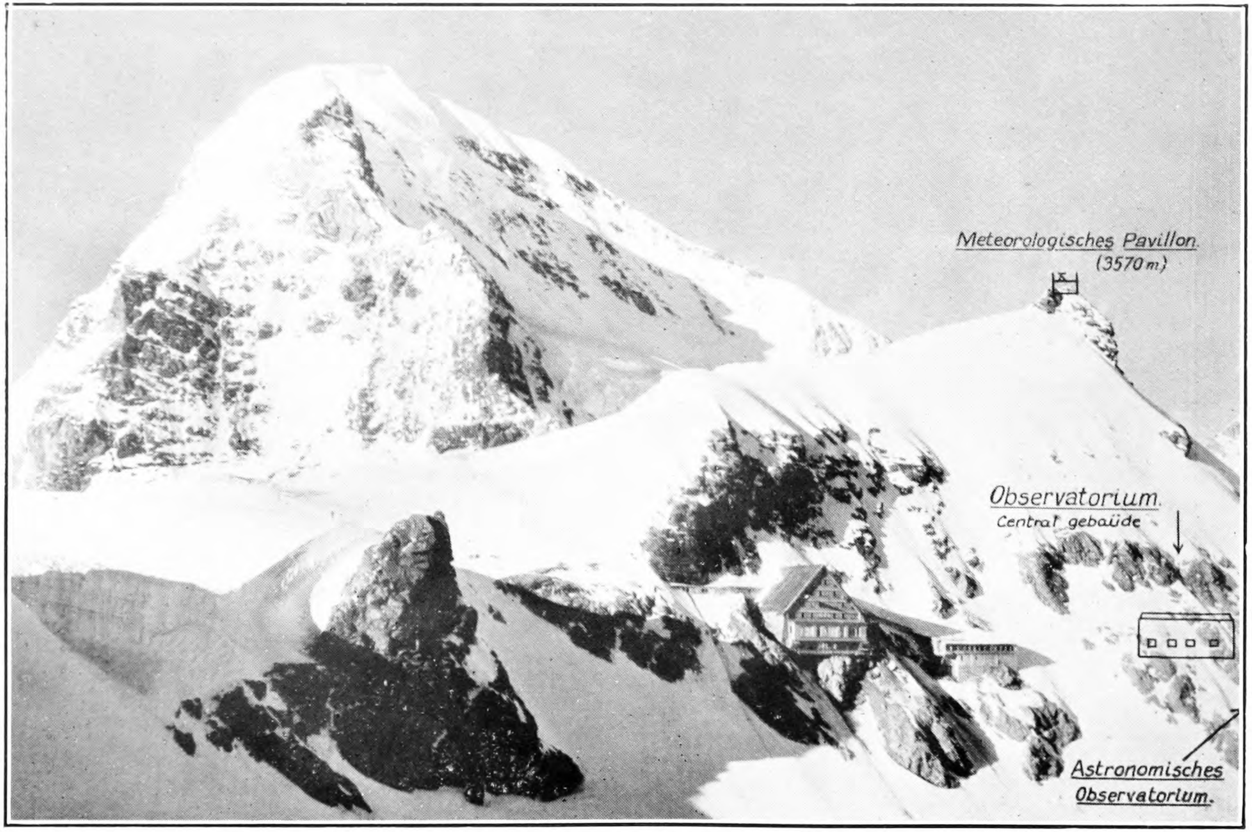
In the evening of the 11th an exceptional hail storm visited the Trichinopoly Cantonment of India. It was preceded by thunder and brilliant lightning in the distance, a high wind, and heavy rain. The hail itself lasted about $\frac{3}{4}$ hour. At first the hail stones were about $\frac{1}{2}$in. to $\frac{3}{4}$in. in diameter, but they soon became unusually large; the largest sphere measured was 2in. in diameter, but there were many agglomerations much bigger. One hail stone picked up about 20 minutes after the storm was over measured $4\frac{1}{16}$in. in length, as the temperature of the air was between 75° and 80° it must have been considerably larger when it fell. A great deal of damage was done to roofs of bungalows, the hail stones breaking through four or five layers of tiles. A heavy storm swept Japan on the 23rd, causing considerable damage and some loss of life, 70 per cent of the average rainfall for May fell in 18 hours. On the 24th a typhoon struck the southern part of Manila, 10 persons were reported killed and 33 missing.

During the first half of the month cool and rather rainy weather prevailed in most regions of the United States except the west and south. A tornado was reported to have visited Virginia on the 2nd, demolishing a school and killing 50 persons; in Columbus (Ohio) a prison wall was blown down and 4 prisoners killed. Very hot weather prevailed in New York and the Atlantic coast at the end of the month; Boston recorded a maximum temperature of 96°F. on the 30th. Deaths from heat stroke were reported.

The special message from Brazil states that rainfall in the north was scanty, being 0·28in. below normal; in the centre the distribution was irregular, but the average was 0·63in. above normal; in the south rain was plentiful with an average of 0·99in. above normal. Six anticyclones passed across the country; the weather in the south and the centre was abnormally unsettled for the month. The first frosts of the season occurred in the south, but the crops generally were in good condition At Rio de Janeiro pressure was 1·2mb. above normal and temperature 2·2°F. below normal.

Rainfall, May, 1929.—General Distribution

England and Wales	103	per cent. of the average 1811-1915.
Scotland	107	
Ireland	109	
British Isles	105	



POSITION OF NEW METEOROLOGICAL OBSERVATORY ON THE JUNGFRAUJOCH

(see p. 140)

M.O. 313.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 64

July 1929

No. 762

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

The Dry Weather of January to June, 1929

The year 1929 opened with two months of abnormal cold, which were described in the *Meteorological Magazine* for February and March. The abnormality has continued, taking the form of one of the most intense droughts of the past century. The average rainfall in percentage of normal in each month has been as follows:—

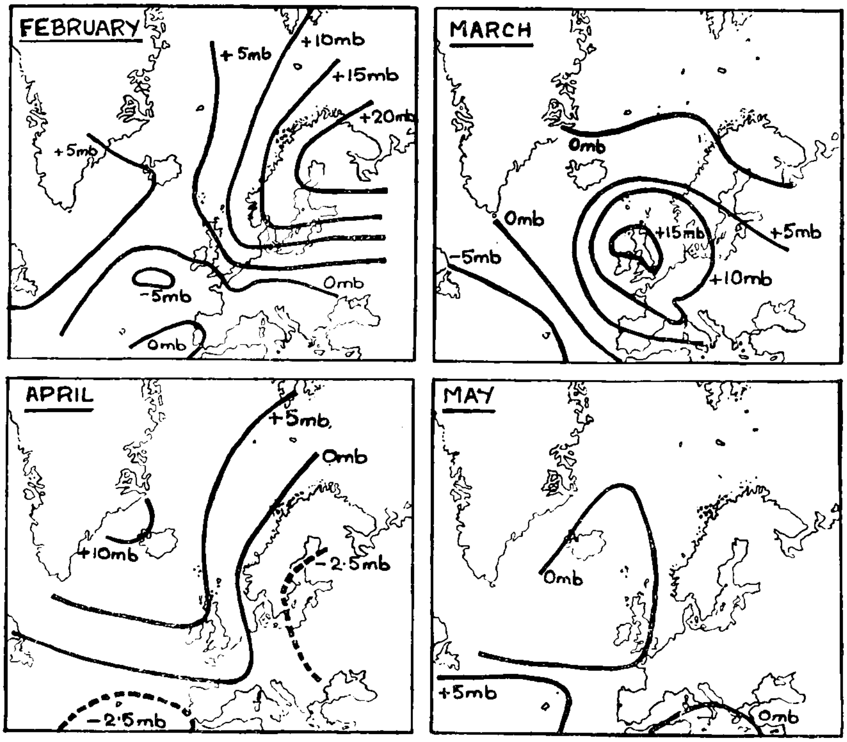
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*Average*
England & Wales	71	49	13	57	103	78	62
Scotland ...	49	54	24	76	107	124	72
Ireland	57	129	24	51	109	83	75
Brtish Isles ...	63	67	18	61	105	91	67

Some notes on the dryness of the months of January to March were also given in the magazine for April, p. 71. Considering the four months January to April, with an average of 52 per cent. over the British Isles, we can say that in the past 70 years only one period of four consecutive months—October, 1879, to January, 1880—had a smaller proportion of their normal fall, though in March to June, 1893, the proportion was the same as in January to April, 1929. The whole period of six months however shows up less dry than either February to July, 1921, or February to July, 1887, in England and Wales; but over the British Isles as a whole January to June, 1929, was as dry as February to July, 1921.

The distribution of pressure has been correspondingly abnormal. A chart of the deviations of pressure from normal during

(85917) P.S. 1602/81. 1,050 7/29 M. & S. Gp. 303.

January was given in the *Meteorological Magazine* for February, p. 2; it showed an excess of more than 20mb. over Iceland, and a deficit of more than 5mb. over the Azores. The deviations of pressure from normal during the months of February, March, April and May are shown in the illustration to this article. In February, pressure was more than 20mb. above normal over Scandinavia, giving the easterly winds which made that month so cold. In March the excess had shifted to the British Isles; the pressure deviation of + 16·5mb. at Malin Head has not been



Pressure Anomalies, 1929.

exceeded in any month in this country for at least 89 years. In April the excess was centred north-east of Iceland and exceeded 10mb. In May pressure was slightly below normal over the British Isles, as would be expected from the slight excess of rainfall, and in June pressure was nearly normal over the British Isles but was above normal north west of Iceland. The pressure chart for June was not available in time for reproduction, but a brief description will be found on p. 148 Thus it will be seen that the average distribution of pressure during the first four months of 1929 has been characterised by a marked excess near or to the north of the British Isles.

It has been found that such a distribution frequently, though not invariably, follows certain abnormalities in the oceanic conditions to the west and north of the British Isles. To the west we have the waters of the Atlantic. When the surface of the North Atlantic west of the British Isles is abnormally cool, there is a tendency for pressure to be above normal near Iceland and below normal near the Azores. The surface temperature of the North Atlantic depends to some extent on the temperature and volume of the Gulf Stream, which is governed largely by the strength and steadiness of the trade winds, strong trade winds causing a high surface temperature 12 to 21 months later. The south-east trade is more important than the north-east trade, the effect of the latter being weak and uncertain. We find that while from February, 1928 onwards the north-east trade has been abnormally weak, the south-east trade has been of practically normal strength during the past two years, the average velocity at St. Helena having been only 0·3m/s. below normal in 1927, and 0·1m/s. below in 1928. It seems, therefore, that variations of the trade winds can have been only a minor factor in the abnormal pressure distribution of the past six months.

The second important factor in our weather lies to the north, namely, the state of ice in the Arctic. Generally speaking, a deficiency of Arctic ice tends to be followed by a weak atmospheric circulation, so that pressure is above normal in Iceland and below normal over the Azores. The effect varies in different seasons; in the two or three years following an abnormal deficiency of Arctic ice, pressure tends to be above normal over Iceland from January to June and above normal over the British Isles in winter and early spring, but below normal over the British Isles in summer (see *Meteorological Magazine*, 63, 1928, p. 214).

The data collected and published annually by the Danish Meteorological Institute under the title, *State of Ice in the Arctic Seas*, show that both in 1927 and 1928 the amount of ice in the Arctic Ocean and Greenland Seas was unusually small. Except for the latter half of May, 1928, the coasts of Iceland have been entirely free of ice, and the fringes of the ice area have receded to an unusual extent in the Greenland Sea, Barents Sea and Kara Sea. From the summer conditions (April to August) in these three seas an Arctic "ice index" can be formed (see *Geophysical Memoirs*, No. 41, p. 27), and for the year 1928 this index figure was 91, the average for the past 34 years being 108.

Another factor in the pressure distribution over the North Atlantic is the previous meteorological situation in north-east Africa, represented by the height of the Nile flood. Mr. E. W. Bliss has found that a high flood tends to be followed by a cold dry winter in the British Isles, which we can also connect with the relation that a high flood tends to be followed by high pressure over Iceland and Greenland and low pressure over the

Azores. Actually during July to September, 1928, the Nile flood at Aswan was somewhat higher than usual though the excess was apparently not remarkable and the river was below its usual height in the latter part of September and in October. Still, these north African conditions may have been a contributing factor in the abnormal pressure distribution over the North Atlantic during 1929.

We have found then that preceding conditions in other parts of the world were such that there existed a definite tendency for pressure to be well above normal to the north of the British Isles during the first half of 1929. That would give us frequent easterly winds and a cold winter, but alone it is not a sufficient explanation of the long-continued drought. High pressure over Iceland only gives us dry weather if it also extends over the British Isles as it did this year, especially in March and June. High pressure over Iceland may be associated with low pressure over the British Isles, in which case we have a wet season, and at present the reason why the limit of the Icelandic high pressure fluctuates in this way remains rather obscure. Probably it is due to some factor, perhaps in the upper air, which has not yet been investigated.

C. E. P. Brooks.

Contamination of the Wick and Muslin of Wet Bulbs at Coastal Stations

By H. Garnett, M.Sc.

It is the practice in country districts to change the wick and muslin of the wet bulb thermometer about once a month, the assumption being made that over that period contamination of the muslin occurs only to so small an extent that values of relative humidity calculated from observations of the dry and wet bulb readings are affected but slightly. This course is probably quite justified in districts remote from towns or other sources of atmospheric pollution, but in these latter areas, as shown in a note by Dr. R. C. Sutcliffe appearing in the *Meteorological Magazine* for July, 1928, the wick and muslin requires to be changed more frequently. Furthermore, observations by D. O. Maclean at Tiree show that an appreciable effect is produced on the wet bulb readings by salt spray. It was to investigate the effect of salt spray on the values of relative humidity that the present work was carried out.

For this purpose the observer at Wick, Scotland, was asked to change the wick and muslin of the wet bulb every seven days and add a note in the monthly return of observations to indicate the change. This was done for the period November 1st, 1926, to

April 1st, 1928, with the exception of short periods for which no record of changes was made.

The exposure of the station at Wick is very open, being situated on a headland on the south side of Wick Harbour with bare and open country in all directions except to the north-west, where the town of Wick lies. To the east there is an open exposure to the North Sea, and the coast here being rocky, conditions are very favourable for the presence of salt spray in the atmosphere. The station is 81 feet above sea level, close to the edge of the cliff.

Following the day on which the wick and muslin were changed, the daily mean relative humidity was taken for each of the six succeeding days and a mean of these daily values taken to give six values representative of the change in humidity with the passage of time following the renewal. These humidity values were plotted against the number of the day after the renewal As was to be expected there was no systematic variation in the daily values obtained, so in order to arrive at a smooth curve it was necessary to take a mean over a long period. Hence mean values were first obtained for the whole period November 1st, 1926, to April 1st, 1928. This period was then subdivided into three, two winter periods November, 1926, to March, 1927, and October, 1927, to March, 1928, and the summer period April, 1927, to August, 1927. For each of these the same procedure was followed, giving in all four curves, which are as shown.

It is presumed that contamination of the wick and muslin is due to salt spray in the atmosphere, and hence one might expect that the presence of salt on the muslin would give an increase in the temperature of the wet bulb, in keeping with the theory of the action of this psychrometer. Vapour pressure over the salt solution being less than over pure water, the difference in the dry and wet bulb readings should gradually decrease with increasing concentration and hence with passage of time. Consequently one would expect curves of the form shown in Fig. 1, but actually they are of the form shown in Fig. 2—relative humidity increasing to a maximum value either two or three days after the renewal and then decreasing. The curves for the two winter periods are very similar, the maximum occurring on the same day in each—on the second day after renewal. In the curve for the summer period the maximum occurs on the third day. This is quite in keeping with expectations, high winds and rough seas in winter resulting in a greater concentration of salt in the atmosphere than is obtained during the quieter weather of summer. The first part of the curves then

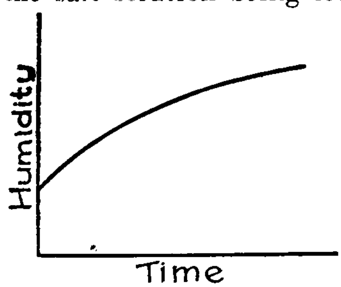


FIG. 1.

bears out what one would expect from a cursory glance at the problem. But the falling off in humidity after the maximum value has been obtained is not easily explained. It would appear that the maximum effect of the salt is obtained after two or three days, and it may be suggested that afterwards the muslin perhaps takes on a roughened surface which materially enhances evaporation with a consequent lowering of the figure deduced for humidity. The magnitude of the effect appears to be quite appreciable and sufficient to be of considerable importance. The initial rise in relative humidity is some 4 per cent. or 5 per cent. and the subsequent fall 2 per cent., or 3 per cent.

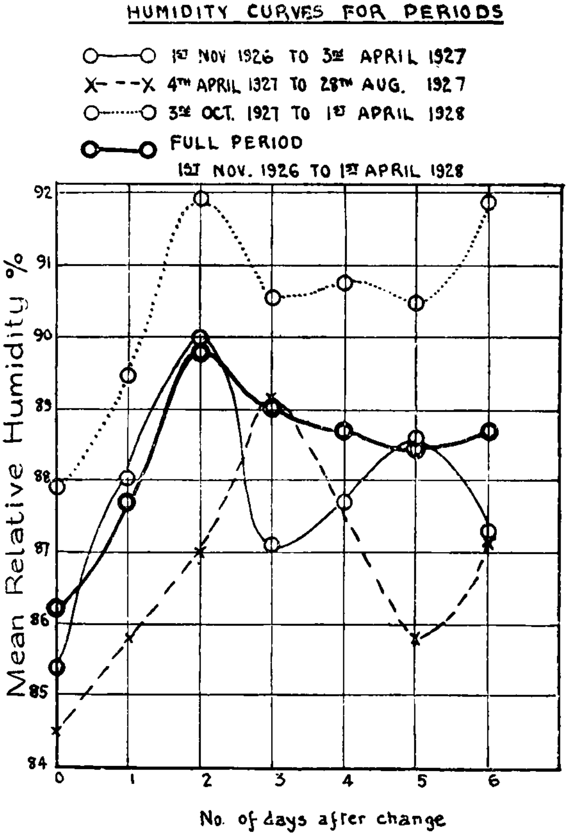


FIG. 2.

The investigation carried out by Dr. Sutcliffe gave results of a similar nature to those found at Wick in the first two or three days after the renewal of the wick and muslin, but in view of the subsequent effect it might be of interest to have a similar investigation to this present one carried out at another town site where contamination of the wick and muslin would be due to the solid impurities in the atmosphere inseparable from numerous smoking chimneys.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, June 19th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, D.Sc., President, in the Chair.

F. J. W. Whipple, Sc.D.—Potential gradient and atmospheric pollution; the influence of "Summer Time."

The electrical potential gradient being affected by atmospheric pollution it was to be expected that the diurnal variation would assume a new character when "Summer Time" was introduced. The Kew Observatory records for periods before and after 1916 have been compared. There are normally two oscillations of potential gradient in the 24 hours. It is found that the early morning minimum and the forenoon maximum were both advanced when "Summer Time" came in, whereas the second oscillation of the day was reduced in amplitude.

A. J. Bamford, M.C., M.A.—Vertical air-currents as measured by pilot balloons.

This paper is an attempt to explain some of the mechanism of tropical convection. The results of the last seven years' pilot balloon observations at Colombo show that in the first half-kilometre the average rate of ascent is considerably faster than the theoretical rate given by the Dines formula, while in the next half-kilometre it is appreciably less than this value. At first sight a curious congestion of air near the half-kilometre level is suggested, but by considering the distribution as well as the amount of the observed accelerations and retardations the writer suggests that the slow upward velocities between one-half and one kilometre can be reconciled with a general atmospheric movement that is on the whole upwards in these layers, by accepting the idea that tropical convection occurs in the form of large rolling whirls of at least a kilometre in diameter, the effect of such whirls being to displace balloons from the ascending side towards the descending side after they pass the level of the centre. The fact that when the mean of several thousand balloon flights shows retardation in a certain level does not appear to indicate that the general air movement at that level is downward, is apparently depressing, from the point of view of observational meteorology; the writer, however, prefers to regard the matter more cheerfully as affording a picture of the structure of tropical convection that would not have been available otherwise. The next part of the paper deals with cases where the simple whirl system is complicated by monsoonal and other circulations, and the last part deals with observations up to ten kilometres. These latter show a consistent, and increasing excess above the theoretical values, but attention is called to the limitations that apply to such deductions and to the importance of comparisons with similar results elsewhere.

George Slater, D.Sc.—Studies on the Rhone Glacier, 1927. *The relationship between the average air-temperature and the rate of melting of the surface of the glacier.*

Observations in Spitsbergen, 1921, suggested to the author the following tentative relationship between the average air temperature and the rate of melting of the ice:—

$$M = \frac{1}{2}\ (t - 32°F.)$$

where M = thickness (in feet) of ice melted per month (30 days) and t = average monthly temperature (°F.).

This would become 0.2 inches of ice melted per day for each degree (F.) above zero under normal atmospheric conditions, wind and rain producing deviations from the normal. With the object of testing this relationship further, observations were conducted on the Rhone Glacier in 1927 over a period of twenty days.

A hole 3 feet deep was bored in the ice and a rod inserted from which a shaded standardised maximum and minimum thermometer was suspended. It was found that when hourly records of temperature were recorded the relationship given above was corroborated. As the recording of hourly temperatures, however, was impracticable, late morning or early afternoon temperatures only were recorded, in addition to the maximum and minimum. An inspection of the tables of Zürich air temperatures (*Das Klima der Schweiz*, 1864-1900) shows that the average of the maximum and minimum temperatures gives too high a value to the summer mean, whereas if the mean between the noon and maximum temperatures be first obtained, and then the mean calculated between this figure and the minimum temperature, the approximation to the true mean is more correct. This method was accordingly adopted. The average temperatures (July 26th to August 15th) were as follows:—maximum 50.6°F., minimum 34.5°F., noon 43.79°F., giving a daily average of 8.8°F. above 32°F. Assuming the rate of 0.2 inches of ice melted per day for each degree, the total amount melted would be 35.2 inches, a figure which is confirmed by actual measurement.

Correspondence

To the Editor, *The Meteorological Magazine*

The dry weather during 1929

The very dry weather here this year calls for a special report. The total rainfall up to June 30th was 12.63 inches, being 4.55 inches under the first six months' average for 44 years. The total number of " rainy " days (.01in. or more) was 85, being 25 under the average for the same. There was an " absolute " drought of 21 days in February and March. The longest drought ever recorded here.

But there were drier first six months previously, viz. :—

1895	...	8.53 inches—" rainy " days		92.
1896	...	9.26 ,,	,, ,,	112.
1891	...	10.46 ,,	,, ,,	91.
1892	...	10.83 ,,	,, ,,	98
1887	...	10.88 ,,	,, ,,	87.

The number of " rainy " days during the past six months (viz., 85) was the lowest ever recorded here.

It is fairly certain there will be a great shortage of water all over the country generally during the summer and autumn.

In the limestone districts of Clare, water is running short even now, but we never will run short of it here, there being any number of springs and streams that never run dry.

W. A. Bentley, Lieut.-Col.

Hurdlestown, Broadford, Co. Clare. July 1st, 1929.

Perplexities of Winter 1928-9

In his interesting notes under this heading Mr. Bonacina contrasts the freezing of the Serpentine and Cumberland lakes and suggests that the greater thickness of the ice on the latter may be due to being fed from cold mountain levels. I suggest it is due to smoke haze over London and also ice on deep water once formed thaws less in the sun. The ice was not gone from Serpentine till March 21st but all gone Wimbledon Park lake March 16th.

That this is due to smoke haze is borne out by the fact that in March, 1885, I failed to find ice in Cambridge fens so came up to Welsh Harp and skated there, although frost in Fens was much severer the sun was clearer.

Stanley Single.

17, *Kensington Palace Mansions, De Vere Gardens, W.*8. *June 22nd,* 1929.

Rain falling through drizzle

Heavy rain falling through drizzle was observed here at 17h. 5m. G.M.T. to-day. The drizzle lasted two to three minutes and ceased on the heavy rain diminishing in intensity. The sky was covered with 7/10 strato-cumulus at 1,500ft. and 3/10 alto-stratus, the gap in the low cloud through which the alto-stratus was observed being almost overhead.

A small pilot balloon liberated a few minutes after the occurrence of the phenomenon showed that the air was calm up to 2,000 ft. at which height cloud passed beneath it.

L. C. Burridge.

R.A.F., Biggin Hill, Kent. June 12th, 1929.

Rainfall on July 4th

During the heavy rainfall which was experienced in East Anglian districts in the early morning of July 4th, an amount of 76.2mm. (3.00in.) was measured at Felixstowe between 4.45 a.m. and 8.00 a.m. B.S.T. The fall continued less intensely until 10.40 a.m. when a further 14.2mm. was measured giving a total continuous fall of 90.4mm. (3.56in.).

This amount is 16.7 per cent. of the normal yearly fall, and it is interesting to note that in these few hours as much rain fell as during the five complete months, February to June, this year.

T. W. VERNON JONES.

R.A.F., Felixstowe, Suffolk. July 6th, 1929.

Early Cherry Culture in England

With reference to the note on the "Early History of the south-west Monsoon" by Mr. G. M. Meyer in the June, 1929, Magazine, the following verse occurs in the *London Lickpenny* by John Lydgate about 1400-1450 :—

Then unto London I did me hie,
Of all the land it beareth the prise.
"Hot peascodes," one began to cry,
"Strawberry ripe" and "Cherries in the rise."
(on the bough.)

Therefore I presume it must be allowed that at this date cherries were sufficiently common to be hawked about the streets of London under the familiar cry as above.

RICHARD COOKE.

The Croft, Detling, Maidstone, Kent. June 27th, 1929.

Weather Lore

Mr. Glasspoole's interesting notes about a rain making superstition associated with a Welsh tarn calls to mind what is related by Gervase of Tilbury :—

"In the same parts (i.e., England) is Haveringmere. If any man sailing or rowing over the mere cry aloud :

'Phrut Haveringmere
And alle those (that) over the fere.'

then forthwith a sudden tempest ariseth, sinking boat and man. . . . . Truly it is a great marvel that dumb waters should be capable of such indignation."

(Quoted by G. C. Coulton, *Social Life in Britain*, Camb. Univ. Press.)

Similar traditions were also attached during the Middle Ages to a small lake in the Alps near Lake Lucerne and to one in the Apennines between Bologna and Pistoia.

Mr. Coulton also gives some interesting "portents" of meteorological interest.

"And this same yer (1361) in the Ascencioun, even about midday, was seyn the Eclipse of the sunne: and ther folowed suche a newe droght that for default of rayn ther was grete barynes of corn, froyt (fruit) and hey, and in the same yere, the vj kalend of Juyn there fill a sangweyn rayne almoost like blood at Burgoyne; and a sangweyn crosse, fro morwe unto

FIG. 1.—ELM TREE, CHORLEY WOOD, STRUCK BY LIGHTNING.

pryme was seyn and apperid at Boloigne in the eyr, the which meny a man sawe and after it mevid (moved) and fill in the myd see."

This latter marvel looks rather like an exaggerated description of the solar cross. This is supported by the fact that it appeared in the early morning, which would also account for the "sangweyn" colour.

CICELY M. BOTLEY.

17, Holmesdale Gardens, Hastings. January 2nd, 1929.

Trees damaged by Lightning

The following notes of trees recently struck by lightning may interest you. They were all damaged during the storm which broke over Chorley Wood on the afternoon of Friday, May 31st, 1929:—

(1) See photograph, Fig. 1. In Stag Lane (garden of King John's Farm, residence of Hon. Arthur Capell).

The highest branch of this tree was broken about 10 feet from the top, the thickness at this point being about 3 inches. Below this point the bark has been stripped from the branch for some 3 or 4 feet. From this point to the ground a strip of bark has been torn from the tree, averaging about 8 inches in width. A channel, which follows the turns in the grain of the tree, has been torn from the wood, leaving a frayed, but not singed, track some 3 inches wide and penetrating, at most $\frac{1}{4}$ inch. The fraying or splintering is much more marked in the upper part of the course. This channel would appear to mark the course of the spark. The bark has been pushed off. I have found no trace of burning.

(2) A deodar in the garden of Chorley Wood cedars. In this case the bark has been torn off in patches; the largest patch is some 25 feet from the ground and is very irregular, in part almost circling the limb. A branch was broken off. On the left side of this patch a deep channel has been torn for some 3 feet to a depth of some 1 to $1\frac{1}{2}$ inches, but no other channel is visible. On the other hand the wood is split with a long vertical crack which is visible on both sides of the trunk; through the crack splinters of wood protrude, thrust out from within. I climbed up and examined them. They suggest that the crack closed on them, nipping them as they were passing. I pulled one or two out. They vary from an inch to 6 inches long and have not been torn from the surface of the wood. Smaller patches of bark have been blown off at lower points on the trunk. Some no larger than a hand. The lowest about 6 feet from the ground.

(3) An ash tree near the "Swillet." The bark was stripped in a broad spiral band extending about 20 feet and ending below

at about 15 feet from the ground. The upper end finishes on the dead stump of a branch right among the foliage and 20 feet below the top of the tree. The surface of the wood is very much frayed and splintered. The bare patch is intermediate in form between the other two.

FRANCIS E. HILEY.

Limners, Stag Lane, Chorley Wood, Herts, June 15th, 1929.

NOTES AND QUERIES

The New Meteorological Observatory on the Jungfraujoch

In the *Meteorological Magazine* for May appeared a brief statement that work has begun on the building of a meteorological observatory on the Jungfraujoch. Dr. J. Maurer, Director of the Eidgenossische Meteorologische Zentralanstalt, Zurich, has kindly sent us further particulars, together with a photograph which we reproduce as the frontispiece of this month's magazine. The funds required have now been subscribed, but before the various buildings (astronomical observatory, meteorological pavilion and central building) can be erected it will be necessary to level the sites by blasting operations. The meteorological pavilion will be at a height of 3,570 metres (11,713ft.) on the rock summit of the " Sphinx "; the central building will be about 100 metres lower and will subsequently be connected with the pavilion by a gallery. Naturally a few alterations may be found to be necessary in the course of the work. The cost of the meteorological pavilion will be £8,000—£10,000 without instruments, that of the whole project £100,000 or more.

The observations of the meteorological observatory will include pressure, temperature, humidity, precipitation, wind direction and velocity, sunshine, duration and actinometric observations and also the principal elements of atmospheric electricity and optical and twilight phenomena.

Birthday Celebrations of Dr. G. Hellmann

We extend our congratulations and best wishes to Professor Dr. G. Hellmann on the occasion of his 75th birthday on July 3rd. Dr. Hellmann retired from the Directorship of the Prussian Meteorological Institute in 1922; he is known in this country chiefly for his researches into the history of meteorology and for his discussions of the climate and especially the rainfall of Germany. The Prussian Ministry for Science, Art and Education is marking the occasion by the establishment of a "Hellmann Medal," to be awarded to veteran observers at stations of the Prussian Meteorological Service in recognition of long service.

The British East African Meteorological Service*

The Joint Meteorological Service for British East Africa was inaugurated on January 1st, 1929, and covers the Territories of Kenya, Uganda, Zanzibar, Tanganyika and Northern Rhodesia. As this region includes the headwaters of the Nile, Egypt and the Sudan are also interested in the new Service and are giving financial support. Mr. Walter, formerly Director of the Meteorological and Statistical Services of the South Indian Ocean, and now Statistician to the Governor's Conference, is acting as Director.

Five First Order stations are being set up, at Kabete in Nairobi, Kenya Colony; at Port Bell in Uganda (in connexion with a base for the Air Services); at Tabora in Tanganyika Territory; at Zanzibar; and at Mazabuka in Northern Rhodesia. At these stations, in addition to the usual meteorological observations, the magnetic elements and atmospheric electric potential will be measured, and pilot balloon ascents will be made. In addition there will be about 40 Second Order Telegraphic Stations observing twice daily. The publications of the new Service will include a monthly bulletin of observations, a series of annals in which records, as far back as can be obtained, will be collected and published and a series of memoirs dealing with special investigations.

Lake Moeris and Climatic Changes

Lake Moeris is the name given to an extensive lost lake in the Faiyum depression southwest of Cairo, now represented only by the small Birket Qarum. The history of this lake has long constituted one of the great problems of Egyptology, but the main lines now appear to have been definitely laid down in an important paper by Miss G. Caton-Thompson and Miss E. W. Gardner, published in the *Geographical Journal* for January, 1929. The paper is too long to summarise in detail, but it appears that the principal lake Moeris was glacial in age, and was maintained by a branch from the Nile, then at a high level. The gradual decline of the lake until it nearly dried up, its resuscitation in Neolithic times, and its final decline to the present small remnant, make an interesting story. The bearing on past climates is complicated by the intermittent connection with the Nile, but the authors apparently read the history as follows:—

From about 18,000 to 14,000 B.C., when the lake was high,

---

*Colony and Protectorate of Kenya. The British East African Meteorological Service. Memoirs 1—Note on the Inauguration of a Joint Meteorological Service for British East African Territories. Under the Direction of A. Walter, Statistician to the Governor's Conference, Nairobi, 1929.

was a "pluvial period" corresponding with the latter half of the Wurm Glaciation of Europe. From about 13,000 to 9,000 B.C., when the lake was dry or nearly so, was a dry period representing the Achen Oscillation. About 9,000 to 6,000 B.C.—the period of the Neolithic lake—was again wet, especially about 7,500 B.C., and this has been followed by progressive desiccation into historic times. The archæological evidence, however, indicates that there was a prolonged period during which the lake, although isolated from the Nile, was able to maintain an almost uniform level from a little after 5,000 until 3,000 B.C., after which it shrank rapidly. The period of constant level coincides in time with the moist Atlantic period of Europe, while the subsequent shrinkage fits in with the dry Sub-boreal period.

In Europe there was a return of moister conditions about 850 B.C. This the authors ignore, assuming that the level of Moeris fell uniformly throughout the historic period until it reached its present size. Their ingenious explanation of the evidence of Herodotus, who visited the Faiyum about 450 and reported that the depression was occupied by a large lake, is not entirely convincing. Again, according to their theory the structure at Dimai (about 250 B.C.) could not be a quay, because it ended on dry land, but with its wide shallow steps ending in a sheer drop of 6ft. it is difficult to see what other purpose it could serve. A temporary rise of the lake in the first millennium B.C. would fit these two pieces of evidence very well, but one gathers from the paper that there is even more cogent evidence against such a rise.

C. E. P. BROOKS.

An Observer's Experiences

News has been received of the death at the age of 73 of William Delday, observer at the climatological and anemometrical station at Deerness, Orkney, since 1919, and assistant observer since 1891, when the meteorological instruments were first placed at Deerness on transfer from their former situation at Swanbister. Mr. Delday was not only a faithful and conscientious observer for the Meteorological Office, but he had a great local reputation as custodian of the weather records, and was no doubt frequently called upon for information regarding the weather. Moreover, he was a poet and writer of sorts, and it is thought that readers may be interested in the following specimen of his writing, which has been rescued from the official files.

Extract from a letter dated March 27th, 1928, describing observing experiences after an accident.

"I did not want our splendid Orcadian record to cease, so I kept the record in circumstances which would have deterred most people from doing so. I underwent an operation in Kirkwall and the doctor wanted me to remain in the city, I told him I could not for I had to keep the weather record in Deerness. I slipped on the ice and broke my lantern, and hurt my knee when going to read the instruments at the school, and was so lame that I had to hire a man to work the horses and he spoiled a first-prize mare. She would not work, so in helping to train a beautiful mare I got my shoulder dislocated. The doctors came and put my arm back again into the socket and bade me to remain in bed. I got a neighbour to come and set the vernier and I read the instruments and dictated the readings to be written. My left arm being lame and my right hand tied to my belly, I kept the record. When my right arm was released, I was changing the sunshine card and coming home I fell and broke my neck. Most people would have lain and not have tried to mend their neck. But I turned on my face and placed my brow against the dyke from the top of which I had fallen, and got hold of one of the stones in the dyke and I pulled till I got my neck in a little better shape. O! the pain. But some more strength came to me and I pulled till my head came into its right position.

Then by gripping the fence at my side, I got on my feet and moved slowly home supporting my head with my hands. When I came into the house, those there never saw my face so white. I stood and ate a biscuit and drank a cup of tea, I could not sit down. I leaned against the wall and then lay down dressed as I was on my bed. They laid the bed clothes over me, I could not lay them myself. I rose at 21h. and looked at the sky and guessed the state of the instruments at the school. I had read the minimum in the morning and I read the maximum next morning and the barometer had been fairly steady. That was the only time while I was reading these instruments that I was not there near to the proper time. I was down on the morrow at 9h. and read the instruments, but I did not get my coat off for two weeks. My neck troubles me yet."

St. Swithin's Day

A passing reference to the legend of St. Swithin's day may be looked for each year in the press, but it is doubtful if the interest is maintained throughout the 40-day period : if it were, the value of the prognostic would undoubtedly go down. The following figures are based on an examination of a series of daily rainfall measurements at Brixton, 1871-1910. (A "wet" day is one on which ·01 in. of rain or more was measured.)

In these 40 years St. Swithin's day was dry 23 times, wet 17 times; the average total rainfall in the 40-day period was 2·97 in., falling on approximately 17 days. These figures agree well with what one would expect from consideration of the *Book* *of Normals of Meteorological Elements for the British Isles*, and therefore the material is evidently a good enough sample. Considering separately the years when St. Swithin's day was dry and when it was wet, one gets average values which may be tabulated as follows:—

St. Swithin's Day

Dry	Wet
in the next 40 days—	
23 dry days, 17 wet	24 dry days, 16 wet
Total rainfall 3·29 in.	Total rainfall 2·54 in.
Longest dry spell 8 days	Longest dry spell 10 days
,, wet ,, 5 ,,	,, wet ,, 5 ,,
Comparatively large departures from these averages are likely. 4 :1 chance of July 31 and Aug. 1 being dry.	Comparatively small departures from these averages are likely. 5 :1 chance of Aug. 4, 7 and 14 being dry.

No particular day seems to be indicated as wet except August 24 (the 40th day) after a wet St. Swithin's day with a 12 :5 chance of "wet." Hence one can claim a statistical justification, though a slight one, for saying that if it rains on St. Swithin's day it will rain 40 days after—with an ambiguity equal to that of some of the sayings of the classical oracles. The legend of St. Swithin's day is usually explained as a reference to the greater rainfall of July and August in this country, compared with that of the previous few months, and therefore as a "key" day, one July day might be expected to be as good as the next. A cursory search produced a list of 12 key days, five in June, six in July, one in August, mostly saints' days, and all supposed to serve as a guide to the character of the weather during the following six weeks or so.

Although weather maxims generally prove on investigation to be of little value to the forecaster, they form an interesting study. The Abbé Moreux gives a large selection of "meteorological proverbs" in the second edition of one of his books on weather forecasting, together with a reply to critics who had objected to the inclusion of such proverbs in the first edition.

One of the Abbé's July proverbs may be quoted:

"S'il pleut à la Visitation (July 2),
Pluie à discrétion."

S. T. A. Mirrlees

Frequency of Rain-days

Mr. F. E. Wright has forwarded a table showing the mean annual frequency of daily rainfall amounts within specified limits as recorded at Sutton, to the south of London, during the last 20 years. As values of this character are not always readily available they are reproduced below :—

Mean annual number of days of rainfall within specified limits, Sutton, 1909-28.

Rainfall inch	Mean No. of days
.01 — .03	43
.04 — .49	116.5
.50 — .74	7.9
.75 — .99	2.8
1.00 — 1.24	.9
1.25 — 1.49	.3
1.50 — 1.74	.4
1.75 — 1.99	.1
over 2.00	.1
	172.

The mean annual rainfall during this period was 29.35in.

At Camden Square (north London) the frequency of days with similar amounts during the 45 years 1858-1902 was in close agreement. The corresponding values for the last eight rows of the table were 5.9, 2.0, 0.7, 0.4, 0.1, 0.1, 0.1 and 161.*

The two wettest days at Sutton during the last 20 years were May 31st, 1911, and July 9th, 1923, with 2.40in. and 2.15in. respectively. In 1917 a fall of 1.87in. on July 30th was followed by one of 1.85in. on August 1st.

J. GLASSPOOLE.

Reviews

Geological Climates, by W. B. Scott. *Fossil marine faunas as indicators of climatic conditions*, by Edwin Kirk. Reprints from the Smithsonian Report for 1927, pp. 271-287 and 299-307.

Neither of these papers is heartening. In the first the President of the Geological Society of America reviews the various theories which have been put forward to account for geological changes of climate, and after a process of elimination arrives at the conclusion that we must look to changes in the sun. This theory is only acceptable because it is impossible to disprove; the fact that it is also impossible to prove is a minor disadvantage. Then Mr. Kirk cuts most of the ground from under our feet by pointing out that marine animals do not give reliable indications of past climates, and hence many of our ideas about the latter have no basis in fact. The whole subject of palæo-

*See *British Rainfall* 1902. p. 35. Frequencies of daily amounts at Kew are given in *London Q.J.R. Meteor. Soc.* 36, 1910, p. 319. based on 63 years' observations. In this case frequencies are given for each month as well as for the year.

climatology, like several other sciences, is passing through a period of crisis, in which old fundamental beliefs are breaking up while no new fundamental principles have yet emerged.

Agroklimatische Verhältnisse Russlands. By Prof. W. v. Poletika. Reprinted from Der Kulturtechniker, Zeitschrift der Deutschen Kulturtechnischen Gesellschaft, xxxi, 1928, No. 6.

Over the enormous area of Russia and Siberia there are very few mountains, and the most important factor in the economic life is the climate. In this interesting paper Professor W. v. Poletika discusses the influence of the climate upon agriculture. Zonal arrangement, resulting from solar control, is developed to an extent unknown anywhere else, and is shown not only in temperature, but in rainfall. Almost a quarter of the whole area is waste, in the north because of the lack of warmth, in the south because of the lack of rainfall, and even in the most favoured localities the lack of spring rainfall and the short vegetation season limit the possibilities of agriculture.

Books Received

Die Ausbreitung von Luftdruckwellen über Europa. By L. Weickmann. (Beitr. Geophys., Leipzig, XVII, 1927, pp. 332-9.)

Das Wellenproblem der Atmosphäre. By L. Weickmann. (Met. Zs., 1927, pp. 241-53.)

Il Clima dei Colli Euganei e di Padova. By Guiseppe Crestani. (Ufficio Idrografico R. Magistrato alle acque, Venezia.) In this paper the author is mainly concerned with the temperature observations at the two stations Padova and Venda. Padova is on the plain at a height of 16m. and the observations discussed extend over the period 1920-6, whereas Venda is near the top of the Colli Euganei at a height of 579m. and the observations extend from 1916-26.

La Lluvia en Venezuela; anos de 1925 y 1926. By Ernesto Sifontes, Caracas, 1928.

Jaarboek, Koninklijk Nederlandsch Meteorologisch Instituut, 1926, A. Meteorologie, B. Aard-Magnetisme (No. 98), Utrecht, 1927.

Ergebnisse Aerologischer Beobachtungen, 1926. K. Ned. Meteor. Inst. (No. 106A). Utrecht, 1927.

Onweders, Optische Verschijnselen, enz. in Nederland. Naar Vrijwillige Waarnemingen in 1925. Deel XLVI. K. Ned. Meteor. Inst. (No. 81). Amsterdam, 1927.

Royal Alfred Observatory, Mauritius; Annual Report, 1927, and Results of magnetical and meteorological observations for July to December, 1927. Port Louis, 1927.

Bollettino Meteorologico della Cirenaica, 1926 (Riassunto delle osservazioni). Governo della Cirenaica, No. 7. Tripoli, 1928.

Bollettino Meteorologico della Tripolitania, 1926 (Riassunto delle osservazioni). Governo della Tripolitania, No. 8. Tripoli, 1928.

Anales del Observatorio Nacional de San Bartolomé en los Andes Colombianos. Observaciones meteorologicas de 1926. Bogota, 1928.

News in Brief

Dr. L. F. Richardson, F.R.S., F.Inst.P., who is in charge of the Physics Dept., Westminster Training College, London, and was formerly Superintendent of Eskdalemuir Observatory, has been appointed Principal of Paisley Technical College.

Professor Henrique Morize has resigned the post of Director of the National Observatory, Rio de Janeiro, which he has held since 1921. He is succeeded by Señor Sodré da Gama.

The Norwegian paper *Tidens Tegn* for May 28th, 1929, contains an account of the flight carried out by the Junkers pilot, Neuenhofen, on May 26th, in which he set up the altitude record of 12,500 metres. To his great astonishment Neuenhofen encountered sharp squalls at 11,000 metres. The temperature at this altitude was – 50°C. and the lowest pressure recorded was 173mb.

A paper on "Extremes of Rainfall over the British Isles" was read on July 2nd by Dr. J. Glasspoole at the summer meeting of the British Waterworks Association, which was held at Portsmouth from July 2nd to 5th.

Errata

May, 1929, p. 101, line 45, and June, 1929, p. 128, line 45, *for* "the average 1811-1915" *read* "the average 1881-1915."

The Weather of June, 1929

June was a relatively cool month in spite of an excess of sunshine in most districts. The total rainfall for the month was also below the normal except in Scotland and west Ireland. The first day of the month was generally cloudy and warm though by the evening rain was spreading in from the west. Dungeon Ghyll (Westmorland) had as much as 1.40in. and Ford (Argyll) 1.19in. during the night, but the amounts measured elsewhere were generally slight. For the rest of the first week an elongated belt of low pressure was maintained from the Atlantic across the country and rain fell on most days though there were many bright periods. Heavy rain occurred on the 4th and 6th; 1.11in. was measured at Swingfield (Dover) on the 4th. Thunderstorms were experienced in the south on the 4th and in the north on the

6th and 8th. An anticyclone spreading in from the Azores on the 9th gave an interval of mainly bright weather and temperature, which had been rather low on the whole rose generally to above 70°F. on the 11th and 12th, 76°F. being recorded at Renfrew, Hull and Lympne. The 9th, 10th and 11th were three very sunny days generally when more than 15hrs. of bright sunshine were registered at a few stations and as much as 15.8hrs. at Deerness (Orkneys) on the 9th. Heavy rain, however, fell in Tiree and northwest Ireland on the 11th owing to a depression over the Atlantic; Blacksod Point had 1.42in. On the 12th a depression from the Bay of Biscay gave general rain over England, the heaviest falls being in the west. This was followed by a further period of showery weather with considerable periods of sunshine but a rather low temperature. Thunderstorms were frequent in the north on the 13th and 14th. Except in the north where useful showers of rain were experienced between the 18th and 24th, mainly dry sunny weather set in on the 17th and persisted to nearly the end of the month. Temperature rose quickly, maxima of over 70°F. were reported at most places on the 18th and 19th, while 83°F. occurred at Greenwich and 82°F. at Norwich on the 19th. On these two days over 15hrs. sunshine were reported locally. Temperature again rose over 70°F. on the 23rd. After this the winds veered to north with a corresponding drop in temperature, ground frosts occurring at a few places round the 26th. The weather remained cool in the east until the 30th but in the west it turned warm, 72°F. was recorded at Kilmarnock on the 27th and 75°F. at Mallarany on the 28th. Rothesay had 16.1hrs. sunshine on the 25th and many other places over 15hrs. between the 25th and 29th. A depression over the Bay of Biscay brought moderate rain to southern England on the 29th and 30th.

Pressure was below normal over northwest and central Europe and the North Atlantic, the greatest deficit being about 5mb. at Stockholm, and above normal over southwest Europe, Spitsbergen, northwest Iceland, Newfoundland and Bermuda, the greatest excess being 3.5mb. at Stykkisholm. Temperature was generally below normal over the whole of west Europe with the exception of Portugal and northeast Sweden, while rainfall was mainly in excess in the north but deficient in the central and western countries.

On the night of May 31st to June 1st a waterspout broke over the Bernese Jura and destroyed the crops in the district of Vendlincourt. Violent thunderstorms were also reported from Canton Vaud (Switzerland) on the 10th and in the neghbourhood of Brussels on the 12th, much damage being done to the crops, trees and vineyards. The heat wave in Spain came to an end on the 12th, when there were heavy falls of rain and hail. Numerous thunderstorms occurred in Yugoslavia during the month. Forest fires broke out in various parts of the Riviera about the 25th. After a month of sunshine and hot weather temperature fell rapidly in the neighbourhood of Milan on the 26th; storms were reported in many parts of the country and snow fell on the high peaks of the Alps and Apennines.

A devastating hailstorm swept over most of Durban on the evening of the 4th. No serious casualties occurred but much material damage was done, roofs collapsing under the weight of the hail. Many of the lumps of ice were said to be larger than a tennis ball.

Forest fires fanned by strong winds and favoured by the drought occurred in northern Japan and Sakhalin at the beginning of the month. Heavy rain fell in Yemen (Arabia) about the 10th so that the River Bana was in flood in the Aden Protectorate. A heat spell was experienced in the Punjab during the first part of the month, maximum temperatures on most days being above 110°F. The monsoon set in definitely in Bombay on the 6th, when nearly 7in. of rain fell. In Calcutta it broke with comparative gentleness on the 15th. In Assam and western Burma it broke with violence causing serious floods, which destroyed many cattle and much of the crops. About the 20th fine weather was experienced in Assam. By the 30th the floods had subsided considerably.

High temperatures were experienced in the northeastern part of the United States during the first days and a heat wave lasting nearly a fortnight set in about the 13th. The heat was accompanied by high humidity. A thunderstorm followed by cool northwest winds occurred on the 25th. Intense heat was also experienced in the southern states and a temperature of 118°F. was recorded both at Phœnix and Yuma in Arizona on the 24th. A hurricane caused damage to sugar plantations in northern Venezuela about the 23rd and heavy storms also occurred in northern Chile.

Icebergs were more numerous than usual on the Grand Banks of Newfoundland.

The special message from Brazil states that the rainfall was deficient over the whole country with 2.13in., 0.91in. and 1.50in. below normal in the northern, central and southern districts respectively. Eight anticyclones passed across the country and the continental depressions often spread southwards. Crops were doing well in the favourable weather despite the scarcity of precipitation, though there were some losses in the south owing to frosts. At Rio de Janeiro pressure was equal to normal and temperature 0.2°F. below normal.

Rainfall, June, 1929.—General Distribution

England and Wales	78	per cent. of the average 1881-1915.
Scotland	124	
Ireland	83	
British Isles	91	

Rainfall: June, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	1·29	64	*Leics* .	Belvoir Castle	1·57	82
Sur .	Reigate, The Knowle	1·57	81	*Rut* .	Ridlington	1·20	...
Kent .	Tenterden, Ashenden	1·09	57	*Linc* .	Boston, Skirbeck	1·59	87
,, .	Folkestone, Boro. San.	1·58	...	,, .	Lincoln	1·25	62
,, .	Margate, Cliftonville	1·05	60	,, .	Skegness, Marine Gdns	·70	39
,, .	Sevenoaks, Speldhurst	1·20	...	,, .	Louth, Westgate	1·20	56
Sus .	Patching Farm	2·54	126	,, .	Brigg, Wrawby St.	·74	...
,, .	Brighton, Old Steyne	2·28	127	*Notts* .	Worksop, Hodsock	·82	41
,, .	Heathfield, Barklye	1·65	79	*Derby* .	Derby, L. M. & S. Rly.	1·17	52
Hants .	Ventnor, Roy. Nat. Hos.	1·57	86	,, .	Buxton, Devon Hos.	1·95	61
,, .	Fordingbridge, Oaklnds	1·20	65	*Ches* .	Runcorn, Weston Pt.	1·73	67
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	1·78	...
,, .	Sherborne St. John	1·30	61	*Lancs* .	Manchester, Whit. Pk.	1·01	38
Berks .	Wellington College	·93	43	,, .	Stonyhurst College	1·77	58
,, .	Newbury, Greenham	1·43	66	,, .	Southport, Hesketh Pk	1·22	56
Herts .	Welwyn Garden City	·51	...	,, .	Lancaster, Strathspey	1·66	...
Bucks .	High Wycombe	1·30	67	*Yorks* .	Wath-upon-Dearne	1·27	57
Oxf .	Oxford, Mag. College	·99	46	,, .	Bradford, Lister Pk	·90	38
Nor .	Pitsford, Sedgebrook	1·05	54	,, .	Oughtershaw Hall	2·84	...
,, .	Oundle	·75	...	,, .	Wetherby, Ribston H.	1·60	76
Beds .	Woburn, Crawley Mill	·87	44	,, .	Hull, Pearson Park	1·45	70
Cam .	Cambridge, Bot. Gdns.	·84	40	,, .	Holme-on-Spalding	·81	...
Essex .	Chelmsford, CountyLab	·58	31	,, .	West Witton, Ivy Ho.	1·49	...
,, .	Lexden Hill House	·79	...	,, .	Felixkirk, Mt. St. John	1·86	85
Suff .	Hawkedon Rectory	1·18	57	,, .	Pickering, Hungate	...	...
,, .	Haughley House	·47	...	,, .	Scarborough	1·30	71
Norf .	Norwich, Eaton	·80	41	,, .	Middlesbrough	2·14	113
,, .	Wells, Holkham Hall	1·90	97	,, .	Baldersdale, Hury Res.	1·31	...
,, .	Little Dunham	1·23	55	*Durh* .	Ushaw College	1·60	74
Wilts .	Devizes, Highclere	1·40	62	*Nor* .	Newcastle, Town Moor	1·50	69
,, .	Bishops Cannings	1·41	58	,, .	Bellingham, Highgreen	3·06	...
Dor .	Evershot, Melbury Ho.	1·94	85	,, .	Lilburn Tower Gdns.	1·70	...
,, .	Creech Grange	1·73	...	*Cumb* .	Geltsdale	2·20	...
,, .	Shaftesbury, Abbey Ho.	1·59	69	,, .	Carlisle, Scaleby Hall	2·52	100
Devon .	Plymouth, The Hoe	2·64	122	,, .	Borrowdale, Seathwaite	5·77	89
,, .	Polapit Tamar	2·42	113	,, .	Borrowdale, Rosthwaite	3·76	...
,, .	Ashburton, Druid Ho.	...	...	,, .	Keswick, High Hill	1·60	...
,, .	Cullompton	2·40	113	*Glam* .	Cardiff, Ely P. Stn.	2·31	93
,, .	Sidmouth, Sidmount	2·31	110	,, .	Treherbert, Tynywaun	5·82	...
,, .	Filleigh, Castle Hill	2·80	...	*Carm* .	Carmarthen Friary	2·45	85
,, .	Barnstaple, N. Dev. Ath.	2·61	117	,, .	Llanwrda	3·31	97
Corn .	Redruth, Trewirgie	3·05	123	*Pemb* .	Haverfordwest, School	1·95	72
,, .	Penzance, Morrab Gdn.	3·31	149	*Card* .	Aberystwyth	3·87	...
,, .	St. Austell, Trevarna	3·33	128	,, .	Cardigan, County Sch.	2·12	...
Soms .	Chewton Mendip	1·82	61	*Brec* .	Crickhowell, Talymaes	3·20	...
,, .	Long Ashton	2·22	...	*Rad* .	BirmW.W.Tyrmynydd	3·55	109
,, .	Street, Millfield	1·91	...	*Mont* .	Lake Vyrnwy	3·51	111
Glos. .	Cirencester, Gwynfa	1·35	56	*Denb* .	Llangynhafal	2·38	...
Here .	Ross, Birchlea	1·40	64	*Mer* .	Dolgelly, Bryntirion	5·06	145
,, .	Ledbury, Underdown	1·33	59	*Carn* .	Llandudno	2·04	100
Salop .	Church Stretton	2·94	121	,, .	Snowdon, L. Llydaw 9	...	...
,, .	Shifnal, Hatton Grange	1·94	87	*Ang* .	Holyhead, Salt Island	1·36	63
Worc .	Ombersley, Holt Lock	1·86	82	,, .	Lligwy	1·64	...
,, .	Blockley	1·36	...	*Isle of Man*			
War .	Farnborough	1·85	78		Douglas, Boro' Cem.	2·06	85
,, .	Birminghm, Edgbaston	1·96	84	*Guernsey*			
Leics .	Thornton Reservoir	1·55	72		St. PeterP't. GrangeRd.	2·39	129

Rainfall : June, 1929 : Scotland and Ireland

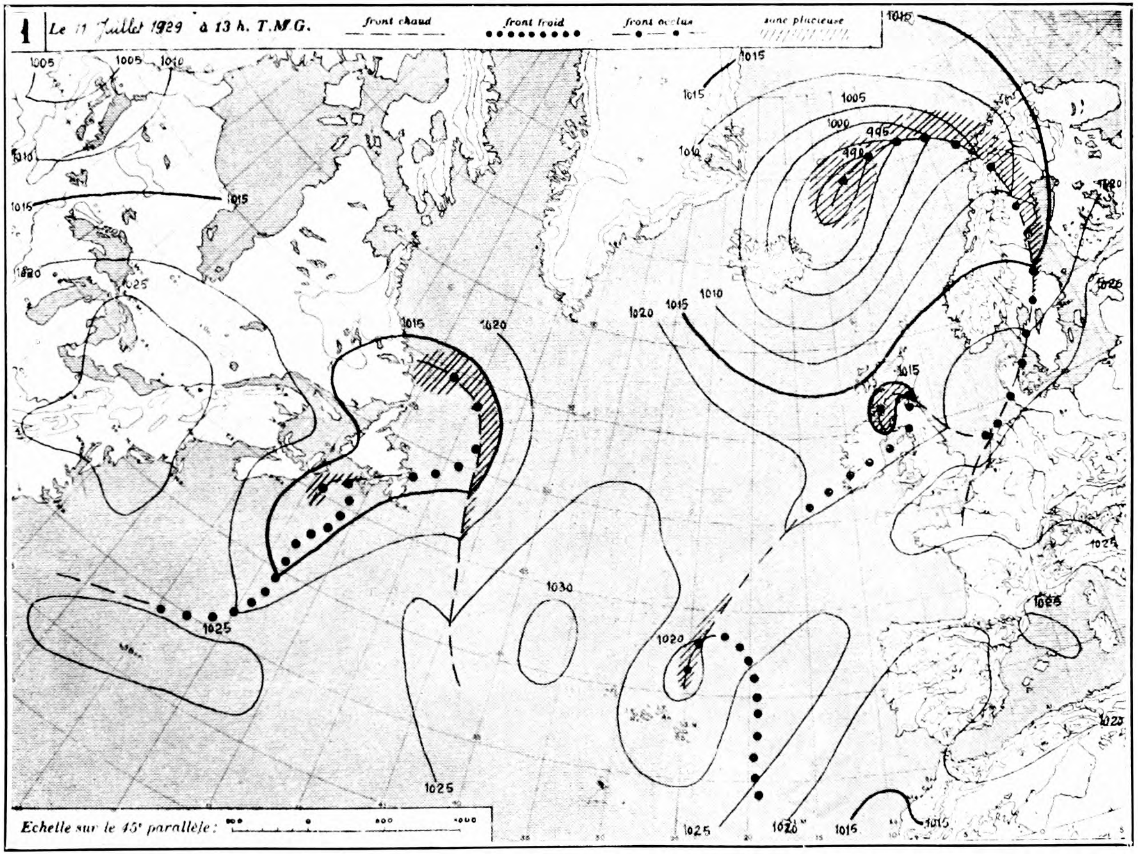
Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	2·29	94	*Suth* .	Loch More, Achfary...	6·92	187
,, .	Pt. William, Monreith	1·94	...	*Caith* .	Wick.....................	3·30	183
Kirk .	Carsphairn, Shiel.......	3·02	...	*Ork* .	Pomona, Deerness......	3·30	179
,, .	Dumfries, Cargen......	2·90	104	*Shet* .	Lerwick..................	2·17	122
Dumf.	Eskdalemuir Obs.......	4·43	141	*Cork* .	Caheragh Rectory......	3·46	...
Roxb .	Branxholm...............	2·03	90	,, .	Dunmanway Rectory...	2·47	71
Selk .	Ettrick Manse..........	...	...	,, .	Ballinacurra.............	1·41	54
Peeb .	West Linton...........	2·72	...	,, .	Glanmire, Lota Lo......	1·48	55
Berk .	Marchmont House......	2·12	92	*Kerry*.	Valentia Obsy..........	3·40	106
Hadd.	North Berwick Res.....	1·93	111	,, .	Gearahameen............	4·10	...
Midl .	Edinburgh, Roy. Obs.	2·49	135	,, .	Killarney Asylum......	1·77	61
Ayr .	Kilmarnock, Agric. C.	3·26	148	,, .	Darrynane Abbey.......	2·97	95
,, .	Girvan, Pinmore..	3·21	111	*Wat* .	Waterford, Brook Lo...	2·66	99
Renf .	Glasgow, Queen's Pk. .	2·99	129	*Tip* .	Nenagh, Cas. Lough...	1·40	57
,, .	Greenock, Prospect H.	3·99	121	,, .	Roscrea, Timoney Park	1·57	...
Bute .	Rothesay, Ardencraig.	3·55	116	,, .	Cashel, Ballinamona...	1·64	71
,, .	Dougarie Lodge.........	3·35	...	*Lim* .	Foynes, Coolnanes......	·99	38
Arg .	Ardgour House.........	6·38	...	,, .	Castleconnel Rec.......	1·58	...
,, .	Manse of Glenorchy...	5·45	...	*Clare* .	Inagh, Mount Callan...	2·40	...
,, .	Oban......................	3·99	...	,, .	Broadford, Hurdlest'n.	2·03	...
,, .	Poltalloch...............	5·19	170	*Wexf*.	Newtownbarry	2·43	...
,, .	Inveraray Castle...	6·32	160	,, .	Gorey, Courtown Ho...	2·26	93
,, .	Islay, Eallabus.........	4·11	157	*Kilk* .	Kilkenny Castle.........	1·95	80
,, .	Mull, Benmore.........	9·30	...	*Wic* .	Rathnew, Clonmannon	1·39	...
,, .	Tiree	3·09	...	*Carl* .	Hacketstown Rectory..	2·00	71
Kinr .	Loch Leven Sluice......	1·77	81	*QCo* .	Blandsfort House......	1·99	77
Perth .	Loch Dhu...............	4·30	103	,, .	Mountmellick...........	1·47	...
,, .	Balquhidder, Stronvar	2·78	...	*KCo* .	Birr Castle..............	1·69	73
,, .	Crieff, Strathearn Hyd.	2·08	79	*Dubl* .	Dublin, FitzWm. Sq...	1·52	78
,, .	Blair Castle Gardens...	1·55	78	,, .	Balbriggan, Ardgillan.	1·31	65
,, .	Dalnaspidal Lodge.....	2·76	86	*Me'th* .	Beauparc, St. Cloud...	2·12	...
Angus.	Kettins School.	1·63	87	,, .	Kells, Headfort.........	2·95	111
,, .	Dundee, E. Necropolis	1·96	109	*W.M*.	Moate, Coolatore......	2·40	...
,, .	Pearsie House...........	2·07	...	,, .	Mullingar, Belvedere..	2·00	77
,, .	Montrose, Sunnyside...	1·73	104	*Long* .	Castle Forbes Gdns......	1·97	76
Aber .	Braemar, Bank...	1·47	75	*Gal* .	Ballynahinch Castle...	3·89	110
,, .	Logie Coldstone Sch....	1·60	82	,, .	Galway, Grammar Sch.	1·71	...
,, .	Aberdeen, King's Coll.	1·84	108	*Mayo* .	Mallaranny..............	3·44	...
,, .	Fyvie Castle.............	2·61	...	,, .	Westport House.........	1·37	51
Mor .	Gordon Castle...........	2·41	118	,, .	Delphi Lodge............	5·76	...
,, .	Grantown-on-Spey......	...	...	*Sligo* .	Markree Obsy...........	2·89	96
Na .	Nairn, Delnies	1·76	100	*Cav'n* .	Belturbet, Cloverhill...	2·62	107
Inv .	Kingussie, The Birches	1·70	...	*Ferm* .	Enniskillen, Portora...	2·44	...
,, .	Loch Quoich, Loan.....	6·00	..	*Arm* .	Armagh Obsy...........	1·85	73
,, .	Glenquoich..............	7·41	151	*Down* .	Fofanny Reservoir......	2·82	...
,, .	Inverness, Culduthel R.	1·80	...	,, .	Seaforde.................	2·16	78
,, .	Arisaig, Faire-na-Squir	4·22	...	,, .	Donaghadee, C. Stn...	2·61	112
,, .	Fort William...........	4·64	...	,, .	Banbridge, Milltown...	2·31	...
,, .	Skye, Dunvegan........	3·70	...	*Antr* .	Belfast, Cavehill Rd...	2·94	...
R & C.	Alness, Ardross Cas ...	1·68	74	,, .	Glenarm Castle.........	2·58	...
,, .	Ullapool................	3·49	...	,, .	Ballymena, Harryville	3·05	105
,, .	Torridon, Bendamph...	5·11	125	*Lon* .	Londonderry, Creggan	3·82	135
,, .	Achnashellach..........	5·29	...	*Tyr* .	Donaghmore............	3·11	...
,, .	Stornoway..............	3·26	141	,, .	Omagh, Edenfel........	2·73	97
Suth .	Lairg.....................	2·64	...	*Don* .	Malin Head.............	3·44	...
,, .	Tongue	3·75	183	,, .	Dunfanaghy..............	3·74	...
,, .	Melvich..................	5·20	268	,, .	Killybegs, Rockmount.	4·26	112

Climatological Table for the British Empire, January, 1929.

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.	1025·7	+ 8·1	51	24	38·8	31·8	35·3	− 3·6	32·1	87	8·7	0·73	− 1·03	10	1·0	12
Gibraltar	1022·1	+ 0·9	67	38	59·7	50·6	55·1	+ 0·3	49·5	78	5·9	0·57	− 4·49	8	..	..
Malta	1019·4	+ 1·8	63	43	55·1	47·7	51·4	− 3·9	46·3	70	6·5	1·28	− 1·93	16	5·5	55
St. Helena	1010·9	+ 0·9	70	57	64·9	58·4	61·5	− 3·0	59·4	97	9·7	1·82	− 1·15	22	..	..
Sierra Leone	1008·4	− 2·4	92	68	86·3	72·6	79·5	− 1·8	74·6	80	1·8	0·00	− 0·41	0	..	..
Lagos, Nigeria	1011·6	+ 1·7	89	68	87·5	74·1	80·8	− 0·1	73·2	78	7·3	0·02	− 1·05	1	..	..
Kaduna, Nigeria	1016·4	+ 4·8	97	..	86·7	..	..	..	58·7	47	..	0·00	0·00	0	..	..
Zomba, Nyasaland	1007·6	+ 0·2	86	62	78·7	64·9	71·8	− 1·0	..	84	9·0	17·98	+ 6·88	25	..	..
Salisbury, Rhodesia	1007·3	− 0·6	85	55	76·7	60·2	68·5	− 1·2	62·8	76	8·0	11·98	+ 4·51	21	5·3	40
Cape Town	1013·4	0·0	102	57	82·3	62·6	72·5	+ 2·6	64·0	64	1·7	0·00	− 0·68	0	..	..
Johannesburg	1011·4	+ 0·6	88	52	76·6	57·0	66·8	+ 0·3	58·9	76	5·8	3·78	− 2·39	14	7·4	54
Mauritius	1012·5	+ 0·6	88	70	83·7	72·9	78·3	− 1·0	74·7	75	7·2	8·60	+ 0·84	21	7·6	58
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1014·6	− 0·6	84	50	79·4	59·3	69·3	+ 2·9	59·7	85	4·6	1·17	+ 0·83	2*	..	..
Bombay	1013·0	− 0·6	92	54	83·8	66·3	75·1	− 0·2	63·6	71	2·1	0·63	+ 0·53	1*	..	..
Madras	1012·2	− 1·9	86	64	83·9	68·5	76·2	+ 0·1	71·6	89	3·3	1·87	+ 0·48	2*	..	..
Colombo, Ceylon	1011·6	+ 0·1	87	63	84·9	70·7	77·8	− 1·3	73·7	74	3·2	6·61	+ 3·11	10	9·7	82
Hongkong	1019·0	− 0·8	74	52	66·9	59·4	63·1	+ 2·9	58·2	74	6·3	0·93	− 0·44	8	5·3	49
Sandakan	..	..	90	72	85·8	73·6	79·7	− 0·1	75·8	84	..	5·88	− 12·57	7	..	..
Sydney, N.S.W.	1008·5	− 4·0	106	61	80·8	67·8	74·3	+ 2·6	67·2	61	5·5	0·32	− 3·41	6	7·6	54
Melbourne	1009·1	− 3·8	101	48	78·4	56·3	67·3	− 0·2	59·0	56	6·0	1·36	− 0·49	11	7·4	51
Adelaide	1011·5	− 1·5	104	51	81·6	60·2	70·9	− 3·0	58·4	38	5·4	0·45	− 0·28	9	9·5	67
Perth, W. Australia	1014·4	+ 1·9	100	51	84·1	61·5	72·8	− 1·1	60·9	43	1·8	0·30	− 0·04	2	11·9	86
Coolgardie	1012·3	+ 0·9	107	47	91·6	59·0	75·3	− 2·1	59·3	39	2·1	0·37	− 0·10	2	..	..
Brisbane	1008·6	− 2·7	102	65	88·9	71·1	80·0	+ 2·8	73·0	66	6·1	4·60	− 1·67	7	9·6	70
Hobart, Tasmania	1003·7	− 6·6	82	43	70·6	52·6	61·6	− 0·7	53·9	57	6·6	2·12	+ 0·33	17	8·9	60
Wellington, N.Z.	1010·9	− 2·4	75	45	66·1	55·0	60·5	− 2.0	57·9	78	7·6	2·15	− 1·18	13	7·1	48
Suva, Fiji	1005·8	− 1·9	90	69	85·2	74·6	79·9	0·0	75·6	79	7·3	14·28	+ 3·56	23	5·7	44
Apia, Samoa	1006·0	− 1·9	87	73	84·3	75·3	79·8	+ 0·8	77·6	83	7·2	24·22	+ 7·41	27	3·6	28
Kingston, Jamaica	1014·6	− 0·5	89	63	85·4	67·3	76·3	− 0·5	65·8	83	5·0	0·55	− 0·41	8	6·1	54
Grenada, W.I.	1009·4	− 3·2	86	69	83·5	72·2	77·9	+ 0·9	72·1	78	2·1	4·40	− 0·03	17	..	..
Toronto	1016·2	− 1·2	45	− 1	29·4	16·7	23·1	+ 1·0	19·1	68	7·4	5·46	+ 2·59	22	3·0	32
Winnipeg	1022·7	+ 2·9	17	−30	− 2·5	−17·5	−10·0	− 5·6	..	..	3·6	0·49	− 0·33	11	4·9	57
St. John, N.B.	1011·0	− 4·7	53	−12	28·4	10·5	19·5	+ 0·3	14·9	68	5·7	4·68	− 0·12	19	3·9	42
Victoria, B.C.	1019·0	+ 3·7	48	14	38·6	31·5	35·1	− 5·0	32·9	83	7·1	2·33	− 2·18	11	2·5	28

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

Erratum, June, 1929, page 127. Note *should read*—Malta (Valleta); station moved from 35° 53′N, 14° 30′E, 185 ft. to 35° 54′N, 14° 31′E, 233·6 ft. from April 20th, 1928. Differences from no[redacted] station throughout.



Bulletin Quotidien d'Etudes, JULY 11TH, 1929, PAGE 3 (*see page* 154).

M.O. 313.

The Meteorological Magazine

Vol. 64

August 1929

No. 763

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

Problems of Tropical Meteorology

The meeting of a large number of meteorologists from all parts of the Empire for the Conference of Empire Meteorologists to be held in London in August may be expected to bring about a great deal of unofficial as well as of official discussion. Every country has its own characteristic phenomena of wind and weather, some of which may prove to be interesting object lessons in the physical processes of the atmosphere; there are other phenomena which are general between the tropics but which are unknown to the inhabitants of temperate regions.

In this direction Sir Gilbert Walker has given a valuable lead in his recent Halley Lecture on "Some Problems of Indian Meteorology."* Starting with a general account of the seasons in India he proceeds to describe the violent thunderstorms of the "hot weather" with hailstones capable of killing men and buffaloes. India also suffers from occasional tornadoes of the American type, one of which wrecked a factory at Cawnpore in 1927. The rainy season brings remarkable cloud formations, which can be traced to the powerful convection caused by the heating of the ground beneath the nearly vertical sun, combined with the shearing of the rising air masses by the winds of the free air. Finally, Sir Gilbert passes to the subject of long-range forecasting, highly important to India and little less so to several other tropical countries. He gives the comparison

* Oxford, Clarendon Press, 1929.

(85667) P. S. 1602/81. 1050. 8/29 M. & S. Gp. 303.

between actual curves and those obtained from "prediction formulæ" for rainfall in the West Indies, South Africa and Australia and for winter temperature in West Canada.

Most of the problems which Sir Gilbert refers to are already some way towards solution, but many of those with which meteorologists in other tropical countries have to deal have not yet been seriously investigated. Almost every colony has its own, especially its local winds and wind-storms with their particular names. An interesting example is the "Sumatra" of the Malacca Straits, a south-westerly squall accompanied by an arched cloud, which always blows at night. No complete explanation of the peculiarities of this wind has been published, but a study of its points of similarity to and difference from typical squalls and so-called "tornadoes" of other parts of the tropics would doubtless throw much light on these "minor circulations."

Other problems concern the extent and causes of local variations or "flickers" in the strength and direction of the trade winds, the existence of "fronts" in tropical cyclones, and the variations of incoming and outgoing radiation in equatorial regions. It would be easy to extend the list almost indefinitely, but enough has been said to show that "the weather" is not likely to fail as a subject for conversation between meteorologists from different parts of the world.

The French Daily Weather Report

The French Meteorological Service has for some time issued its daily weather report in two parts, the *Bulletin Quotidien de Renseignements* and the *Bulletin Quotidien d'Etudes*. The idea of separating the report into two parts, one for general use and one for students of meteorology seems a good one, but the separate purpose of the parts as indicated by their titles has not been fulfilled very clearly in the past. Each part has consisted of four single pages and has contained both tabular matter and charts; the station reports have been divided into two groups, those from French stations being published in the *Bulletin Quotidien de Renseignements* and those from "foreign" stations in the *Bulletin Quotidien d'Etudes*.

From July 1st, 1929, the form of the report has been altered and it is interesting to note the manner in which General Delcambre, the head of the *Office National Météorologique*, has endeavoured to meet the requirements of the French public, both those seriously interested in meteorology and those whose interest is more superficial. The *Bulletin Quotidien de Renseignements* has been reduced to a single sheet providing two pages of the same size as those of our own *Daily Weather Report*, while the

Bulletin Quotidien d'Etudes has been expanded to a publication of four sheets, that is eight single pages. The annual subscription for the latter is 320 fr. as against 140 fr. for the more modest single sheet of the former.

The *Bulletin Quotidien de Renseignements* in its simplified form contains a 7 a.m. chart for northwest Europe and the eastern Atlantic, on which are entered winds, isobars and lines showing the change of pressure in the past 24 hours. Beneath this map are forecasts given separately for the region around Paris and for the whole of France. On the reverse side there is a smaller map showing changes of pressure in the past three hours with large arrows indicating the direction of movement of the isallobaric systems; also charts of maximum and minimum temperature and rainfall. The different phases of the *système nuageux*, of which so much use is made in French forecasting, are indicated on another map which shows the state of the sky at 7 a.m., the regions in which the several types of cloud formation prevail being indicated by distinctive symbols. This report seems admirably to fulfil its purpose of being a simple and (if we except the *système nuageux*) non-technical publication.

The *Bulletin Quotidien d'Etudes* in its new form commences with tables of readings at 7 a.m,, 1 p.m., and 6 p.m., for French stations together with aerological reports, while the last page contains a small table of ships' reports from the Atlantic and Mediterranean. It is interesting to note that readings from foreign stations no longer find a place in the report. More than one-half of the eight pages are devoted to charts. In the first of these, which is reproduced as the frontispiece of this number of the magazine, polar fronts appear for the first time in the French daily weather report. The chart is an ambitious one showing isobars and fronts over the whole of that part of the Northern Hemisphere which extends from Europe in the east to eastern Canada, the Great Lakes and part of the United States in the west. The fronts are shown very clearly, by broken lines for a warm front and a row of black dots for a cold front. Fronts are often difficult to locate, sometimes their very existence is doubtful. Further they vary greatly in intensity and importance and it therefore seems regrettable that no observations are entered on the chart to help the student to judge of the nature of the fronts and of their effect on the weather in the vicinity. The chart on which these fronts are shown is for 1 p.m. G.M.T. A Northern Hemisphere chart for 1 a.m. covering an area centred at the pole occupies most of the last page of the report, and shows isobars but not fronts.

The importance attached to isallobars in France is shown by the inclusion of six small charts of changes of pressure in the periods of 24 hours, 12 hours and 3 hours respectively, ending at 7 a.m. and again for the same periods ending at

6 p.m. The only forecasts contained in this report are in the form of two charts, one for the anticipated changes of pressure in the 12 hours ending at 7 a.m. the following morning and the other for the state of the sky and the wind anticipated at this hour. Alongside these two charts are written an analysis of the situation and some comments on the reasons which have led to the deductions drawn. The report appears to be issued on the day following that to which it refers, as a short critical discussion is included of the success or otherwise obtained in the forecasts. Such a discussion is likely to be of value by giving the reader an insight into the lines on which the forecasters work, and may in addition be helpful to the forecasters themselves. Curves showing the daily march of temperature both at the summit of the Eiffel Tower and in the courtyard of the *Office National Météorologique* are also included in a report, the form of which suggests a considerable appetite for meteorological information amongst French students of meteorology.

J. S. Dines.

The Thunderstorm of July 20th, 1929

Thundery clouds were visible during the day in London, moving from between southwest and southsouthwest. They were mainly of alto-cumulus castellatus type, with a stratified base which I estimated to be at about 8,000 feet, but a few large isolated cumulo-nimbus clouds had developed before noon. Brief but sharp thunderstorms occurred in a few localities scattered over the southeastern area. During the evening a line-squall moved rapidly over the area from about south to north, and violent thunderstorms developed in some districts, though as usual these were far less general than the squall itself. The worst storm appears to have formed quickly along a belt from the New Forest to London, with over two inches of rain locally, and large hailstones fell in west and north London. The squall attained a maximum velocity of 50 miles per hour at Kew Observatory. After a very hot day, temperature fell decidedly, the largest fall reported being from 83°F. to 65°F. at Worthy Down, Winchester. The fall was of course greatly intensified by the rain. In London the front of the storm was somewhat extended along the line of the squall, but subsequently the main elongation of the storm was from about southwest to northwest, covering the western and northern parts of the town. A fine view of the storm belt was obtained from central London, and the foci of maximum lightning frequency were moving fairly quickly along the belt, which slowly receded. This elongation of the storm in a direction nearly parallel to the upper wind current is rather frequent, and is responsible for most prolonged storms. The duration in western and northern London was fully an hour.

At Duxford at 10h. conditions were quite stable, owing to the absence of moisture. The lapse rate of temperature above 8,000 feet was such that, if the air were saturated, conditions would have been unstable higher up without any change of temperature being necessary. There can be little doubt that the necessary moisture was brought by the southwest upper current. Humidity rose somewhat at the ground, where there was little wind, but when there is strong convectional mixing the humidity at the ground is influenced by the humidity up aloft. On dry hot days the absolute humidity sometimes drops between 7h. and 13h., and becomes much lower inland than on the coast. Pilot balloons all showed a southsouthwest current of 20 to 30 m.p.h. at 6,000 feet, with only light winds at low levels.

It has often been stated that instability in these conditions is due to cooler oceanic air over-running hot continental air. There may be some truth in this (though it has never been demonstrated from observations), but it can only be a partial explanation, as it ignores the most vital thing of all, namely, the moisture. Equally severe storms may develop with no westerly wind component at any height, provided that there is enough moisture. On some occasions an upper southwest current is dry, and there are no thunderstorms. On an ordinary sunny day in summer, an adiabatic lapse-rate of temperature is established up to about 4,000 feet. Over-running cooler air would increase the lapse rate in the vital layer just above this, and if the adiabatic rate were exceeded one would at once have "trigger" action to start off the storm. Evidence for this is however so far lacking, and indeed super-adiabatic lapse rates are very rare above the lowest few hundred feet. The necessary trigger action is very effectively supplied by the cold front, which displaces the entire mass of air up to the height of a few thousand feet. It seems probable that if there had been no cold front there would have been no large and very severe storm, but only the small storms. In the case of many severe storms the trigger action is certainly not a line squall, but it may always be some sort of front, or at least a line of convergence. When the clouds are low, convergence is probably less essential.

At Duxford at 10h. the temperature at 5,000 feet was 16°F. above the July normal, and at 19,000 feet the excess was 15°F. When there is a pronounced excess of temperature at all heights with a normal lapse rate, conditions are unstable for saturated air. (Meteorologists with access to a Neuhoff diagram may easily verify that at high temperatures the saturated adiabatic lines are much more steeply inclined than at low temperatures.)

It is a mistake to suppose that it is necessary to have polar air, or even relatively cold air, at high levels to produce instability. It need hardly be added that there are nevertheless many occasions when over-running cooler air at high levels is necessary before conditions become unstable.

C. K. M. DOUGLAS.

During the severe thunderstorm of July 20th the extreme edge of the anvil was in the zenith at 19h. 30m. G.M.T., but the squall did not arrive till 20h. 45m. The storm seemed to travel very fast, and therefore the forward extension of the anvil must have been immense. There was a well marked roll cloud with the squall. The height of the anvil must have been unusually great. At 20h. 15m. there was a peculiar yellow light over everything, which was clearly being reflected from that part of the cloud still in sunshine. One would, however, have expected the light to have been redder, had not the anvil been unusually high.

Between 20h. 30m. and 21h. 30m. the longest interval between flashes was three seconds. Two minute runs were made at five minute intervals and this seemed to give a fair idea of the intensity. Rainfall was not heavy.

Pressure rose 3mb. instantaneously, with the passage of the squall at 20h. 45m. and fell 1mb. at about 21h. There was a second sudden rise of 1mb. at midnight followed by a similar fall about a quarter of an hour later.

The sky clearly partially at 22h., but there was a shower later unaccompanied by thunder.

C. S. LEAF.

Correspondence

To the Editor, *The Meteorological Magazine*

Line-Squall of July 12th

The line-squall, associated with the wave of cold air in front of an anticyclone, which passed south-eastward across England on the afternoon of July 12th was not so severe at Calshot as further to the north. However, owing to the almost complete absence of the usual signs of approach of such squalls, it was particularly dangerous to small craft.

The first signs of the "front" were noted about 9h. G.M.T. when cumulo-nimbus tops could be seen along the northwest horizon. This line of clouds moved very slowly up towards the zenith, losing, however, their heavy appearance, and by 14h. there were only a few detached cumuli left, although the boundary line was still apparent.

Owing to the situation of this station some peculiar temperature changes were experienced prior to, and during the squall. A gentle south-westerly sea-breeze had set in at 11h.; but as soon as the first cumulus reached the zenith it became light and variable, and was replaced by a gentle NNW breeze at 14h. 20m. The temperature during the sea-breeze period had been fairly uniform, ranging from 72° to 74°. Immediately the shift of wind came, it rose rapidly 9° to 81°, this figure being reached at 14h. 45m., while humidity fell from 67 per cent. to 41 per cent. At 15h. G.M.T. the wind suddenly freshened to over 30 m.p.h. with a gust of 38 m.p.h. at 15h. 5m. while it veered slightly to N. The squall was accompanied by a fall of temperature from 80° to 73° and a rise of humidity from 43 per cent. to 70 per cent. After 10 minutes, or so, the wind moderated, but remained fresh during the remainder of the evening, while the few cumulus clouds passed away to eastward. The shift of wind and rise of temperature at 14h. 20m. were apparently fictitious, being merely air off the hot land pushed ahead of the squall, and forcing back the sea-breeze. It was not until 15h. that the true squall commenced without warning with the usual fall of temperature. The "front" appeared to be moving somewhat slowly, about 12 m.p.h., as it passed over Hythe some 50 minutes earlier.

T. F. Twist.

Calshot. July 16th, 1929.

The morning and early afternoon of July 12th at Grayshott were clear and calm, with light cirrus cloud and some far-off cumulonimbus low down on the horizon to northwest. At 14h. 42m. there was a sudden wind storm from northwest accompanied by dense dust haze, the wind force being 7 and remaining steady until 15h. when it gradually fell to force 3. The screen temperature dropped 8° in about 10 minutes and the range of visibility which had been about 25 miles dropped to 2 miles. This dust haze gradually cleared as the wind fell. No rain appears to have fallen in the neighbourhood. After the storm a well defined alto-cumulus-castellatus cloud appeared.

S. E. Ashmore.

Windwhistle Cottage, Grayshott, Hindhead, Surrey. July 14th, 1929

The afternoon of July 12th was quiet and clear with a light wind of force 2 from a west nor'west to north westerly direction. At 14h. 40m. wind force rose in sudden gusts to force 7 from NNW by 14h. 45m. The air became full of driving dust clouds, visibility decreasing immediately from 18½ miles to 1¼ miles. Temperature fell from 300·7°A. to 294·4°A.—a fall of over 11°F. Relative humidity rose from 25 per cent. to 62 per cent. Vapour pressure increased by 6·5mb. Pressure rose 1mb. instantly. Wind continued at force 4-5 with gusts reaching force 6 until 16h., when it steadied to force 3. Direction remained northerly until 17h., when it became NE.

At 14h. 50m. a large cumulus of the "cauliflower" type was observed far to the north of the Observatory. Fresh "cauliflowers" were forming near the base and climbing to the top remarkably rapidly. The convection currents must have been at the very least 1,000 feet per minute, possibly double this speed. The top of the cumulus varied considerably minute by minute. At times high cumulus heads pushed high above the main mass only to be swept flat in a few seconds—the top of the cloud presenting a smooth undulating edge. This change took place several times. The least changeable part of the system was a well-defined scarf cloud which appeared to encircle the cumulus about three-quarters of the way up. At first this appeared projecting from behind the cumulus, but at the time of detailed observation it apparently completely girdled the main mass. A further point of interest was that the bottom of the cumulus had not the characteristic flatness of this type but was indefinite and bulging. By 17h. the whole mass had collapsed, leaving an indefinite, flattened cloud of the "roll" type.

J. STURCH.

Kew Observatory. July 29th, 1929.

On the numbering of hours in autographic charts of meteorological instruments

The distinctive character of the day as a unit of time has led to the system of numbering hours from 0 to 24 beginning from midnight; and this has now been generally accepted in meteorological practice. But in many charts of self-recording instruments hours are numbered from 0 to 12 from midnight to noon and again from noon to midnight. It is suggested that the substitution of the numbers 13 to 24 for the afternoon hours would bring these charts more into agreement with meteorological practice and would be more convenient for tabulation of the meteorograms.

K. P. RAMAKRISHNAN.

Meteorological Office, Poona, 5. April 3rd, 1929.

[The practice to which Mr. Ramakrishnan calls attention is general in the trade. It has to be remembered that recording instruments are supplied for numerous purposes other than those of meteorology, and makers of instruments naturally number their charts in the manner preferred by the majority of their customers. Charts used by the Meteorological Office are always numbered on the 0 to 24 system recommended by Mr. Ramakrishnan, and we welcome this opportunity of bringing to the notice of the trade the desirability of adopting a similar practice in the case of instruments used mainly for meteorological purposes.—ED., *M.M.*]

The Underground Water Level in the North Downs

Consequent upon the prolonged drought conditions a rapid fall in water level has now commenced, both in the deep-seated hill wells on the North Downs, and in those below the escarpment. Three hill wells, Hucking (Old Forge), Little Pett and Stockbury Village, all situate on the ridge north of Maidstone, have now been under monthly observation since 1911. Below the escarpment, at Detling, the variation in the water level at the "Croft" well has been recorded, monthly or daily, since 1885, and "Naylor's" Detling since 1914. The wells are all in the belt of the Middle Chalk, and vary in depth from 270 feet to 62 feet, the draught on any of them is very slight.

During 1928 the water level was very high throughout, due to the extreme wetness of the previous year, and exceeded that of any recorded year with the exception of 1916. The hill wells reach their maximum level during June, but below the hill, this as a rule occurs in April.

	Hucking (Old Forge) (feet)	Little Pett (feet)	Stockbury Village (feet)
June, 1928	83.2	72.11	47.3
,, 1929	57.10	36.0	38.10
Average 1911-28 ...	63.2	52.8	40.8

	Detling (The Croft) (feet)	Detling (Naylor's) (feet)
April, 1928	27.4	19.8
,, 1929	18.1	12.1
Average 1911-28	22.3	16.2

During the replenishment period, September to December, 1928, the rainfall at Detling amounted to 13.46 inches compared with an average of 13.94 inches. The storage period, January to April, 1929, yielded 3.77 inches as against an average of 9.52 inches. Up to the present the departures from the average water level are not very great, and scarcity is unlikely to be experienced during the present year. Whatever the course of subsequent events 1930 is likely to be a low underground water year. There is some evidence of a permanent lowering of the water level in the hill wells, independent of the rainfall; this is attributable, in great measure, to the large amount of water pumped out of this area consequent upon the rapid growth of the adjacent towns of Rochester, Chatham and Gillingham.

SPENCER RUSSELL.

July 23rd, 1929,

Rainfall on August 4th, 1929

I registered at 10 a.m. this morning 3·49in. of rain for the previous 24hrs., the heaviest daily fall in the twenty-eight years' record for this station. It nearly all came between 1 p.m. on the 3rd and 6 a.m. on the 4th, there was no thunder, wind S. to SW.

J. GRUBB.

Winscombe, Somerset, August 4th, 1929.

Unusual Audibility

A 70-inch pilot balloon released at 5h. 40m. G.M.T. on May 2nd travelled away westward from a 12-mile-an-hour wind attaining an elevation of 25° at the first minute. The upper winds were light and variable. At 17,000 feet the balloon was quite distinct, but while my attention was taken for a moment to record the reading, the balloon disappeared from view. There was no cloud in the vicinity, while a sudden shift of position seemed improbable; I presumed therefore that the balloon had burst. This supposition was confirmed when *I distinctly heard the report of the explosion* about 20 seconds after the disappearance.

As far as I personally am concerned, the thing is beyond doubt. You may be sceptical, but don't you think it is worth investigating with balloons timed to burst at definite heights?

In the foregoing case the angle of elevation at the burst was 70° and the horizontal distance from the theodolite 6,700 feet in a direction 300°.

Moreover, this is not an isolated case. Under similar conditions on a previous occasion I heard a balloon burst at 14,000 feet.

W. L. BAXTER.

502 (*Ulster*) *Bombing Squadron, R.A.F., Aldergrove, Co. Antrim. May 30th,* 1929.

In connexion with this, Dr. F. J. W. Whipple sends us the following note:—

"It might be worth while to make a test on the ground under favourable conditions or better still over water. The bursting of a balloon is perhaps equivalent as a source of sound to the clapping of the hands. The best echoes I ever heard were across Lake Tomogami in Canada and I should think the interval to the last echo was as much as 20 seconds."

OFFICIAL NOTICE

Course of Training for Observers

It is proposed to hold a course of training for observers at climatological stations on Monday and Tuesday, September 23rd and 24th, 1929, at Kew Observatory, Richmond.

Subject to limitations of space at the Observatory, the course will be open to all climatological observers or deputy observers in connexion with the Meteorological Office. There will be no fee.

Admission to the course will be by ticket, which may be obtained on application to the Director, Meteorological Office (M.O.7), Air Ministry, Kingsway, London, W.C.2, from whom further information regarding the course may also be obtained.

NOTES AND QUERIES

Sunshine Records during the Spring and Summer of 1929

Much has been heard of the dryness of the present year; its brilliance, or the abundance of its sunshine, which from some points of view has been even more noteworthy, has passed with less remark. Yet something in the nature of a record was established in March when the sunshine totals for that month were in excess of the normal in each of the twelve districts into which the British Isles are divided, and when with only three exceptions, every station in every district for which the normal amount of sunshine is known, received an excess, which in North Wales was more than 4 hours per day. This represented actual sunshine equal to 69 per cent. of the possible. It was the sunniest March for over 20 years at such widely scattered places as Aberdeen, Eastbourne and Teignmouth, for 34 years at Southport and for well over 40 years at Strelley, Nottingham.

The following month, in Ireland and over the British Isles as a whole, was the driest April since 1921, but did not give us an aggregate amount of sunshine very widely different from the normal. In the north of Scotland, along the western seaboard of England and in the Channel Islands there was an excess. This amounted to over an hour per day in the Hebrides, some parts of Lancashire and Cheshire and in North Wales. There was a deficit of approximately the same amount in the eastern counties, some parts of the Midlands and in the south of Ireland. Some of the more notable periods of the month were, more than 10hrs. sunshine on each of the 4 days 9th-12th at Cahirciveen, more than 11hrs. on each of the 4 days 13th-16th at Stornoway, over 12hrs. on the 19th in many parts of southern England, and 13hrs. on both the 21st and 22nd at Lympne. If the character of a month in relation to sunshine, be determined by the number of sunny or sunshine days, rather than by the actual number of hours recorded in that month, April would undoubtedly be regarded as a sunny month in all districts. At many places in northwest England there were no absolutely sunless days and few places had more than 3, while in many parts the number of days on each of which at least 4 hours sunshine was recorded, ranged from 17 to 27. In southeast England, including the London area, few places had more than 4 sunless days, the days with at least 4 hours sunshine ranging from 13 at Greenwich to 22 at Littlehampton. There were rather more sunless days in each of the other districts, but these seldom exceeded 5, and the number of sunny days with at least 4 hours each varied from 18 to 21 in southwest England, about the same in northeast England, rather less in the eastern counties and least in the Midlands.

Although the first half of May was mainly cool and unsettled with some heavy rain between the 4th and 8th, the monthly totals of sunshine were above the normal in all districts. Not only was the district value in excess, but every station in west Scotland, northwest England and southeast England showed an excess which ranged from half an hour per day at Dumfries, 1·24hrs. at Kilmarnock to 1·89hrs. at Ventnor and 2·23hrs. at Sealand (Flint). Only one station in northeast England, one station in the Midlands, two in the eastern counties and three in southwest England showed a deficit, and of these only one exceeded half an hour per day. There were some very fine periods during the month among which the following may be noted. An average of 13.5hrs. on each of the last 7 days of the month at Hutton, 12·6hrs. at Llandudno and 12·4hrs. at Colwyn Bay: of 12·7 hrs. on each of the last 5 days of the month at Markree Castle (Sligo), of 13·3hrs. on each of the 7 days 19th-25th at Gorleston, of 12·3 hrs. on each of the 6 days 16th-21st at Stonyhurst, and just over 12hrs. on each of the 9 days 19th-27th at both Norwich and Sprowston. Among the brilliant days of the month was the 25th with 15hrs. or more at Ascot, Southampton, Hoylake, West Kirby, Colwyn Bay and Llandudno; 15hrs. or more was recorded at Bournemouth on both the 25th and the 26th, and at Darwen, Hutton and Southport on the 29th. There was practically no day on which the sun did not make its appearance in north Ireland and northwest England, and at most places in the latter district it shone for at least 4 hours on each of 24 days. There were very few sunless days in either the Midlands, northeast or south England, but there were from 1 to 7 days in the eastern counties. The number of days with at least 4 hours varied from 22 to 26 in southeast England (25 at Enfield), 22 to 25 in northwest England, 19 to 24 in southwest England, rather less in the eastern counties and round about 22 days in the Midlands.

During the first week of June there was rain in many parts of the country, which was followed by showery weather between the 12th and 17th. There were, however, some considerable sunny periods, and the aggregate amount for the month was equal to or above the normal in most districts. The most favoured part of Great Britain was the western side, especially Cheshire and North Wales. Sunshine totals equal to a mean of 9hrs. per day were recorded at some places, while many other stations had an equivalent of more than 8hrs. per day, with a percentage of the possible duration of well over 50. At Rhyl the excess was more than an average of 2hrs. per day, and at Hoylake 2·5hrs. With the exception of Westminster with a deviation of + 1·1hrs. and Ventnor with + 1·2hrs., there was no marked difference from the normal in the southeast district of England. There was a decided deficiency in the eastern counties, some east-coast stations sustaining a loss of more than an hour per day. As in May, so in June, there was practically no day in northwest England when the sun did not appear, and there were very few places in England or in Ireland that were absolutely sunless on any day. In the eastern counties the sun shone for at least 4 hours each day during two-thirds of the month, but the number was rather less in the Midlands and the southeast district of England. Over a very wide area the period 9th-11th was remarkably sunny. In some parts of the Midlands the mean for the 3 days was between 13 and 14hrs., over 14hrs. at some of the south-coast stations, reaching 14·5hrs. at St. Leonards. The mean for the 3 days at Hoylake was 14·6hrs. There was another fine period in many places at the end of the month, when the daily mean for the last 6 days was 13·2hrs. at Aber (Bangor). For the 7 days 23rd-29th the mean at Colwyn Bay and Rhyl was 12·8hrs. and at Leyland 13·1hrs. Fine days yielding 14 or more hours sunshine occurred at Bridlington and Cleethorpes on the 11th, at Hull on the 11th and 18th, and at Dublin on the 26th. Many places had 15 hours or more on one day, of which mention may be made of Luton and Oxford on the 18th, Wallasey on the 25th, Cronkbourne both on the 25th and 26th, Rhyl, Colwyn Bay and Aber on the 26th and Stonyhurst on the 27th.

A comparison with previous years shows that April, 1929, was the sunniest April since 1921 in northwest and southwest England and in the Channel Islands: since 1925 in north Scotland and since 1927 in west Scotland, the eastern side of England, the Midlands and southeast England. In north Ireland the month was less sunny than that of last year. May showed a much better record, and was the sunniest May in northwest England for at least 20 years, its nearest approach being that of 1925. It was the sunniest since 1911 in north Ireland, the year 1915 being only a little less sunny. In all other English districts, south Ireland and in the Channel Islands it was the sunniest since 1922. On comparison, June does not stand out anything like so favourably as either April or May. While it was the sunniest June since 1925 in Ireland, the western districts of England and the Midlands, and since 1926 in the Channel Islands, it was less sunny than that of last June in the north of Scotland, and the east of England.

During the past 20 years there have been only three occasions in northwest England when April was sunnier than that of 1929: 4 occasions in the north of Scotland and 5 in both southwest England and the Channel Islands. In May during the same time, there was only one sunnier May in north Ireland and the Midland counties of England, two in south Ireland, southeast England and the eastern counties, three in north Scotland and four in the Channel Islands. Sunnier Junes than that of 1929 have occurred on one occasion in north-west England, that of 1925, two in south Ireland, three in southwest England, six in north Scotland, the Midlands, north Ireland, and the Channel Islands, eight in southeast England, ten in the eastern counties and twelve in northeast England.

Taking the period May-June together it was the sunniest in northwest England for at least 20 years, since 1915 in north Ireland, since 1921 in south Ireland, since 1922 in northeast England and the Midlands, and since 1925 in south Ireland, the northeast, and south districts of England and in the Channel Islands. The full data for July are not yet available, but the short table on p. 172 shows that in that month also the sunny character of the year was maintained in England and eastern Scotland though not in Ireland or western Scotland.

C. A. Bracey.

Meteorological Service for the French Colonies

By a decree of April 29th, published in the *Journal Officiel de la République Française* for May 2nd, the President of the Republic instituted a Colonial Meteorological Service under the authority of the Minister for the Colonies.

The service will be formed by the association of the existing local services, each of which will, however, remain the charge of the Colony concerned. The aim of the service is to carry out research work, to summarise all meteorological records, to supply information, to collaborate with French and other meteorological services and to publish observations and researches.

For each colony or group of colonies there is to be a central establishment and a number of stations. The principal station in each section is to be provided with all the necessary equipment for ground and pilot balloon observations and if necessary with an apparatus for short wave wireless telegraphy. In addition to stations of the first and second order, provision is also made for research stations for the study of special conditions. Arrangements are also made for the safeguarding of air lines.

March Fogs and May Frosts

"As many fogs as there are in March, so there are frosts in May" is an old weather saw prevalent in this part of Hampshire, and in view of the abnormal number of March fogs and May frosts this year, and their apparent correlation, it was of interest to note whether this relation was generally true. Mr. J. S. Smith accordingly extracted the figures for the past ten years for South Farnborough, the criterion of fog being a horizontal visibility of less than 1,000 yards at 7h. G.M.T., and that of frost a night grass minimum temperature of less than 30·5°F. The layman's fog criterion is probably a horizontal visibility considerably less than 1,000 yards, more of the order of 200 yards or less, and for this reason these have also been included in the table.

Number of occasions of fog at 7h. G.M.T. during March :—

Visibility less than	1919	1920	1921	1922	1923	1924	1926	1927	1928	1929
50 yds.	0	0	0	0	0	1	0	0	0	1
100 ,,	0	0	0	0	1	1	0	0	1	3
200 ,,	2	1	1	0	3	3	0	1	1	5
500 ,,	5	3	3	1	4	4	1	1	2	7
1,000 ,,	9	7	4	1	8	6	4	2	2	13

Number of ground frosts in May :—

Year	1919	1920	1921	1922	1923	1924	1926	1927	1928	1929
Occasions	1	5	3	8	5	3	1	1	7	12

The observations for 1925 have been excluded owing to incomplete frost data.

It will at once be seen that whatever standard of visibility is taken for our fog definition, the simple relation given above does not hold in general. A fog standard of less than 500 yards gives the best agreement, viz., 30 per cent., or if a divergence of ± 1 in frequency is allowed, 50 per cent., but even so there are very serious disagreements in 1919, 1922, 1928 and 1929. It is worthy of note, however, that the abnormal number of fogs (visibility less than 1,000 yards) in March, 1929, was followed by an abnormal number of frosts in the following May, probably a heritage from the recent severe winter.

The data were further examined to see if any other simple alegebraical expression could be obtained indicating any relationship, but without success.

W. H. BIGG.

The Diurnal Variation of Rainfall

A novel method of representing the diurnal variation of the frequency of rainfall is adopted in a paper in the U.S. *Monthly Weather Review* for January 1929, which discusses the rainfall statistics for New Orleans for the thirty years 1898 to 1927.

The percentage frequencies of measurable precipitation during each hour are set out as radial distances from the centre of a clock face, and the points so obtained joined by a continuous line. The hours from 6 a.m. to 6 p.m. are distinguished by light shading, while those from 6 p.m. to 6 a.m. are filled in black. The diagrams bring out very clearly the concentration of the summer rainfall, from June to October inclusive, in the afternoon hours from noon to 4 p.m., contrasted with the uniform distribution of the winter months, in which rainfall occurs with almost equal frequency at all hours.

The paper contains several other illuminating methods of handling hourly rainfall statistics. A "Clock chart of frequencies" shows the number of hours in each month with amounts between various limits, and brings out the contrast that while small hourly amounts are most frequent in winter, large amounts are concentrated in the months from April to September. The largest amount in a clock hour was 3·44 inches, and the largest in 60 minutes 3·60 inches. One would like to see data from some of the British Observatories discussed in a similar pictorial manner.

Hurricane at Suva, Fiji

Capt. E. W. G. Twentyman, the observer at Suva, Fiji, has forwarded with his "Meteorological Register" for January, 1929, some notes regarding a hurricane which passed near Suva on January 22nd. The barometer readings show that pressure fell gradually from 1010mb. on the 11th to 1000mb. on the morning of the 21st. During the 21st a more rapid fall set in and continued till the afternoon of the 22nd, the lowest pressure reading, 979mb., being reached at 14h. 15m. (zone time, 12 hours fast on G.M.T.).

For several days previous to the storm the winds were from an easterly point, mainly light. On the 21st the wind was NE. by N., force 3 on the Beaufort scale, squally NE. after 18h., but by 8h. 30m. on the 22nd, NNE., force 6. During the day the wind gradually backed, to N. by W. between 12h. 40m. and 14h. 15m., WNW. at 15h. 30m., W. at 17h., and SW on the 23rd. Wind force reached 7 or above during most of the 22nd until after 17h. the greatest estimated force being 9-10 at 17h. and the greatest measured velocity by electrical cup anemometer 59 m.p.h. at 16h. 20m. Next morning a SW. wind, force 5, was still blowing and continued till afternoon.

Rain fell from 18h. on the 21st to 4h. on the 22nd, 4.24in. being measured on the morning of the 22nd. No further rain was recorded until after 16h. when showers occurred, 0.62in. being measured at 8h. 30m. on the 23rd.

The storm appears to have passed a short distance southwest and south of Suva and from the notes given one can make a rough estimate of the rate of travel, about 15 miles an hour.

Reviews

Weather. Practical, Dramatic and Spectacular Facts about a Little Studied Subject. By E. E. Free and Travis Hoke. With Maps and Drawings by Elise Seeds. Size 9 × 6in., pp. 337 *Illus.* London, Constable & Co., 1929. 14s. net.

The authors state in the Preface that they planned this book by asking everyone they met what they most wanted to know about the weather. That is perhaps as good a way as any, for if the result is not particularly systematic it is certainly readable, and it does manage to cover most of the ground—or perhaps one should say, of the air. The early chapters deal with the more usual aspects, such as "Why Weather Exists," "Rain and Clouds," "Heat Waves and Cold," and "The World's Climates," while towards the end of the book we meet with more recondite matters—"Weather's Radio Voice," "Aviator's Air," and "Wall Street Weather." It is in these later chapters that the "practical, dramatic, and spectacular facts" come most to the fore, and these will be of most interest to readers who already know something of the subject. But no part of the book is without its purple passages, as for example on rain :—

"If it never rained the earth would be a far wetter place than it is. The air would be steam, as it was in rainless ages long ago. The ground would be slime. Every building would drip huge drops, inside and out. Every person would slosh around with his body and clothes wringing wet, as though he had just crawled from a pond. Life would be one long Turkish bath."

On the "old-fashioned winter":—

"Convenient to Thanksgiving Day, it began with a tremendous snowfall which immediately piled up in drifts exactly six feet high. These drifts remained six feet high until they disappeared overnight in time for May Day . . . . during which time ears, apples, toes, noses and potatoes froze solid and remained that way, thus providing wholesome merriment for all."

One of the best things in the book is probably accidental. In describing the evidence for "weather rhythms" in history, the authors remark: "They are the clues over which scientific detectives now pour." Are there so many of us as that?

Of course, if the book were written entirely in this style, it would become simply boring, but the authors are wise enough to use such passages fairly sparingly, so that they keep the interest from flagging. Most of the book consists of bright and vigorous but not exaggerated accounts of current meteorological fact and theory. The authors have read very widely and for the most part carefully, and succeed in communicating what they have read, though now and again they fall into errors. Thus on

p. 44 we read that "Air close to the ground is seldom cooled by radiation or by contact with cold objects." The theory of city fogs is rather weird :—

> "The main cause of city fogs is that cities perspire just as do plants and animals.
>
> "A city is constantly discharging into the air above it a large amount of moisture. And usually the city is warmer than open country covered with vegetation. Hence the air above a city tends to become super-saturated with moisture. As the air cools, by rising, by radiation or by slow mixture with colder air, some of this excess perspiration is condensed to produce fog."

A word must be said about the illustrations. The photographs have been well chosen and are very good; the reviewer has never seen a better picture of fog than the photograph of the Thames facing p. 160. The drawings are fairly good when they are definitely diagrams or when they are frankly humorous; the symbolical representations of cherubs and gentlemen with bellows are less happy.

The book may not be one for the serious student of meteorology except to amuse his leisure hours, but it can be recommended to those who would like to know something about the weather, especially as a subject for conversation, but do not feel equal to tackling a thorough-going text-book.

C. E. P. Brooks.

India Meteorological Department. *Scientific Notes*, Vol. 1, Nos. 1-3, pp. 1-36. Prices 2s., 1s., 1s. 3d.

We welcome this new series of meteorological memoirs from India, giving the results of recent researches carried out by some of the younger meteorologists in that country. The first paper, "A comparison of upper and gradient winds at Agra and Bangalore," by Mohammad Ishaque shows that at Agra the direction of the gradient wind agrees best with the direction of the observed wind at a height of 0·5km., where the average departure is only 6 degrees, compared with 50 degrees at ground level. The agreement between the observed and gradient velocities is not so good, and even at 1km., where it is best, the correlation is only 0·39. Further south at Bangalore there is practically no relationship between gradient wind and observed wind.

The second paper, "An analysis of the Madras hourly rainfall records for the years 1865 to 1875 and 1901 to 1917, by V. Doraiswamy Iyer brings out the interesting result that "the probability of rainfall tends to increase with the deflection of wind direction from the prevailing direction in all seasons" so that the heaviest rains occur with northerly winds during the south-west monsoon and with north-westerly winds during the north-east monsoon. During the hot weather the prevailing winds are south-easterly and the rain falls mainly with the rare winds from north-west.

In the third paper V. V. Sohoni deals with "Thunderstorms of Calcutta, 1900-1926." These are striking phenomena, associated with squalls which in two instances exceeded 60 miles per hour, and a drop of temperature sometimes exceeding 20 degrees. Generally the rainfall is not excessive, but a terrific storm on July 22nd, 1926, gave 5·26in. in just over 3 hours, of which 4·20in. fell in an hour and a quarter. All three memoirs are well printed and abundantly illustrated.

Obituary

We regret to learn of the death of Prof. Walter G. Duffield, D.Sc., Director of the Australian Commonwealth Solar Observatory at Mount Stromlo.

We regret to announce the death of Mr. E. S. Wood, the senior clerk in the Meteorological Office at Leuchars, Fifeshire, on August 8th.

The Weather of July, 1929

Apart from occasional heavy thunderstorms dry sunny weather prevailed generally in England and eastern Scotland during July. In western Ireland and western Scotland the month was wet. The first day of the month was cool and cloudy in most places, changing to unsettled weather on the 2nd. From then to the 6th a complex low pressure system lay over the British Isles and heavy rain fell locally on most of these days; 3in. at Felixstowe and 2·95in. at Harwich on the 3rd, 2·14in. at Gorleston and 1·46in. at Dundee on the 4th, and 1·89in. at Stockport on the 5th were among the largest amounts recorded. Thunderstorms were experienced in most parts of England and Ireland on the 4th and a few on the 5th and 6th. In the south of England the 5th was a very sunny day, *e.g.*, 15hrs. bright sunshine occurring at Margate. 14·7hrs. at Greenwich. During the 7th and 8th a wedge of high pressure passed across the country, giving sunny dry weather generally with frost at night in parts of Scotland, N. England and the Midlands; 22°F. was recorded on the ground at Burnley on the 8th. In the south and east the weather continued dry and sunny with a rising temperature, but in the west and north it became unsettled and rainy from the 9th-11th owing to a depression approaching Ireland. On the 12th an anticyclone spread in from the west and a cold current passing southeast across the Midlands caused a sudden squall during the afternoon with wind reaching gale force in gusts and local rain and thunder. Temperature dropped rather more than 10°F. in some places. Following this the warm sunny weather in the south spread over the rest of the country and sunshine records exceeded 15hrs. at many places on the 13th, 14th and 15th, being as much as 15·5hrs. at Durham on the 13th. Temperature rose above 80°F. on most days in most parts of England from the 11th to 21st, and in south Scotland on the 15th and 16th, 90°F. being reached at Greenwich on the 20th and in Scotland 82°F. at Kilmarnock on the 15th. Thunderstorms occurred in Scotland and East Anglia on the 16th and 17th, and in south and east England on the 20th, where they were accompanied by a sudden squall and local heavy rain. At Hampstead 2·01in. fell in an hour and at Rickmansworth 1·77in. in an hour. Meanwhile a depression off the western seaboard brought unsettled weather and rain to Ireland and northwest Scotland from the 16th to 20th, and on the 21st and 22nd this spread also to England, though the amounts measured in the south were slight. From the 23rd to 26th there was another period of dry sunny weather with over 13 hrs. bright sunshine at many places; 13·6hrs. at Armagh on the 23rd, 13·1hrs. at Rothesay on the 25th and at Falmouth on the 26th. A depression approaching from the Atlantic brought unsettled weather in the west on the 27th, which spread east on the 28th when continuous rain fell in all districts. This definitely ended the settled weather in England and rain fell in all parts of the British Isles until the end of the month; 1·90in. was measured at Ballynahinch (Galway) on the 27th, 1·61in. at Castle Hill (Devon) and Mary-Tavy (Devon) on the 28th, 2·06in. at Delphi (Mayo) on the 30th, and 2·02in. at Aberdeen on the 31st. The distribution of sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs).
Stornoway	103	—42	Valentia	130	—29
Aberdeen	173	+14	Liverpool	199	+ 6
Dublin	150	—20	Falmouth	257	+32
Birr Castle	135	— 9	Kew	257	+56

Pressure was above normal over western and southern Europe, the North Atlantic, Newfoundland and Bermuda, the greatest excess being 4·3mb. at Madrid and 4·1mb. at Stykkisholm, and below normal over Spitsbergen and northern Scandinavia, the greatest deficit being 5·5mb. at Spitsbergen. Temperature in western Europe was somewhat below normal generally except in England, while rainfall was below normal at Spitsbergen, northern Scandinavia and central Europe, but above normal in southern Scandinavia and Ireland.

Violent thunderstorms accompanied by hail were experienced in central Europe on the evening of the 4th. Several people were killed and considerable damage done to buildings and trees. Persistent rain caused serious floods in eastern Galicia on the 15th. For about a fortnight in the middle of the month dry, hot sunny weather was experienced in France, Belgium, Germany, Switzerland and Italy. Thunderstorms and hail were experienced from the 21st onwards, and the weather became cooler with some rain. The drought caused damage to crops in Italy, and there were many forest fires.

Heavy storms washed away part of the railway between Atbara and Abuhammad in the Sudan about the 24th.

Owing to heavy rain at the beginning of the month serious floods were reported from Cochin State on the 8th, but were subsiding by the 11th. The drought in Hongkong ended on the 13th, when heavy rain fell. Floods occurred at Tabriz (Persia) on the 15th. Heavy rain in Gujarat and Sind on the 13th and 14th and in Assam about the same time resulted in serious floods. The crops were destroyed to a great extent and fifteen people were killed. The floods continued in Sind until after the 30th. The Arabian Sea monsoon had weakened somewhat by the 18th, but the Bay monsoon was still active. A sudden flooding following heavy rain occurred in the river Sabarmati at Ahmedabad on the 27th, and the aerodromes at Karachi were rendered unsafe on the 28th by rains said to be the heaviest for several years.

Owing to the breaking of a rail by frost an express train ran off the tracks at Armidah, New South Wales, but no one was hurt.

Owing to the drought in the prairie provinces of Canada the wheat harvest is expected to be below normal. Later in the month, however, heavy rain and several thunderstorms occurred in central and eastern Canada. Temperature in the United States was high early in the month in the far west, and in many Rocky Mountains and Plains sections. Later, this high temperature area moved eastward to the North Atlantic States. By the end of the month rain was needed in the northwestern and eastern States, though no widespread drought had developed. Parts of Jamaica, however, were suffering from drought about the middle of the month.

The special message from Brazil states that the rainfall in the northern and central districts was generally scarce with an average of 0·31in. and 0·16in. below normal respectively, while the distribution in the southern district was irregular with an average 0·39in. above normal. Six anticyclones passed across the country but were less intense than those of the previous month. Temperature in the south was below normal. Crops were generally in good condition except in some regions of the south affected by frost. At Rio de Janeiro pressure was 1·6mb. above normal and temperature 0.9°F. below normal.

Rainfall, July, 1929.—General Distribution

England and Wales	79	per cent. of the average 1881-1915.
Scotland	108	
Ireland	119	
British Isles	96	

Rainfall: July, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	2·20	92	*Leics* .	Belvoir Castle	1·41	58
Sur .	Reigate, The Knowle	1·99	95	*Rut* .	Ridlington	1·90	...
Kent .	Tenterden, Ashenden	1·41	67	*Linc* .	Boston, Skirbeck	1·74	79
,, .	Folkestone, Boro. San.	1·11	...	,, .	Lincoln	1·06	48
,, .	Margate, Cliftonville	·59	30	,, .	Skegness, Marine Gdns	1·66	76
,, .	Sevenoaks, Speldhurst	1·35	...	,, .	Louth, Westgate	1·42	57
Sus .	Patching Farm	1·62	67	,, .	Brigg, Wrawby St.	1·37	...
,, .	Brighton, Old Steyne	1·70	78	*Notts* .	Worksop, Hodsock	·97	43
,, .	Heathfield, Barklye	1·87	75	*Derby* .	Derby, L. M. & S. Rly.	1·57	66
Hants .	Ventnor, Roy. Nat. Hos.	1·49	74	,, .	Buxton, Devon Hos.	4·00	102
,, .	Fordingbridge, Oaklnds	1·44	72	*Ches* .	Runcorn, Weston Pt.	1·22	44
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	3·18	...
,, .	Sherborne St. John	1·19	53	*Lancs* .	Manchester, Whit. Pk.	3·30	100
Berks .	Wellington College	1·74	84	,, .	Stonyhurst College	3·93	101
,, .	Newbury, Greenham	1·23	55	,, .	Southport, Hesketh Pk	2·54	89
Herts .	Welwyn Garden City	1·90	...	,, .	Lancaster, Strathspey	3·92	...
Bucks .	High Wycombe	1·69	86	*Yorks* .	Wath-upon-Dearne	·88	35
Oxf .	Oxford, Mag. College	1·23	54	,, .	Bradford, Lister Pk.	2·15	78
Nor .	Pitsford, Sedgebrook	1·72	73	,, .	Oughtershaw Hall	4·58	...
,, .	Oundle	1·86	...	,, .	Wetherby, Ribston H.	2·95	118
Beds .	Woburn, Crawley Mill	1·10	49	,, .	Hull, Pearson Park	1·71	73
Cam .	Cambridge, Bot. Gdns.	2·37	110	,, .	Holme-on-Spalding	1·86	...
Essex .	Chelmsford, County Lab	1·70	80	,, .	West Witton, Ivy Ho.	2·68	...
,, .	Lexden Hill House	1·88	...	,, .	Felixkirk, Mt. St. John	2·14	78
Suff .	Hawkedon Rectory	1·87	77	,, .	Pickering, Hungate	1·97	...
,, .	Haughley House	2·19	...	,, .	Scarborough	2·40	99
Norf .	Norwich, Eaton	3·73	144	,, .	Middlesbrough	2·08	81
,, .	Wells, Holkham Hall	3·08	133	,, .	Baldersdale, Hury Res.	3·49	...
,, .	Little Dunham	3·08	112	*Durh* .	Ushaw College	3·28	117
Wilts .	Devizes, Highclere	1·81	78	*Nor* .	Newcastle, Town Moor	1·79	67
,, .	Bishops Cannings	1·94	78	,, .	Bellingham, Highgreen	4·38	...
Dor .	Evershot, Melbury Ho.	1·85	73	,, .	Lilburn Tower Gdns.	4·44	...
,, .	Creech Grange	1·45	...	*Cumb* .	Geltsdale	3·83	...
,, .	Shaftesbury, Abbey Ho.	1·65	64	,, .	Carlisle, Scaleby Hall	4·65	142
Devon .	Plymouth, The Hoe	1·79	65	,, .	Borrowdale, Seathwaite	13·87	164
,, .	Polapit Tamar	2·05	76	,, .	Borrowdale, Rosthwaite	...	...
,, .	Ashburton, Druid Ho.	...	...	,, .	Keswick, High Hill	5·68	...
,, .	Cullompton	1·38	51	*Glam* .	Cardiff, Ely P. Stn.	2·21	71
,, .	Sidmouth, Sidmount	1·22	49	,, .	Treherbert, Tynywaun	6·08	...
,, .	Filleigh, Castle Hill	4·11	...	*Carm* .	Carmarthen Friary	3·11	88
,, .	Barnstaple. N. Dev. Ath.	2·04	75	,, .	Llanwrda	4·16	96
Corn .	Redruth, Trewirgie	1·85	61	*Pemb* .	Haverfordwest, School	3·37	105
,, .	Penzance, Morrab Gdn.	1·83	67	*Card* .	Aberystwyth	2·95	...
,, .	St. Austell, Trevarna	2·11	63	,, .	Cardigan, County Sch.	2·38	...
Soms .	Chewton Mendip	2·54	73	*Brec* .	Crickhowell, Talymaes	3·10	...
,, .	Long Ashton	1·84	...	*Rad* .	Birm W. W. Tyrmynydd	3·80	92
,, .	Street, Millfield	1·24	...	*Mont* .	Lake Vyrnwy	4·27	125
Glos. .	Cirencester, Gwynfa	1·64	63	*Denb* .	Llangynhafal	3·05	...
Here .	Ross, Birchlea	1·87	82	*Mer* .	Dolgelly, Bryntirion	4·66	109
,, .	Ledbury, Underdown	1·90	84	*Carn* .	Llandudno	2·07	87
Salop .	Church Stretton	2·65	108	,, .	Snowdon, L. Llydaw 9	...	...
,, .	Shifnal, Hatton Grange	2·29	102	*Ang* .	Holyhead, Salt Island	2·32	89
Worc .	Ombersley, Holt Lock	1·51	71	,, .	Lligwy	2·90	...
,, .	Blockley	1·54	...	*Isle of Man*			
War .	Farnborough	2·13	83		Douglas, Boro' Cem.	2·84	93
,, .	Birminghm, Edgbaston	1·55	67	*Guernsey*			
Leics .	Thornton Reservoir	2·18	88		St. Peter P't. Grange Rd.	1·96	97

Rainfall: July, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt	Stoneykirk, Ardwell Ho	3·45	119	*Suth*	Loch More, Achfary...	4·09	76
,,	Pt. William, Monreith	3·53	...	*Caith*	Wick....................	1·31	50
Kirk	Carsphairn, Shiel.......	5·32	...	*Ork*	Pomona, Deerness......	1·48	58
,,	Dumfries, Cargen......	5·56	172	*Shet*	Lerwick..................	1·13	49
Dumf.	Eskdalemuir Obs.......	7·92	193	*Cork*	Caheragh Rectory......	5·40	...
Roxb	Branxholm..............	3·94	130	,,	Dunmanway Rectory...	6·59	169
Selk	Ettrick Manse...........	...	...	,,	Ballinacurra.............	3·09	111
Peeb	West Linton............	4·11	...	,,	Glanmire, Lota Lo......	4·87	168
Berk	Marchmont House......	3·88	127	*Kerry*	Valentia Obsy..........	5·35	142
Hadd.	North Berwick Res.....	2·46	95	,,	Gearahameen............	10·90	...
Midl	Edinburgh, Roy. Obs.	2·22	84	,,	Killarney Asylum......	5·95	179
Ayr	Kilmarnock, Agric. C.	4·10	132	,,	Darrynane Abbey.......	4·36	114
,,	Girvan, Pinmore........	...	...	*Wat*	Waterford, Brook Lo...	3·46	107
Renf	Glasgow, Queen's Pk..	2·70	92	*Tip*	Nenagh, Cas. Lough...	3·95	126
,,	Greenock, Prospect H.	6·41	163	,,	Roscrea, Timoney Park	3·52	...
Bute	Rothesay, Ardencraig.	4·49	113	,,	Cashel, Ballinamona...	3·63	125
,,	Dougarie Lodge.........	4·41	...	*Lim*	Foynes, Coolnanes......	4·24	138
Arg	Ardgour House.........	9·20	...	,,	Castleconnel Rec.......	3·70	...
,,	Manse of Glenorchy...	4·58	...	*Clare*	Inagh, Mount Callan...	7·51	...
,,	Oban......................	4·98	...	,,	Broadford, Hurdlest'n.	3·89	...
,,	Poltalloch...............	4·15	100	*Wexf.*	Newtownbarry	4·54	...
,,	Inveraray Castle.........	7·55	151	,,	Gorey, Courtown Ho...	2·83	96
,,	Islay, Eallabus.........	3·82	112	*Kilk*	Kilkenny Castle.........	2·13	76
,,	Mull, Benmore.........	12·40	...	*Wic*	Rathnew, Clonmannon	1·89	...
,,	Tiree	3·72	...	*Carl*	Hacketstown Rectory..	2·86	83
Kinr	Loch Leven Sluice......	3·49	121	*Leix*	Blandsfort House......	3·31	106
Perth	Loch Dhu................	5·20	108	,,	Mountmellick...........	3·65	...
,,	Balquhidder, Stronvar	...	...	*Off'ly*	Birr Castle..............	3·47	118
,,	Crieff, Strathearn Hyd.	3·47	117	*Dubl*	Dublin, FitzWm. Sq...	2·29	89
,,	Blair Castle Gardens...	2·39	93	,,	Balbriggan, Ardgillan.	1·77	65
,,	Dalnaspidal Lodge.....	3·91	93	*Me'th*	Beauparc, St. Cloud...	3·03	...
Angus.	Kettins School.	3·25	138	,,	Kells, Headfort.........	3·23	102
,,	Dundee, E. Necropolis	3·49	127	*W.M*	Moate, Coolatore......	3·67	...
,,	Pearsie House...........	2·84	...	,,	Mullingar, Belvedere..	3·06	96
,,	Montrose, Sunnyside...	...	...	*Long*	Castle Forbes Gdns......	4·58	147
Aber	Braemar, Bank.........	3·91	152	*Gal*	Ballynahinch Castle...	10·47	252
,,	Logie Coldstone Sch....	3·74	126	,,	Galway, Grammar Sch.	4·91	...
,,	Aberdeen, King's Coll.	3·80	135	*Mayo*	Mallaranny..............	9·41	...
,,	Fyvie Castle............	2·51	...	,,	Westport House.........	4·42	143
Moray.	Gordon Castle..........	1·96	61	,,	Delphi Lodge...........	13·98	...
,,	Grantown-on-Spey......	4·03	131	*Sligo*	Markree Obsy............	4·92	142
Nairn.	Nairn, Delnies	2·15	80	*Cav'n*	Belturbet, Cloverhill...	3·19	102
Inv's	Kingussie, The Birches	3·03	...	*Ferm*	Enniskillen, Portora...	...	...
,,	Loch Quoich, Loan.....	6·10	...	*Arm*	Armagh Obsy...........	2·51	87
,,	Glenquoich..............	6·61	103	*Down*	Fofanny Reservoir......	4·43	...
,,	Inverness, Culduthel R.	2·86	...	,,	Seaforde.................	2·48	78
,,	Arisaig, Faire-na-Squir	3·42	...	,,	Donaghadee, C. Stn...	2·96	106
,,	Fort William...........	5·90	...	,,	Banbridge, Milltown...	2·41	...
,,	Skye, Dunvegan........	5·03	...	*Antr*	Belfast, Cavehill Rd...	3·93	...
R & C.	Alness, Ardross Cas ...	2·39	79	,,	Glenarm Castle.........	2·27	...
,,	Ullapool.................	2·57	...	,,	Ballymena, Harryville	2·75	80
,,	Torridon, Bendamph...	5·45	101	*Lon*	Londonderry, Creggan	4·02	109
,,	Achnashellach..........	4·67	...	*Tyr*	Donaghmore............	3·43	...
,,	Stornoway...............	2·63	87	,,	Omagh, Edenfel.........	4·05	119
Suth	Lairg.....................	1·45	...	*Don*	Malin Head.............	2·96	...
,,	Tongue	1·78	58	,,	Dunfanaghy.............	...	...
,,	Melvich..................	1·90	68	,,	Killybegs, Rockmount.	5·00	114

Climatological Table for the British Empire, February, 1929.

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	+ 3·3	52	13	38·1	27·5	32·8	— 7·3	28·6	88	7·7	0·51	— 1·03	9	1·8	19
Gibraltar	1017·8	— 2·2	69	46	61·5	51·6	56·5	+ 0·6	50·8	79	5·7	4·66	+ 0·44	14	..	..
Malta	1011·0	— 5·7	59	39	54·1	45·6	49·9	— 5·4	45·6	72	7·5	3·38	+ 1·18	19	5·0	46
St. Helena	1010·7	+ 1·1	71	58	67·7	60·1	63·9	— 2·5	60·9	95	9·7	3·45	— 0·35	26	..	..
Sierra Leone	1011·2	+ 0·4	92	70	88·1	73·9	81·0	— 1·3	75·9	75	2·5	0·00	— 0·30	0	..	..
Lagos, Nigeria	1010·9	+ 0·8	89	72	88·0	77·4	82·7	+ 0·5	76·9	79	5·8	1·46	— 0·61	4	..	..
Kaduna, Nigeria	1015·2	+ 3·2	96	56	92·6	63·3	77·9	+ 1·0	59·6	33	..	0·00	— 0·04	0	..	..
Zomba, Nyasaland	1007·0	— 0·9	84	62	79·5	64·2	71·9	— 0·1	..	81	8·0	8·89	— 1·76	18	..	..
Salisbury, Rhodesia	1007·2	— 0·9	84	54	77·9	59·6	68·7	— 0·1	63·0	76	6·4	3·91	— 3·49	12	6·8	54
Cape Town	1014·1	+ 0·7	100	51	79·9	58·9	69·4	— 0·9	61·1	77	3·1	0·46	— 0·12	1	..	..
Johannesburg	1010·6	— 0·6	86	43	78·6	56·3	67·5	+ 2·1	58·0	70	3·9	5·99	+ 0·77	10	9·7	75
Mauritius	1010·9	— 0·1	90	67	84·2	73·2	78·7	— 0·6	75·2	75	6·0	4·50	— 3·90	18	9·5	74
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1013·2	— 0·1	91	51	82·5	59·9	71·2	+ 0·2	59·8	79	2·7	0·63	— 0·47	2*	..	..
Bombay	1011·3	— 1·4	97	53	83·7	67·3	75·5	— 0·1	65·1	70	0·6	0·00	— 0·03	0*	..	..
Madras	1011·5	— 1·4	87	65	84·9	69·7	77·3	— 0·4	72·4	83	2·9	6·41	+ 6·09	3*	..	..
Colombo, Ceylon	1010·8	— 0·3	91	67	86·4	71·7	79·1	— 0·6	74·7	74	5·1	1·78	— 0·29	6	8·8	74
Hongkong	1018·1	— 0·6	76	47	63·1	55·6	59·3	+ 0·2	55·4	79	8·4	0·59	— 1·01	4	2·6	23
Sandakan	..	..	87	73	84·7	74·2	79·5	— 0·6	76·2	85	..	16·05	+ 6·43	13	..	..
Sydney, N.S.W.	1013·7	— 0·4	83	58	77·3	67·5	72·4	+ 1·1	68·3	78	7·6	11·00	+ 6·76	18	5·1	38
Melbourne	1014·5	0·0	95	51	81·2	61·7	71·5	+ 4·1	64·1	64	5·9	3·13	+ 1·41	8	7·8	57
Adelaide	1012·5	— 1·8	103	53	91·1	70·0	80·5	+ 6·4	63·0	39	2·9	0·05	— 0·61	1	10·8	81
Perth, W. Australia	1011·1	— 1·9	104	50	84·8	64·6	74·7	+ 0·6	63·6	50	5·2	0·43	— 0·02	6	8·6	65
Coolgardie	1010·8	— 1·7	109	51	91·6	62·0	76·8	+ 0·8	61·7	48	4·3	1·23	+ 0·48	5	..	..
Brisbane	1010·9	— 1·6	92	67	84·2	70·7	77·5	+ 1·0	71·7	78	8·3	6·23	+ 0·04	22	5·7	43
Hobart, Tasmania	1017·3	+ 3·8	93	45	72·5	55·8	64·1	+ 1·7	57·8	68	6·5	1·26	— 0·19	7	7·5	54
Wellington, N.Z.	1014·9	— 0·9	75	48	67·5	54·8	61·1	— 1·4	56·6	71	6·8	0·80	— 2·34	6	8·4	61
Suva, Fiji	1008·3	+ 0·6	89	70	85·4	74·9	80·1	— 0·4	76·8	83	7·3	18·03	+ 7·90	25	5·0	39
Apia, Samoa	1008·8	+ 0·4	88	73	84·5	74·7	79·6	+ 0·6	77·2	81	6·4	14·97	— 0·74	23	..	..
Kingston, Jamaica	1014·7	— 0·6	88	64	85·0	67·7	76·3	— 0·2	65·0	82	1·5	0·50	— 0·10	3	7·5	65
Grenada, W.I.	1009·7	— 3·6	86	69	84·4	71·1	77·7	+ 0·6	72·5	79	1·6	2·55	— 0·23	16	..	..
Toronto	1019·9	+ 1·9	43	— 3	28·1	15·7	21·9	+ 0·2	18·1	72	7·3	1·49	— 1·09	13	3·6	34
Winnipeg	1021·3	— 0·5	30	—26	8·8	—9·5	—0·3	+ 0·3	..	..	5·7	0·28	— 0·56	9	4·8	48
St. John, N.B.	1018·3	+ 4·2	41	— 1	29·1	13·8	21·5	+ 1·6	16·0	79	5·1	2·72	— 1·18	12	5·2	50
Victoria, B.C.	1023·2	+ 7·3	49	24	41·9	33·1	37·5	— 2.8	34·4	84	7·1	1·03	— 2·50	10	4·1	40

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

THE BELL ROCK LIGHTHOUSE.
(The anemometer mast is seen on the left of the dome.)

M.O. 313.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 64

Sept. 1929

No. 764

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

The Bell Rock Anemometer

By E. G. BILHAM, B.Sc., D.I.C.

By the time this article is in print important additions will have been made to the equipment for the measurement of wind on the Scottish coasts. Anemographs of the Dines pressure tube type, with twin-pen wind direction recorders, will be in operation at new stations which have been established at the Butt of Lewis (at the extreme northern tip of the Outer Hebrides) at Kirkwall (Orkney) and on the Bell Rock Lighthouse, near the entrance to the Firth of Tay. For various reasons special interest attaches to the anemometer on the Bell Rock Lighthouse, and it is proposed to give a brief account of the instrument and its surroundings.

The Bell or Inchcape Rock is known to all of us as the scene of the dramatic retribution which befell " Sir Ralph the Rover " in Southey's well-known poem. On first seeing the Rock at low tide one is torn between admiration of its perfection as a site for an anemometer and horror of its character as a menace to shipping. Reference books state that it is about 6 acres in extent, but there is very little continuous " land " to be seen even at full low tide. At that period a number of rocky ridges emerge, but the highest point is not more than a few feet above sea level. At high tide the entire mass is submerged. The nearest land (see Fig. 1) is the town of Arbroath (" Aberbrothock " of the poem), about 12 miles to northwest on the Forfarshire coast. The Rock is in the direct path of shipping

(86010) P. S. 1602/81. 1050. 9/29 M. & S. Gp. 303.

approaching the Firth of Tay from the east or the Firth of Forth from the north. The lighthouse, which was designed and built between the years 1808 and 1810 by Robert Stevenson, father of the Thomas Stevenson to whom we owe the Stevenson thermometer screen, is a graceful structure of freestone on a foundation of solid granite. The tower is 100 feet high.

The need for setting up a well exposed anemometer on the east coast of Scotland has been felt in the Meteorological Office for some years past. In May, 1927, by the courtesy of the Commissioners of Northern Lights, the possibilities of the light-

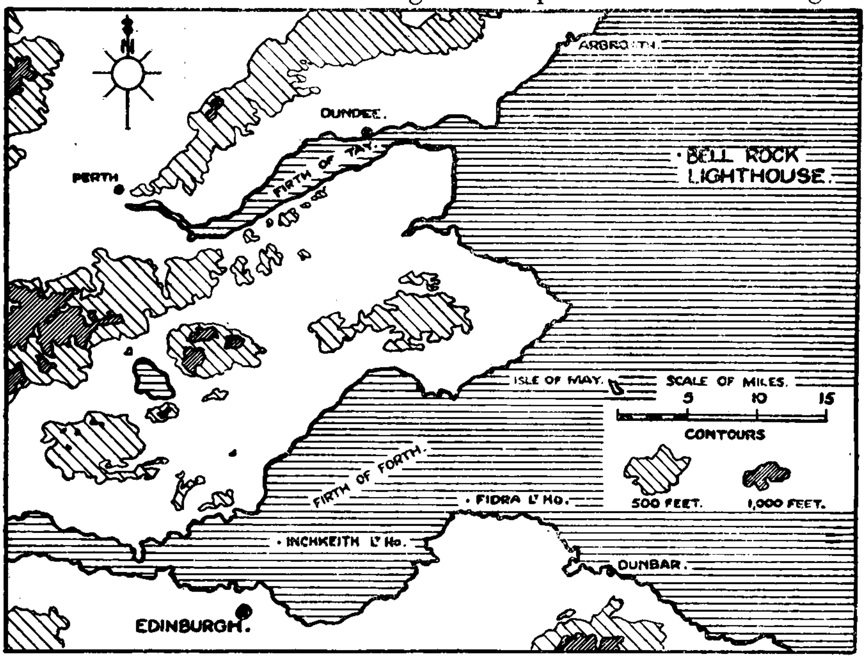


FIG. 1.—MAP SHOWING THE SITUATION OF THE BELL ROCK LIGHTHOUSE.

houses at Inchkeith, Fidra, the Isle of May and the Bell Rock were explored by Lt.-Col. E. Gold and Major A. H. R. Goldie. As a result of this survey definite proposals for an anemometer on the Bell Rock were formulated and the Commissioners of Northern Lights gave their approval. The details of the scheme required very careful consideration, involving the collaboration of the Instruments Division of the Office with the Engineer's Department of the Northern Lighthouse Board. In particular, the provision of access to the vane and of accommodation for the recording instrument furnished difficult problems. These problems were solved by Mr. D. A. Stevenson, M.Inst.C.E., Chief Engineer to the Board, who also made all the arrangements for the erection of the mast. Towards the end of July, the Meteorological Office received notification that everything was ready for adjusting and starting the instrument.

On August 19th, the writer, accompanied by Mr. S. F. Stanley of the Instruments Division and Mr. MacLeod, who had erected the mast, left Granton by the Northern Lighthouse Board steamer *May*, passages in which had been kindly arranged by the Board. The adjustment of a wind direction recorder cannot be carried out satisfactorily if the wind exceeds a moderate breeze. Also, at the Bell Rock, remote from all prominent landmarks, it was essential that the visibility should be good. When the party arrived at the lighthouse on the evening of the 19th, the conditions were distinctly unfavourable, but fortunately the weather was all that could be desired on the morning of the 20th and we had the satisfaction of seeing the instrument

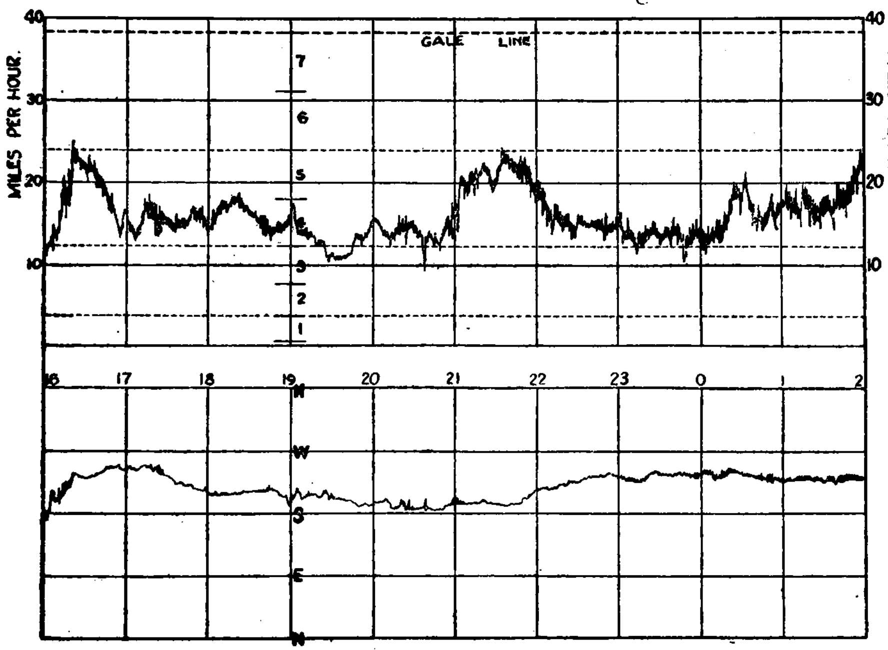


Fig. 2.—A portion of the first anemogram obtained at the Bell Rock Lighthouse, August 20th—21st, 1929.

beginning its first record at 11h. 20m. G.M.T. on that date. A portion of this record is reproduced (reduced to two-thirds natural scale) in Fig. 2. The character of the trace reflects the unique exposure of the instrument. Even in a wind of 20 to 25 miles per hour, the short-period oscillations are confined to a range of a mile or two on either side of the mean, while the direction recording pen shows oscillations of only a few degrees. When this trace is compared with one obtained in a similar wind at a land station, the contrast is very striking.

The photograph forming the frontispiece to this article was taken at low tide from the south-southwest extremity of the Rock. The mast is seen projecting above the dome on the left hand (*i.e.*, northwest) side. Unfortunately, the vane does not show up well, and on account of the foreshortening due to its high angular elevation, the mast appears shorter than it actually is. The vane is about 10 feet higher than the wind vane on the top of the dome and is supported on a mast made of 3-inch galvanised steam-piping bolted to the upper gallery. The spindle operating the direction recorder passes down the mast and then through a short length of smaller bore tubing into the top of a hollow casting, inside which it is connected through a universal coupling to a gear wheel about 4 inches in diameter. This gear wheel rests on a single steel ball at the bottom of a long bearing and transmits the movements of the vane to the recording mechanism.

The gearing between the spindle from the vane and the direction recorder consists of three meshed brass wheels all in the same horizontal plane. The first, or driver, is attached to the spindle in the manner already described. The second is of 8 inches diameter and has a similar type of bearing. The third, which is identical in size with the driver, is coupled directly to the helix of the direction recorder. The need for this arrangement arose from the fact that the direction recorder could not be placed vertically under the vane. It was necessary to step across a horizontal distance of about 10 inches and gearing of some kind was, therefore, essential. The method actually adopted forms the simplest and least objectionable solution of the problem. Access to the instrument is obtained from the inside of the light-room by means of a door which, when closed, lies flush with and forms part of the wooden interior lining of the room.

The only feature of the velocity recording arrangement calling for special mention is the fact that the pipes conveying the pressure and suction from the head to the recorder are of copper, 1-inch internal diameter, throughout. The head and vane are, of course, of the most recent pattern, incorporating the improvements mentioned on pp. 7-8 of the *Meteorological Magazine* for February, 1929. Access to the vane for cleaning and lubricating purposes is provided by means of an iron ladder which can be seen in the photograph inclined to the mast at an angle of about 45 degrees.

Supercooling on Water Films on Wet Bulbs

Correspondence in the February, 1929, and May, 1929, numbers of the *Meteorological Magazine* by Col. Gold and Mr. Belasco bears on the persistence of unfrozen water on a wet bulb thermometer bulb to temperatures considerably below freezing point. The effect has been frequently observed at Cardington, where a recording system of electrical resistance thermometers is in operation. The apparatus records from both a wet and a dry bulb placed in an ordinary Stevenson screen; the wet bulb having the usual arrangement of muslin and wick.

The wet bulb often remained for a long period (in one case 10 hours) below freezing point without any ice forming. When freezing set in there was a rapid rise of temperature to 32°F. The time occupied by this rise is difficult to determine, as the thermometer records only once in three minutes; but certainly in most cases, and probably in all, it was less than three minutes. After the rise, the temperature remained for a time at 32°F. and then began to fall. If the rise when freezing occurred was large, the temperature began to fall again almost immediately. If, however, the rise was small, a period, once as long as three quarters of an hour, elapsed before any fall began. This is what one would expect; for if W is the "water equivalent" of the thermometer, M is the mass of water on its surface, and t°F. the depression of temperature below 32°F. just before freezing, the mass m frozen is given by:—

$$154\,m = (M + W)t.$$

(154 being latent heat of fusion of water.)

The water remaining unfrozen is thus:—

$$M - m = M - \frac{(M + W)t}{154}$$

so that the amount of water remaining, and consequently, the time before it is all frozen, are greatest if t is small. In addition, of course, when t is large the thermometer bulb after freezing is surrounded by objects much colder than itself so that losses of heat are rapid.

It may be noted that if—

$$154M < (M + W)t, \text{ i.e., } \quad \text{if } \frac{W}{M} > \frac{154}{t} - 1$$

the temperature recorded by the thermometer will not rise to 32°F. The condition will not arise in practice, for with $t = 10°$ $W/M = 14{\cdot}4$ for the case where the heat is just sufficient to cause the rise to 32°, M is of the order of 0·5 gm.; so that $W = 7$ gm. approximately. This would require the mass of the thermometer bulb to be at least 70 gm., whereas actually it is not more than 20 gm.

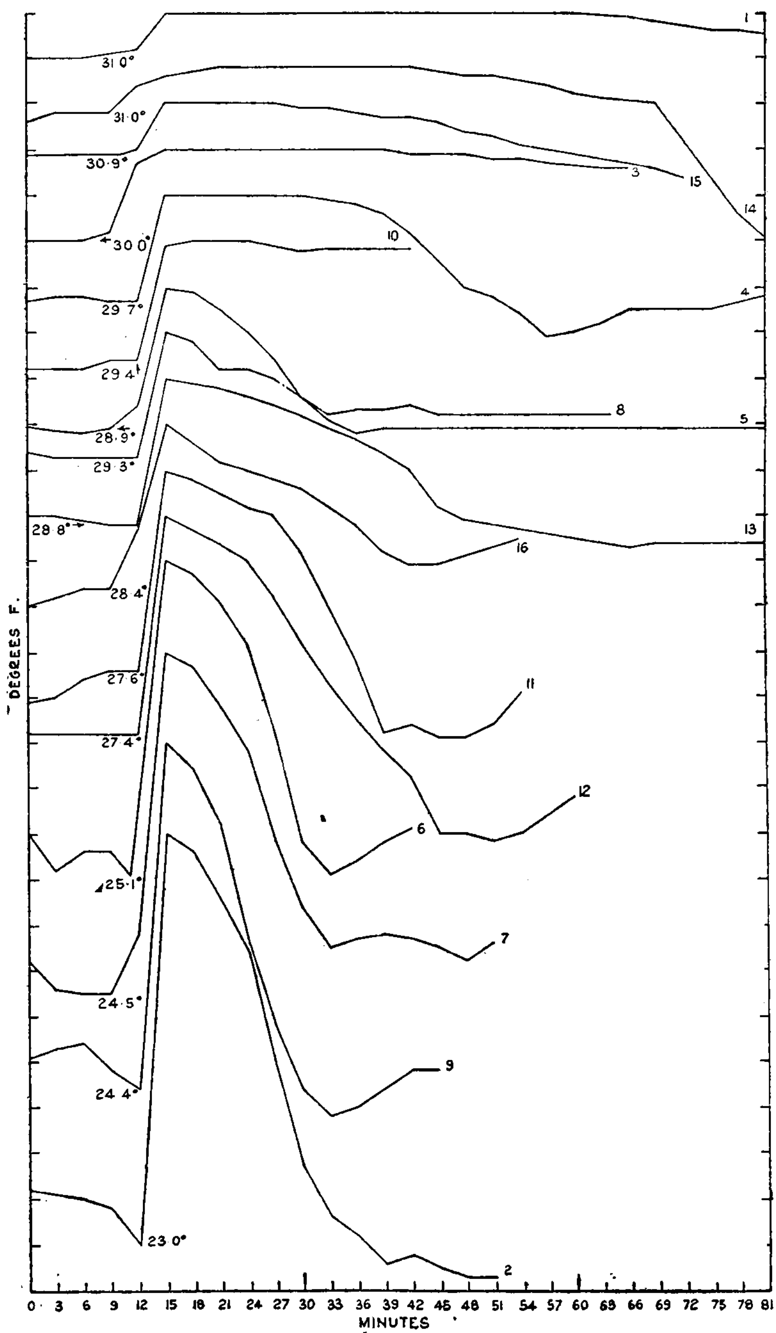
Table I gives the details of occasions on which freezing has followed supercooling. Fig. 1 shows the variations of temperature recorded by the wet bulb during a period from 15 minutes before to rather more than an hour after freezing. The highest point on each curve is 32°F.; other temperatures must be obtained by measurement from this point with the aid of the 1°F. divisions marked on the ordinate axis. It is not possible to determine whether freezing was quite spontaneous or whether some agitation was necessary to induce it. The wind

FIG. I

VARIATION OF TEMPERATURE BEFORE, DURING & AFTER FREEZING.

THE HIGHEST POINT ON EACH CURVE IS 32°F.

THE DIVISIONS OF THE ORDINATE AXIS ARE EACH 1° F. THE CURVES ARE NUMBERED TO CORRESPOND WITH THE NUMBERING IN TABLE I.

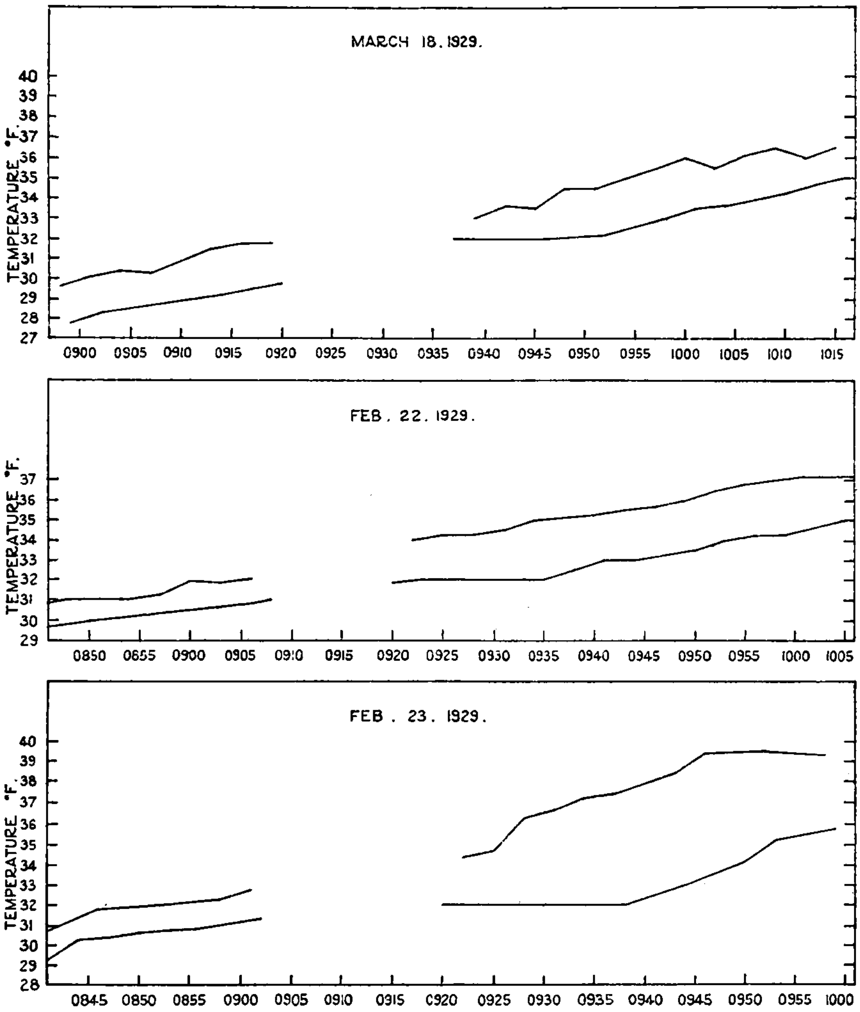


speed at the time is given in the table: but there is no evidence that agitation from this source really induces freezing.

When an ice-covered wet bulb is warmed up again one would expect it to remain for an appreciable period at 32°F. while the ice thaws. We have examined the records for examples of

FIG. 2.

CASES OF WET BULB "STICKING" AT 32°F. DURING A PERIOD OF RISING TEMPERATURE



this and we have discovered one or two, but the general conclusion is that the period for which the wet bulb temperature sticks at 32° is quite short. Evidently as soon as the air temperature rises high enough to cause thawing, the ice actually covering the bulb thaws very quickly, because it has a large surface compared with its volume. As soon as this film has thawed the temperature of the bulb commences to rise again, although the wick below, and the water vessel, may still be frozen. Only three undoubted cases of this phenomenon have

TABLE I.

	Date	Time at which freezing commenced G.M.T.	Approx. wind speed at time	Approx. period below 32°F. before freezing		Temperature recorded just before freezing	
				Wet bulb	Dry bulb	Wet bulb	Dry bulb
	1929	h. m.		Hours	Hours	°F.	°F.
1	Jan. 26	0 6	15 m.p.h.	3½	—	31·0	33·0
2	Feb. 4	0 1	Calm	8¼	7½	23·0	23·3
3	Feb. 4	18 53	5 m.p.h.	1¼	1	30·0	30·6
4	Feb. 7	18 55	Calm	2½	2¼	29·7	30·0
5	Feb. 11	1 33	12 m.p.h.	3¾	3	28·9	31·4
6	Feb. 21	6 9	3 m.p.h.	10	9¾	25·1	25·5
7	Feb. 22	5 24	Calm	6	5	24·5	24·7
8	Feb. 25	7 44	17 m.p.h.	1¾	1¼	29·3	30·2
9	Mar. 4	22 56	Calm	3½	2½	24·4	25·2
10	Mar. 6	23 33	3 m.p.h.	1¼	1¼	29·4	29·2
11	Mar. 8	2 58	Calm	4	3¼	27·6	27·7
12	Mar. 9	5 46	Calm	3½	3½	27·4	24·0
13	Mar. 17	4 27	3 m.p.h.	6	6	28·8	28·8
14	Mar. 17	20 22	Calm	¾	¾	31·0	31·2
15	Mar. 19	3 0	8 m.p.h.	1	1½	30·9	31·0
16	Apr. 4	0 52	3 m.p.h.	2½	2¼	28·4	28·3

been recorded; and all these, unfortunately, are incomplete as they occurred just when the charts were being changed in the morning. Fig. 2, however, shows the variations of wet and dry bulb temperatures on these occasions.

B. C. V. ODDIE.

OFFICIAL NOTICE

Discussions at the Meteorological Office

The series of meetings for the discussion of recent contributions to meteorological literature, especially in foreign and colonial journals, will be resumed at the Meteorological Office during the session 1929-30. The meetings will be held on alternate Mondays at 5 p.m., beginning on Monday, October 14th, 1929, when Lieut.-Col. E. Gold, D.S.O., F.R.S., will open the discussion of a paper by Finn Malmgren entitled "On the properties of sea ice." (*Norwegian North Polar Expedition with the "Maud,"* 1918-25, *Scientific Results.* Vol. 1, No. 5, Bergen, 1927.)

The dates for subsequent meetings are as follows:—

October 28th, November 11th and 25th, December 9th, 1929; January 13th and 27th, February 10th and 24th, and March 10th, 1930.

The Director of the Meteorological Office wishes it to be known that visitors are welcomed at these meetings.

Correspondence

To the Editor, *The Meteorological Magazine*

Underground Water Level in the North Downs

With reference to the note on the above published in the August number of the *Meteorological Magazine* it should have been stated that the figures given refer to the actual depth of water in the respective wells. Heights above sea level and depths of the wells are as follows:—

	Height above S.L.	*Depth.*
	Ft.	*Ft.*
Hucking (Old Forge)	360 ...	270
Little Pett	257 ...	186
Stockbury Village	347 ...	268
Detling (The Croft)	355 ...	118
Detling (Naylor's)	301 ...	62

SPENCER RUSSELL.

August, 1929.

Frequency of Rain Days

Referring to the note under the above heading in the July number of the *Meteorological Magazine* (p. 144) it may be of interest to give the figures for Ditcham, Petersfield, for the 20 years 1906 to 1925. The rain gauge is situated on the South Downs 554 feet above sea level.

Rainfall. *inch.*	*Mean No. of Days.*
·01— ·03	50·5
·04— ·49	117·2
·50— ·74	14·0
·75— ·99	4·9
1·00—1·24	1·9
1·25—1·49	0·8
1·50—1·74	0·4
1·75—1·99	0·4
Over 2·00	0·2

As Dr. Glasspoole remarks such figures are not always readily available, and such as have been published are not all grouped in the same way. They seem to me to deserve a closer analysis. The number of falls of ·01 inch at Ditcham, for instance, varies extraordinarily; the maximum was 51 in 1908, the minimum 9 in 1913; in fact light falls were much rarer in 1913 than in 1908; the figures for ·01 to ·03 inch are 71 for 1908, and 34 for 1913, the total number of rain days being 189 and 184 respectively.

C. J. P. CAVE.

Stoner Hill, Petersfield. July 29th, 1929.

Summer Thunderstorms

It has frequently been observed that practically the only type of summer thunderstorm occurring at night is that associated with "turret cloud" taking place in the higher layers of the atmosphere. The conditions necessary for the development of diurnal thunderstorms would not of course be present during the nocturnal hours. It would be interesting to have the opinion of your readers as to what might constitute an exception to this apparent rule. From observations over a fairly lengthy period I have come to the conclusion that the only thunderstorm occurring at night apart from the type mentioned above is the one associated with a westerly wind of northerly origin with the conditions very nicely adjusted. The cumulus clouds would appear to partake more of the character of the diurnal type, and it is noteworthy that such clouds do not disappear or disintegrate with the approach of sunset as is usual with their class. An outstanding example of this kind of storm is of course the one which occurred at Cannington near Bridgwater in August, 1924, when rain and hail fell continuously for 5 hours. I believe the temperature was considerably below normal on that occasion.

R. W. Green.

80, Worrall Road, Clifton, Bristol. August 20th, 1929.

"Sumatras"

In the current number of the *Meteorological Magazine*, on page 154, par. 2, it says:—

". . . . a south-westerly squall accompanied by an arched cloud, which always blows at night."

Having recently spent three years in the southern China Sea and the Federated Malay States, I think this statement is incorrect. "Sumatras" are often experienced in the daytime, sometimes as early as eleven in the forenoon.

Before writing this letter I consulted another officer who was stationed there at about the same time that I was, but in a different ship at that time, and he agrees with me and even gave me an instance of how he was caught by a Sumatra whilst out in a boat, and had to seek shelter for about three hours.

H. E. Turner, R.N.

H.M.S. Flinders, c/o G.P.O. August 21st, 1929.

Twelve-Rayed Ice Crystals

In the *Meteorological Magazine* for April there is an account by Dr. Whipple of twelve-rayed ice crystals with the remark that Pernter and Exner state: "Vom sternformigen Dodekagon is nun schon gar keine Rede; man findet dafür in den Mikrophotographien nicht einmal eine leise Andeutung" (2nd Edition, 1922, p. 318).

However, in the *Monthly Weather Review* for January, 1920, there is an illustration after one of Bentley's photographs showing an apparently 12-rayed crystal. Commenting upon this, Edgar T. Wherry says, regarding it as a modification of the usual hexagonal form: "Here however the crystals belonging to the opposite ends have apparently pushed each other aside so that they now lie at 30° from one another. The property of ice crystals of exhibiting gliding on the basal plane without disruption has permitted them to remain attached and an apparently 12-rayed crystal is the result."

CICELY M. BOTLEY.

17, Holmesdale Gardens, Hastings. July 19th, 1929.

I am much obliged to Miss Botley for the reference. May I express the hope that any reader of the *Meteorological Magazine* who has the opportunity will examine 12-rayed crystals and see if our theory that the twelve rays are not in one plane is verified.

F. J. W. WHIPPLE.

Smoke from Trees

At 8 p.m. to-day I was in Kensington Gardens and looking towards the sunset sky I saw the tallest elms with long streamers of smoke reaching up 30 or 40 feet and as the top blew away fresh smoke came from below as if the tree was on fire. Can anyone explain this phenomenon? The park keeper said it was gnats, but I can only think it was vapour due to cooling after the intense heat of the day.

STANLEY SINGLE.

*17, Kensington Palace Mansions, De Vere Gardens, W.*8. *September 4th,* 1929.

NOTES AND QUERIES

The Line-Squall and Channel Wave of July 20th, 1929

The line-squall and the accompanying wave on the south coast on July 20th were so remarkable and present such interesting problems that it seems worth while to supplement the information given in the August number of the *Meteorological Magazine*, which dealt mainly with the thunderstorm. A study of the autographic records at various stations confirms the general descriptions previously given. The squall was in a line from west to east and swept northward from the English Channel, travelling at about 40 miles per hour as far as London, and subsequently at 30 miles per hour, passing Bedford and Cambridge but not reaching Cranwell. The western end of the squall lagged somewhat, and at Rothamsted the squall wind was from southeast by south. No pronounced squall and no rain were experienced as far west as Salisbury Plain. The squall evidently originated well out to sea, as it caused a great wave on the south coast, especially near the Straits of Dover, by which two lives were lost.

An interesting note on the wave has been received by Mr. J. S. Dines from Prof. J. Proudman, F.R.S., of the Liverpool Observatory and Tidal Institute. He has calculated that if a sudden increase of atmospheric pressure equal to a height H of sea water occurs along a line parallel to the coast, and if this line travels directly across the sea with a constant speed V, then two similar discontinuities of sea level will be produced, one travelling with velocity V and another with velocity $c = \sqrt{gh}$ where g is the acceleration of gravity and h the depth of the sea, supposed uniform. The discontinuity of speed V will have a magnitude $\frac{H}{\frac{V^2}{c^2}-1}$ while that of speed c will have a magnitude $\frac{V}{c} \cdot \frac{H}{1-\frac{V^2}{c^2}}$.

The first discontinuity to arrive at any point will consist of a rise of sea level, the second of a fall. The rise of the barometer was about 1·5 millibars, which gives H a value of a little over half an inch. To produce a large magnification it is obvious that V and c must be almost equal. If this condition were satisfied, we should have a rise of sea level followed soon afterwards by a slightly greater fall, giving the effect of a wave. If we take the depth of the English Channel to be 40 metres, the value of c is 20 metres per second, or 45 miles per hour, in good agreement with the velocity of the line-squall. There can be little doubt that this was the explanation of the wave, and that an unusual combination of factors was required. The wave would be considerably magnified on entering the shallow coastal waters.

It is difficult to give any adequate explanation either of the squall or of its rapid advance without any appreciable pressure gradient for southerly winds. It seems inconceivable that the surface cooling over the Channel could have caused a squall penetrating over 100 miles inland. Nor was the squall a mere product of the rain, as in some districts there was practically no rain with it. I know of no real precedent for the occurrence. A considerable movement independent of the "geostrophic" wind has occurred fairly frequently. The squall of July 12th* moved much quicker than the geostrophic wind in its rear.

If we consider the conditions over a larger area, we find some evidence of the passage of an extremely feeble ill-defined cold front moving from west to east. The Bergen chart for the morning of July 21st marks an "occlusion" (obviously of cold

*See letters in the August number of the *Meteorological Magazine*.

front type) across the North Sea, Belgium, and northern France, between continental air and maritime polar air. The latter was evidently a very old type of polar air, since temperature reached 80°F. in London on 21st, though this was 7° lower than on the previous day. The travelling cloud system which brought the moisture for the thunderstorms was associated with this occlusion. The connexion between the line-squall and the feeble front at right angles to it is not obvious. Probably a tongue of cooler air, a few thousands of feet deep, went eastwards up the English Channel during the day, though this is mere surmise.

The rainfall distribution was irregular, but the patches of heaviest rain lay along a belt oriented at an angle of about 45 degrees with the squall and nearly parallel to the wind at the cloud level. This suggests that the well-known linear arrangement of thunderstorms may sometimes be due to causes other than fronts.

It is interesting to note that the great forward extension of the anvil observed by Mr. C. S. Leaf at Cambridge was absent in London, where the storm was newly developed. In Central London there was also no true squall cloud, and its appearance at Cambridge was probably due to the large amount of heavy rain to southward, which would have made the lower air damp.

C. K. M. DOUGLAS.

The Indus Floods

Following the floods in Sind about the end of July, more serious flooding occurred at various parts of the course of the Indus during August. The following notes have been compiled mainly from reports published in *The Times*.

Early in the month the river breached its banks near Khanwahar and in Khairpur, submerging several villages and causing extensive damage. These floods, which were due to excessive rainfall in the lower parts of the Indus plain, were beginning to subside when on the 18th it was announced that severe floods due to a different cause were likely to be experienced in the upper parts.

Near its source the Shyok river, a tributary of the upper Indus, pursues a southward path in a narrow valley for about 20 miles from Yapchan, at about 16,000 feet above sea level and some 1,200 miles from the sea. Into this valley four glaciers, the chief of which are known as the Great and the Little Kumdan, protrude from the westward, and periodically one or the other may encroach sufficiently to dam up the Shyok river; when a sufficient head of water has accumulated the dam may burst suddenly and liberate a large flood which, amongst other effects occasionally creates a large rush of water backwards up the Kabul river. "During their minor cycles of advance one or more of these glaciers have on different occasions thrust their snouts right across the course of the Shyok river, only to be stopped by the great cliffs on its left bank. By the making and breaking of these dams of living ice, the Shyok valley has been the scene of many disastrous inundations, the suddenness of such cataclysms entailing much loss of life in the riverine villages of Lower Nubra and Chorbat.''*

One of these outbursts occurred in October, 1926, another was expected about September, 1928, and arrangements were made for warning of the burst to be given by the lighting of a chain of bonfires. About this time the dam was said to be over 400 feet high, nearly 1,000 yards long and about a mile wide, the lake behind it being within some 60 feet of the top. Owing to some misunderstanding an alarm was given which turned out to be false, but arrangements were made for a warning system to be kept in operation. When the burst actually occurred, about August 17th, 1929, warning was sent to 50 villages in the Indus valley, but it was reported that the villagers were reluctant to leave owing to the false alarm of the previous year.

At Khalsar, where the river rushes through a narrow gorge the flood mounted rapidly to 93 feet above the normal level and fell again in 24 hours. By 8 p.m. on the 18th the flood, travelling about 20 miles an hour, had reached its maximum of over 50 feet at Attock, 600 miles from the dam, where an important bridge carries the railway from Peshawar over the Indus. The level reached at Attock was 3 feet below the highest recorded flood. Strengthening measures were taken in 1928, and the bridge was in no danger. It was reported that the backwash 20 miles up the Kabul river, which enters the Indus near Attock, reached a height of 2 feet.

Warnings were issued that floods might be expected in Sind about the 23rd, the level being likely to rise 3 feet above any previously measured. However the height of the flood decreased rapidly and at Sukkur, some 500 miles below Attock, the rise was negligible, owing, it is thought, to the water having overflowed the banks after passing Attock and the flood having thus been dissipated. (In the neighbourhood of Attock the ground level is less than 1,000 feet above sea level, and the river is emerging on the plain.) By the 21st, villages in the Punjab which had been evacuated were being re-occupied and owing to the precations taken the loss of life and damage caused by the flood were comparatively small. The danger from the Shyok flood was now over, but more dangerous floods soon threatened from another cause.

On the 23rd it was reported from Bombay that 36 hours con-

* T. O. Longstaff: Glacier Exploration in the Eastern Karakoram, *London, Geog. J.*, XXXV, 1910, p. 648.

tinuous rain had fallen throughout Sind, the fall in this period exceeding in some cases the annual average. Heavy rains were also being experienced in Baluchistan, in the Punjab, and in Kashmir. By the 29th the water level at Attock was 2 feet higher than during the Shyok flood, and water was flowing back along the Kabul river. Extensive flooding was now occurring, communication by road and rail was being interrupted, and reports of serious loss of life and damage to property were being received. Owing to the heavy rains large volumes of flood water were being discharged into the Indus by the Punjab rivers, so that it was regarded as impossible to give even an approximate forecast of the level likely to be reached in the lower reaches of the river. Recommendation was made by a conference of engineers that immediate action should be taken to raise the river "bunds" 6ft. above the existing water level. On September 2nd a message from Lahore announced that communication was almost completely cut over the vast area extending from Kashmir to Sind, numerous roads and bridges having been washed away. Air patrols were reconnoitring various districts and precautions were being taken against outbreaks of disease.

In the Punjab the loss of life and property is stated to be the greatest on record.

By September 3rd the "bund" at Sukkur had been raised by 4½ft. as it was expected that the floods from the Punjab and from the northern Indus would reach the town together. According to plan if the water rose a further 6in. at Sukkur it would be necessary to evacuate the low-lying parts further down the Indus. The danger level was exceeded on September 5th, and the peak of the flood passed on the 7th. Many villages in the neighbourhood were inundated but no loss of life was reported. On the 10th it was stated that northern Sind had escaped great damage but the outlook for southern Sind was still uncertain. Extensive preparations were being made at Hyderabad, the "bunds" having been raised by 5 or 6 feet. On the 13th it was reported that the river had reached a record high level in Lower Sind and that extensive areas were under water. Several lives were lost and great damage was caused to the crops.

S. T. A. Mirrlees.

Barometric Oscillation and Rainfall

In a recent paper* by S. Fujiwhara and Z. Kanagawa it is claimed that the observation of atmospheric oscillation on the barograph serves as a useful and reliable guide for forecasting

*Tokyo, Centr. Meteor. Observatory, Geophys. Mag., I, 1928, No. 6, p. 304.

rain. The period of free oscillation of the atmosphere depends on the lapse rate and so can be used as an indicator of the stability of the atmosphere. The greater the lapse rate the greater is the period of oscillation, and Fujiwhara and Kanagawa find that in Japan oscillations with periods of more than ten minutes are generally associated with rain.

The present investigation was undertaken with the object of testing the reliability of atmospheric oscillation as a means of forecasting rain in England. The records of the float barograph at the Meteorological Office, Kingsway, for the period January-June, 1928, were examined in conjunction with hyetograph records for the same period. Fifteen cases of oscillation with period of more than ten minutes were observed, and of these, nine were associated with rain. The time between commencement of oscillation and commencement of precipitation varied from about ten hours downwards; in one case oscillation and precipitation set in simultaneously. This result indicates a fairly close relationship between the two phenomena, but is not so decisive as that of Fujiwhara and Kanagawa at the Central Meteorological Observatory of Japan, Tokyo.

D. E. DAVIES.

A 24 Monthly Period of Rainfall Fluctuation in Saragossa

A statistical examination of the monthly rainfall at Saragossa has revealed a well-marked periodicity of rather more than 24 months.* Saragossa is to the south of the Pyrenees in the valley of the river Ebro in the centre of the province of Aragon. In this region the summer and winter rains are about equal, but on the average the spring fall exceeds that of the summer and the autumn that of the winter. In order to eliminate this seasonal variation the rainfall values for successive 12 months have been examined for the period 1910 to 1924. When these values are plotted the recurrence of maximum values and minimum values at intervals of 12 months is clearly demonstrated. The periodicity is given as rather more than 24 months, although less than 25 months. It is also noted that harmonic analysis has not revealed the existence of smaller components of this value.

It is interesting to recall that in the case of our own country where longer records are available, it has been shown that the two-year recurrence is really compounded of two periodicities of 1.7 and 2.1 years, both of which have persisted with very little change through two centuries at least.

J. GLASSPOOLE.

***Sobre un Período de unos veinticuatro meses para la fluctuatión de la precipitatión en Zaragoza,* by José Domingo y Quílez; Madrid, An. Soc. Española Meteor., 2, 1928, pp. 9-15.

Recording Ink for Low Temperatures

As a result of some experiments recently carried out at the Royal Aircraft Establishment, South Farnborough, a formula has become available for making ink which will remain liquid at temperatures much lower than that at which ordinary recording ink freezes. The special ink has the composition—ethylene glycol 50c.c., water 50c.c., methyl violet 2c.c. When tested against the ordinary commercial recording ink on the type of trough pen usually fitted to recording instruments, the ordinary ink failed at −15°C., whereas the special ink continued satisfactory down to −45°C. Much better results were obtained with a pen resembling an ink tracing pen, the ordinary ink failing at −35°C., while the special ink was usable down to −60°C.

These results indicate that the ordinary type of ink is satisfactory for most meteorological purposes. With the usual trough pen, however, the ethylene glycol ink is clearly the one to select when the instrument is exposed to temperatures of −15°C. or below.

The Atmosphere as a Colloid

It is not every meteorologist who can say offhand what a colloid is, though most of us know that colloidal chemistry is an important and growing branch of knowledge. According to the dictionary "colloid" is derived from the Greek κολλα, glue, so that a colloid is a gluelike substance. The chemist regards glue as typical of a very intimate mixture of water and another substance, finely divided. The atmosphere carries in suspension not only dust but also smaller aggregates, the Aitken nuclei and electrified particles or ions. In this sense it is a colloid.

By their choice of title the authors of this little book* indicate the range of the facts which they have put together and, at the same time, they are able to appeal to colloidal chemists to apply their methods to numerous problems which puzzle the meteorologist.

One outstanding puzzle is to discover how and why cloud particles combine to form raindrops. Is the process partly electrical? Does it depend in some way on the nature of the nuclei on which the water condensed to form the cloud particles? Is the age of the cloud an important factor? The authors think that the forecasting of rain cannot be reliable as long as the forecaster has no means of assessing the character and number of the nuclei of condensation.

As to the part played by nuclei in the formation of cloud some remarkable examples are given. The most striking is a case in which the exhaust from an aeroplane served to produce

*Die Atmosphäre als Kolloid. August Schmauss und Albert Wigand. F. Vieweg & Sohn, Akt. Ges., Braunschweig. 1929.

a beautiful cloud, which assumed the form of cirro-cumulus and, in the course of an hour, spread to a width of 800 metres. This appears to have happened in air which was supersaturated with respect to ice though not saturated with respect to water at the prevailing temperature.

Returning to the question of the development of rain from cloud, we may quote an incident given on the authority of Major Holtzey of Lindau. In the course of a walk the Major was able to look down on a sea of mist which covered the Rhine Valley but which was so shallow that the church towers stood out above it. It was cloudless overhead. On the return journey the party walked into the mist, and after ten minutes they were soaked through with rain, which was certainly not mere drizzle. That there was sunshine on the upper limit of the mist could be recognised all the time. Can a parallel be found for this experience? It is surely inconsistent with all current ideas as to rain-formation to assume that the raindrops developed in the low-lying mist. It is more natural to suppose that a sudden shower had developed in the upper air.

To emphasise the importance of something outside the range of thermodynamical processes in the production of thunderstorms, the authors quote from Knoche's account of a remarkable storm which developed on the Paraguay on October 3rd, 1927. There had been a great drought, for seven months not a drop of rain had fallen over a very large area. Without previous warning the storm broke at seven in the evening. From the beginning there was lightning on all sides, red-gold spark-lightning and brilliant white pearl-lightning. At the culmination of the storm there were to be seen crossing one another hundreds of luminous circular arcs, the light from which was strong enough to compel the observer to shut his eyes. With all this lightning no thunder was to be heard; a ghastly quiet prevailed, not a breath of air stirred, not a drop of rain fell. At 1.30 a.m., when the lightning had lasted for 6½ hours, thunder suddenly began, a squall arrived from the south and the air cooled rapidly.

Knoche explains the absence of thunder, somewhat vaguely, by the stratification of the air. Regarding it as probable that the electrical phenomena were due to the dust-haze produced by prairie fires, he supposes that the critical circumstance was a great difference in conductivity between adjacent masses of air. This is barely a hint at an explanation, but it serves to emphasise the appeal for more research.

For the rest let us say that the book is one which we should like to have translated into English. It brings together so much information which cannot be found elsewhere within the compass of a single volume. It is to be hoped that such a translation will be published.

F. J. W. WHIPPLE.

Books Received

Monthly Rainfall of India for 1926, Calcutta, 1927.

Report on Rainfall Registration in Mysore for 1927. By C. Seshachar, M.A., Bangalore, 1928.

Meteorology in Mysore for 1927, being the results of observations at Bangalore, Mysore, Hassan and Chitaldrug. Thirty-fifth Annual Report. Bangalore, 1928.

Obituary

We regret to learn of the death on September 10th, 1929, after a long illness, of Mrs. Hugh Robert Mill.

We regret to learn of the deaths of two members of the meteorological staff of the Ben Nevis Observatory. Mr. Robert MacDougall died in London in July last and Mr. Angus Rankin died at Cordoba, Argentina. Mr. Rankin was on the staff at Ben Nevis during the whole period of the Observatory's existence, 1883 to 1904, first as principal assistant and latterly as superintendent. After the closure of this Observatory he was appointed to the staff of the Meteorological Office of the Argentine Republic. He is chiefly known for his work on the rainband; also the rarely-seen halo of 17°-18°, which he was the first to observe, is named after him.

We regret to announce the death on August 14th, in a motorcycling accident, of Mr. W. G. Williams, Grade III Clerk of the Meteorological Office stationed at Eskdalemuir Observatory.

The Weather of August, 1929

The August weather over the British Isles was warm and rather dry in the south and east but unsettled and rainy in the north and west. During the first week unsettled conditions prevailed generally, depressions moving northeastward across the country. Thunderstorms occurred at many places on the 1st and in northern England and Ireland again on the 4th and 6th. These were sometimes accompanied by heavy rain but the largest rainfall measurements were recorded on the 3rd when 3·36in. fell at Tyn-y-waun (Glamorgan) and 2·90in. at Mary-Tavy (Devon). An anticyclone began to spread in from the Atlantic on the 6th, and the 6th and 7th were the only rainless days of the month at Stornoway (Hebrides). Subsequently this anticyclone spread northeast, the tracks of the depressions were further north and weather became much more settled in England, especially in the east and southeast, practically no rain falling in the latter districts from the 8th—15th while maximum temperatures generally rose above 70°F., reaching 76°F. at Greenwich on the 11th, 14th and 15th. The sunniest days of the first half of the month were the 2nd, 8th and 13th, 13·7hrs.

were recorded at Stonyhurst on the 2nd, 12·2hrs. at Bath on the 8th and 13·5hrs. at Portsmouth on the 13th. Meanwhile unsettled conditions persisted in the north. The fair weather was broken in the southeast on the 16th when a complex low pressure system spread over the country. Thunderstorms accompanied by heavy rain occurred locally that day and again in Scotland on the 17th; 1·54in. fell at Rothesay and 1·44in. at Crowborough (Sussex) on the 16th and 1·41in. at Inverness on the 17th. A wedge of high pressure passed across the country on the 18th, giving generally fine weather that day, 11·2hrs sunshine both at Mallarany and Plymouth. Subsequently for some days depressions were centred near Iceland and small secondary depressions caused heavy scattered rainfall in the north and west while in the south and east a spell of fine sunny weather with a rising temperature began, which lasted until the end of the month. On the 31st 91°F. was reached at Greenwich, 90°F. at Margate and 89°F. at Maldon (Essex). On the 25th the fine sunny weather of the south extended temporarily over Scotland and Ireland but conditions there soon became unsettled again. Among the heaviest rain measurements during the later part of the month were 3·13in. at Hafod Fawr (Merioneth) and 2·35in. at Stonyhurst (Lancashire) on the 23rd and 2·53in. at Killybegs (Co. Donegal) on the 30th. Thunderstorms occurred in many parts on the 28th and 31st. The distribution of sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs).
Stornoway	121	—12	Valentia	128	—27
Aberdeen	125	—25	Liverpool	171	+ 7
Dublin	123	—39	Falmouth	188	—23
Birr Castle	118	—24	Kew	186	— 1

Pressure was above normal over the North Atlantic and western Europe except for Norway, north Sweden, Scotland, east Iceland and Spitsbergen, the greatest excesses being 3·8mb. at Bornholm and 3·2mb. at Madrid and over the Atlantic at Long. 39°, Lat. 50°, and the greatest deficit 4·3mb. at Vardo. Temperature was generally slightly below normal except in northern Norway and England while rainfall was below normal in central Europe and southern Scandinavia and above normal in northern Sweden and at Spitsbergen.

Severe thunderstorms were experienced in Burgundy and Dauphiné on the 7th and 8th, which caused great damage to the vine crops as well as to buildings, and cold weather and thunderstorms occurred generally in Spain early in the month. Owing to the unusually dry season the " hunger stones " in the Elbe at Tetchen, which bear inscriptions recording the droughts of several centuries have again appeared above waterlevel. Heavy rain in the Alps on the 12th and 13th caused many torrents to overflow their banks, and bridges were swept away.

A heavy fall of snow was reported from the Valle de Aran in Lerida, Spain, on the 14th. Violent thunderstorms in Canton Ticino had destroyed by the 21st the greater part of the dams erected in 1928 to check the flow of water coming down the landslide of Motto Arbino. Continuous rains throughout the month caused serious floods in Jugoslavia on the 22nd and Bulgaria on the 26th. Several people were drowned.

A typhoon which killed many people swept across the delta of the Song-koi (Tongking, Indo-China) on the 4th. Heavy welcome rain fell in the Hadramaut (Arabia) about the 7th. On the 17th the great Shyok glacier dam burst and serious floods resulted.* The floods in Tabriz continued for the greater part of the month. Floods were also experienced in West Shantung about the 21st. During a typhoon which passed close to Hongkong and Macao on the 22nd the wind speed was said to be 120m.p.h. The rainfall was also heavy and removed anxiety concerning the water deficiency.

The Nile flood this year is said to be the highest for 40 years.

General light or moderate rain fell in Victoria and the eastern part of New South Wales on the 12th, which will be of much benefit to the wheat areas.

Light rains in Manitoba and Saskatchewan and heavy rains in Alberta during the week ending the 10th helped to improve the crop outlook. Hot dry weather prevailed in British Columbia the following week but beneficial rains were experienced there between about the 18th and 24th. Temperature fell considerably in the eastern United States on the 3rd and there was a slight fall of snow in the Berkshire Hills (Massachusetts). Temperature, however, was above normal in the south from about the 7th to 13th. Moderate beneficial rains fell in most States. A hurricane which passed near Cuba on the 21st had previously caused much damage to the forest region of northern Venezuela.

The special message from Brazil states that the rainfall in the northern regions was scarce with an average 1·02in. below normal, in the central regions irregular with 0·28in. above normal and in the southern regions plentiful with 1·61in. above normal. Seven anticyclones passed across the country and a violent gale occurred at Rio de Janeiro on the 30th. The crops were generally in good condition. At Rio de Janeiro pressure was 1·7mb. below normal and temperature 1·1°F. above normal.

Rainfall, August, 1929.—General Distribution

England and Wales	79	per cent. of the average 1881-1915.
Scotland	139	
Ireland	119	
British Isles	104	

*See p. 189.

Rainfall: August, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Lond .	Camden Square.........	2·13	96	*Leics* .	Belvoir Castle..........	1·63	62
Sur .	Reigate, Alvington.....	2·31	...	*Rut* .	Ridlington...............	1·80	...
Kent .	Tenterden, Ashenden...	1·93	84	*Linc* .	Boston, Skirbeck........	·86	36
,, .	Folkestone, Boro. San..	2·10	...	,, .	Lincoln.....................	1·85	75
,, .	Margate, Cliftonville...	2·01	104	,, .	Skegness, Marine Gdns	·80	33
,, .	Sevenoaks, Speldhurst	3·29	...	,, .	Louth, Westgate........	1·14	41
Sus .	Patching Farm.........	2·98	118	,, .	Brigg, Wrawby St.....	2·44	...
,, .	Brighton, Old Steyne..	2·36	108	*Notts* .	Worksop, Hodsock......	1·94	79
,, .	Heathfield, Barklye....	2·90	107	*Derby* .	Derby, L. M. & S. Rly.	2·01	77
Hants .	Ventnor, Roy. Nat. Hos.	1·82	91	,, .	Buxton, Devon Hos....	4·81	110
,, .	Fordingbridge, Oaklnds	1·69	64	*Ches* .	Runcorn, Weston Pt...	3·52	98
,, .	Ovington Rectory.......	...	...	,, .	Nantwich, Dorfold Hall	3·48	...
,, .	Sherborne St. John.....	·83	34	*Lancs* .	Manchester, Whit. Pk.	3·91	113
Berks .	Wellington College.....	1·01	43	,, .	Stonyhurst College.....	7·98	158
,, .	Newbury, Greenham...	·68	26	,, .	Southport, Hesketh Pk	4·03	116
Herts .	Welwyn Garden City...	·48	...	,, .	Lancaster, Strathspey	6·65	...
Bucks .	High Wycombe..........	1·04	45	*Yorks* .	Wath-upon-Dearne.....	1·86	77
Oxf . .	Oxford, Mag. College..	...	...	,, .	Bradford, Lister Pk....	2·19	81
Nor .	Pitsford, Sedgebrook...	1·21	50	,, .	Oughtershaw Hall......	9·02	...
,, .	Oundle....................	·48	...	,, .	Wetherby, Ribston H.	2·08	76
Beds .	Woburn, Crawley Mill	·43	19	,, .	Hull, Pearson Park.....	2·06	71
Cam .	Cambridge, Bot. Gdns.	·37	16	,, .	Holme-on-Spalding.....	2·37	...
Essex .	Chelmsford, County Lab	1·44	66	,, .	West Witton, Ivy Ho.	2·38	...
,, .	Lexden Hill House....	1·14	...	,, .	Felixkirk, Mt. St. John	2·92	102
Suff .	Hawkedon Rectory.....	1·32	51	,, .	Pickering, Hungate....	2·40	...
,, .	Haughley House........	1·41	...	,, .	Scarborough.............	2·11	76
Norf .	Norwich, Eaton.........	1·15	49	,, .	Middlesbrough..........	2·53	92
,, .	Wells, Holkham Hall	...	...	,, .	Baldersdale, Hury Res.	3·30	...
,, .	Little Dunham..........	1·25	46	*Durh* .	Ushaw College..........	2·95	101
Wilts .	Devizes, Highclere......	1·63	57	*Nor* .	Newcastle, Town Moor	2·73	93
,, .	Bishops Cannings.......	2·03	65	,, .	Bellingham, Highgreen	3·76	...
Dor .	Evershot, Melbury Ho.	2·57	81	,, .	Lilburn Tower Gdns....	4·22	...
,, .	Creech Grange..........	...	...	*Cumb* .	Geltsdale.................	4·71	...
,, .	Shaftesbury, Abbey Ho.	1·12	38	,, .	Carlisle, Scaleby Hall	5·92	144
Devon .	Plymouth, The Hoe...	3·59	116	,, .	Borrowdale, Seathwaite	16·18	140
,, .	Polapit Tamar...........	3·89	122	,, .	Borrowdale, Rosthwaite	13·37	...
,, .	Ashburton, Druid Ho.	...	...	,, .	Keswick, High Hill.....	5·29	...
,, .	Cullompton..............	3·21	105	*Glam* .	Cardiff, Ely P. Stn.....	3·21	74
,, .	Sidmouth, Sidmount...	2·26	80	,, .	Treherbert, Tynywaun	7·41	...
,, .	Filleigh, Castle Hill....	4·58	...	*Carm* .	Carmarthen Friary.....	3·19	69
,, .	Barnstaple, N. Dev. Ath.	3·25	98	,, .	Llanwrda..................	4·46	81
Corn .	Redruth, Trewirgie.....	...	...	*Pemb* .	Haverfordwest, School	3·09	74
,, .	Penzance, Morrab Gdn.	2·94	93	*Card* .	Aberystwyth............	3·89	...
,, .	St. Austell, Trevarna...	3·09	85	,, .	Cardigan, County Sch.	2·22	...
Soms .	Chewton Mendip........	4·70	105	*Brec* .	Crickhowell, Talymaes	2·80	...
,, .	Long Ashton............	...	...	*Rad* .	Birm W. W. Tyrmynydd	3·10	57
,, .	Street, Millfield	2·99	...	*Mont* .	Lake Vyrnwy...........	6·12	118
Glos. .	Cirencester, Gwynfa....	...	...	*Denb* .	Llangynhafal............	2·64	...
Here .	Ross, Birchlea..........	1·36	53	*Mer* .	Dolgelly, Bryntirion...	7·87	140
,, .	Ledbury, Underdown..	1·22	47	*Carn* .	Llandudno...............	2·38	79
Salop .	Church Stretton........	2·28	70	,, .	Snowdon, L. Llydaw 9	22·87	...
,, .	Shifnal, Hatton Grange	1·65	59	*Ang* .	Holyhead, Salt Island	3·09	97
Worc .	Ombersley, Holt Lock	1·35	50	,, .	Lligwy.....................	3.14	...
,, .	Blockley..................	1·70	...	*Isle of Man*			
War .	Farnborough............	2·04	75		Douglas, Boro' Cem....	5·00	131
,, .	Birminghm, Edgbaston	2·06	76	*Guernsey*			
Leics .	Thornton Reservoir....	2·12	76		St. Peter P't. Grange Rd.	1·65	70

Rainfall : August, 1929 : Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	5·47	146	*Suth* .	Loch More, Achfary...	9·46	162
,,	Pt. William, Monreith	5·53	...	*Caith* .	Wick....................	4·79	174
Kirk .	Carsphairn, Shiel.......	8·27	...	*Ork* .	Pomona, Deerness......	4·80	167
,, .	Dumfries, Cargen......	6·24	142	*Shet* .	Lerwick	4·50	149
Dumf.	Eskdalemuir Obs.......	7·52	146	*Cork* .	Caheragh Rectory......	4·79	...
Roxb .	Branxholm	4·95	154	,, .	Dunmanway Rectory...	4·88	104
Selk .	Ettrick Manse...........	...	...	,, .	Ballinacurra............	2·42	65
Peeb .	West Linton............	4·90	...	,, .	Glanmire, Lota Lo......	2·72	74
Berk .	Marchmont House......	4·64	140	*Kerry*.	Valentia Obsy..........	5·09	106
Hadd .	North Berwick Res......	4·43	140	,, .	Gearahameen............	8·30	...
Midl .	Edinburgh, Roy. Obs.	3·72	120	,, .	Killarney Asylum......	3·02	68
Ayr .	Kilmarnock, Agric. C.	6·36	162	,, .	Darrynane Abbey.......	4·39	101
,, .	Girvan, Pinmore..	5·53	124	*Wat* .	Waterford, Brook Lo...	2·52	66
Renf .	Glasgow, Queen's Pk. .	5·25	148	*Tip* .	Nenagh, Cas. Lough...	5·83	148
,, .	Greenock, Prospect H.	6·90	127	,, .	Roscrea, Timoney Park	3·77	...
Bute .	Rothesay, Ardencraig.	7·49	154	,, .	Cashel, Ballinamona...	3·27	92
,, .	Dougarie Lodge.........	6·43	...	*Lim* .	Foynes, Coolnanes......	4·06	105
Arg .	Ardgour House	12·36	...	,, .	Castleconnel Rec.......	5·83	...
,, .	Manse of Glenorchy...	8·60	...	*Clare* .	Inagh, Mount Callan...	8·14	...
,, .	Oban.....................	5·89	...	,, .	Broadford, Hurdlest'n.	6·91	...
,, .	Poltalloch	6·37	130	*Wexf*.	Newtownbarry	...	...
,, .	Inveraray Castle.........	9·76	148	,, .	Gorey, Courtown Ho...	2·65	80
,, .	Islay, Eallabus.........	8·09	185	*Kilk* .	Kilkenny Castle.........	3·35	96
,, .	Mull, Benmore.........	18·00	...	*Wic* .	Rathnew, Clonmannon	3·28	...
,, .	Tiree	5·55	...	*Carl* .	Hacketstown Rectory..	4·16	103
Kinr .	Loch Leven Sluice......	4·54	118	*Leix* .	Blandsfort House......	4·08	103
Perth .	Loch Dhu...............	8·70	129	,, .	Mountmellick...........	4·20	...
,, .	Balquhidder, Stronvar	...	...	*Off'ly* .	Birr Castle..............	4·96	130
,, .	Crieff, Strathearn Hyd.	6·37	151	*Dubl* .	Dublin, FitzWm, Sq...	3·87	127
,, .	Blair Castle Gardens...	3·12	92	,, .	Balbriggan, Ardgillan.	4·35	113
,, .	Dalnaspidal Lodge.....	5·53	101	*Me'th* .	Beauparc, St. Cloud...	4·76	...
Angus.	Kettins School.	3·53	107	,, .	Kells, Headfort.........	4·30	104
,, .	Dundee, E. Necropolis	3·29	97	*W.M* .	Moate, Coolatore......	4·15	...
,, .	Pearsie House...........	5·52	...	,, .	Mullingar, Belvedere..	5·07	122
,, .	Montrose, Sunnyside...	4·66	167	*Long* .	Castle Forbes Gdns......	5·69	139
Aber .	Braemar, Bank...	2·81	82	*Gal* .	Ballynahinch Castle...	9·33	170
,, .	Logie Coldstone Sch....	2·22	70	,, .	Galway, Grammar Sch.	5·59	...
,, .	Aberdeen, King's Coll.	2·80	102	*Mayo* .	Mallaranny..............	8·67	...
,, .	Fyvie Castle............	3·88	...	,, .	Westport House.........	5·62	139
Moray.	Gordon Castle...........	2·74	86	,, .	Delphi Lodge...........	12·22	...
,, .	Grantown-on-Spey......	...	...	*Sligo* .	Markree Obsy...........	6·52	150
Nairn.	Nairn, Delnies	3·98	165	*Cav'n* .	Belturbet, Cloverhill...	5·35	144
Inv .	Kingussie, The Birches	3·12	...	*Ferm* .	Enniskillen, Portora...	...	...
,, .	Loch Quoich, Loan.....	...	...	*Arm* .	Armagh Obsy...........	5·52	152
,, .	Glenquoich	11·29	137	*Down* .	Fofanny Reservoir......	9·43	...
,, .	Inverness, Culduthel R.	3·62	...	,, .	Seaforde..................	5·81	155
,, .	Arisaig, Faire-na-Squir	6·19	...	,, .	Donaghadee, C. Stn...	4·31	130
,, .	Fort William...........	8·93	...	,, .	Banbridge, Milltown...	4·93	...
,, .	Skye, Dunvegan........	8·83	...	*Antr* .	Belfast, Cavehill Rd...	5·93	...
R & C.	Alness, Ardross Cas ...	5·13	173	,, .	Glenarm Castle.........	6·00	...
,, .	Ullapool	8·33	...	,, .	Ballymena, Harryville	6·56	154
,, .	Torridon, Bendamph...	8·00	121	*Lon* .	Londonderry, Creggan	6·83	147
,, .	Achnashellach..........	8·83	...	*Tyr* .	Donaghmore............	8·09	...
,, .	Stornoway...............	5·83	147	,, .	Omagh, Edenfel.........	6·85	160
Suth .	Lairg.....................	4·95	...	*Don* .	Malin Head..............	5·38	...
,, .	Tongue	5·08	159	,, .	Dunfanaghy.............	5·38	...
,, .	Melvich..................	7·41	249	,, .	Killybegs, Rockmount.	8·67	155

Erratum for Darrynane Abbey July 5·35/141

Climatological Table for the British Empire, March, 1929.

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.	1027·7	+14·3	68	22	53·4	32·9	43·1	+ 0·7	34·6	93	6·2	0·03	− 1·66	1	4·7	40
Gibraltar	1017·9	+ 0·9	68	48	61·8	54·4	58·1	+ 0·6	52·7	77	7·0	4·32	− 0·47	12	..	..
Malta	1018·7	+ 3·9	62	44	58·2	49·7	53·9	− 3·2	50·3	80	5·7	3·05	+ 1·57	11	6·1	52
St. Helena	1011·0	+ 1·4	70	58	66·4	59·9	63·1	− 3·7	60·5	93	9·3	3·69	− 1·25	26	..	..
Sierra Leone	1011·1	+ 0·4	93	70	88·1	74·4	81·3	− 1·1	75·8	76	3·6	0·53	− 0·63	2	..	..
Lagos, Nigeria	1011·5	+ 2·1	90	73	88·0	78·9	83·5	+ 0·2	78·4	80	64	1·73	− 2·01	9	..	..
Kaduna, Nigeria	1013·9	+ 2·8	99	62	95·8	68·9	82·3	+ 1·2	68·5	37	..	0·74	+ 0·30	1	..	..
Zomba, Nyasaland	1009·5	− 0·2	82	58	77·3	64·1	70·7	− 0·6	..	86	8·7	11·90	+ 2·82	21	..	..
Salisbury, Rhodesia	1009·9	− 0·2	81	50	75·4	58·7	67·1	− 1·1	61·8	77	7·0	5·98	+ 1·48	20	5·7	47
Cape Town	1015·3	+ 0·8	95	49	78·5	59·9	69·2	+ 1·1	60·1	75	3·5	0·49	− 0·39	5	..	..
Johannesburg	1015·6	+ 0·6	80	45	70·9	52·6	61·7	− 1·6	54·4	76	5·7	3·75	− 0·69	14	7·0	57
Mauritius	1013·1	+ 1·1	87	70	84·0	72·0	78·0	0·0	74·5	69	6·2	3·59	− 5·78	28	8·9	73
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1010·6	+ 0·7	103	59	92·4	70·2	81·3	+ 1·2	70·5	82	1·7	2·59	+ 1·15	2*	..	..
Bombay	1009·8	− 1·1	96	71	89·7	75·0	82·3	+ 2·8	74·1	77	0·8	0·02	0·00	0*	..	..
Madras	1010·7	− 0·2	93	65	89·2	72·0	80·6	− 0·5	75·0	80	2·0	0·01	− 0·18	0*	..	..
Colombo, Ceylon	1010·2	− 0·2	90	70	87·1	73·5	80·3	− 1·0	76·4	74	5·0	6·69	+ 2·02	13	7·9	65
Hongkong	1017·8	+ 1·7	83	52	70·6	61·1	65·9	+ 2·6	60·3	75	5·9	0·51	− 2·28	1	6·0	50
Sandakan	..	..	87	72	85·6	74·1	79·9	− 1·2	76·8	84	..	12·82	+ 4·77	23	..	..
Sydney, N.S.W.	1015·2	− 1·0	91	55	75·4	63·3	69·3	0·0	64·4	71	5·6	5·28	+ 0·49	12	7·0	57
Melbourne	1016·4	− 0·6	97	46	74·6	54·8	64·7	+ 0·2	57·7	65	6·2	3·92	+ 1·66	15	5·5	45
Adelaide	1017·9	+ 0·8	101	49	78·4	58·4	68·4	− 1·4	57·1	43	6·9	0·30	− 0·75	6	6·4	52
Perth, W. Australia	1017·0	+ 1·7	93	50	80·9	59·7	70·3	− 0·8	60·1	53	3·7	0·09	− 0·69	3	9·9	80
Coolgardie	1017·7	+ 2·9	97	49	81·0	55·1	68·1	− 3·6	56·5	58	2·5	0·77	+ 0·03	3	..	..
Brisbane	1013·9	− 0·5	99	61	82·7	66·9	74·8	+ 0·5	68·7	72	6·5	6·59	+ 1·03	16	7·0	57
Hobart, Tasmania	1013·1	− 0·9	88	39	66·9	50·2	58·5	− 0·9	52·6	68	6·3	1·03	− 0·67	14	7·0	56
Wellington, N.Z.	1016·0	− 1·2	73	46	65·5	54·2	59·9	− 0·6	56·8	81	7·4	4·92	+ 1·59	13	5·9	48
Suva, Fiji	1009·3	+ 0·8	90	70	86·2	74·4	80·3	+ 0·2	76·4	80	6·0	12·03	− 2·67	28	6·3	52
Apia, Samoa	1009·4	+ 0·2	88	70	85·1	74·1	79·6	+ 0·3	76·8	80	5·5	11·85	− 1·69	19	5·8	48
Kingston, Jamaica	1014·6	− 0·3	88	66	85·4	69·1	77·3	+ 0·2	67·2	83	2·2	0·39	− 0·63	5	6·7	56
Grenada, W.I.	1010·3	− 2·4	88	69	85·2	72·1	78·7	+ 1·0	72·5	79	3·7	1·01	− 1·73	9	..	..
Toronto	1012·8	− 4·2	65	4	44·4	29·3	36·9	+ 8·0	30·6	78	6·8	3·42	+ 0·77	16	3·8	32
Winnipeg	1012·3	− 6·5	62	−18	33·2	14·0	23·6	+ 9·2	..	..	5·5	1·28	+ 0·17	11	4·8	40
St. John, N.B.	1010·5	− 3·7	49	− 4	36·1	22·7	29·4	+ 1·0	26·0	79	7·0	2·98	− 1·56	16	5·0	42
Victoria, B.C.	1016·8	+ 1·0	57	35	49·6	39·6	44·6	+ 1·4	40·0	89	7·0	2·19	− 0·36	12	5·8	49

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

M.O. 313.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 64

Oct. 1929

No. 765

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

Conference of Empire Meteorologists, London, August, 1929

By F. ENTWISTLE, B.Sc.

Superintendent, Aviation Services Division.

It is a well recognised fact that the study and practice of meteorological science in any country depend for success on close and efficient co-operation between the meteorological services of the various countries of the world. The task of securing international agreement on such matters as methods of observations, forms of codes and times of issue of wireless weather reports is undertaken by the International Meteorological Committee and its various Commissions, and the progress which has been made in the different branches of meteorology, particularly since the war, is due in no small measure to the work of this Organization. There are, however, special meteorological problems which affect the British Empire as distinct from the wider international family and, while the directors of the various Empire meteorological services are represented on the International Meteorological Committee, there is no similar organization for the discussion of more intimate Imperial matters. It is for this reason that the Conference of Empire Meteorologists which met in London in August and which included representatives from India, the Dominions and more than twenty Colonies, marked an important step in the development of Imperial communications. Shortly after the war Sir

Napier Shaw, then Director of the Meteorological Office, arranged for a conference of the directors of the meteorological services of the Empire, but in addition to Great Britain, only Australia, Canada, Ceylon, India, New Zealand and South Africa were represented on that occasion. The 1929 Conference may be regarded as the first of its kind, in that it included representatives from practically every part of the Empire.

The delegates assembled on August 20th at the Air Ministry, where they were welcomed by Lord Thomson, Secretary of State for Air. Dr. G. C. Simpson, Director of the Meteorological Office, was unanimously elected President of the Conference, and after he had addressed the delegates and outlined the programme of work which had been drawn up, the meeting adjourned until the following day when the main work of the Conference began.

The first three days were devoted to the discussion of meteorology in relation to aviation and airship navigation in the British Empire. From the point of view of recent developments in aviation, particularly the inauguration of the first commercial Empire air route between England and India and of the projected experimental Empire airship flights, the choice of the present year for the Conference was particularly happy, in that it afforded an opportunity for full discussion of the various problems which had arisen in connexion with these developments in a way that would not otherwise have been possible. The procedure adopted was followed throughout the Conference. The Superintendent of the Division of the Meteorological Office responsible for the particular branch of the subject under discussion read a memorandum which he had prepared, and his address was then followed by a general discussion. In the case of aviation and airships, the first morning was devoted to placing the memoranda before the delegates. The first of these dealt with the development of Imperial air routes and the meteorological requirements of the Royal Air Force and of Dominion air services. The arrangements for the supply of weather information on the civil international air routes of western Europe were described together with an outline of the meteorological arrangements made in connexion with the recently inaugurated Air Mail to India. The requirements that would have to be met when other long-distance air routes for regular commercial flying came into operation were then dealt with. The second memorandum by Mr. M. A. Giblett, Superintendent of the Airships Services Division, dealt with the meteorological problems in relation to airship navigation. The reporting and forecasting organization which had been drawn up for Empire airship flights was described, together with the method of collecting meteorological information and statistics for the selection of airship routes and bases. An account was also given of the experimental investigations into wind structure and temperature conditions which had been carried out in this country and in Egypt, and which are of particular importance in the navigation and especially the mooring of airships.

The two papers were followed by a short address by Lieut.-Col. E. Gold, the President of the Meteorological Sub-Committee of the International Commission for Air Navigation, which is responsible for securing international agreement regarding the general organization on air routes. Col. Gold gave an account of the origin and development of the International Commission, and dealt with the question of the relationship of the meteorological services of the Empire with this organization. In the afternoon the delegates visited Croydon aerodrome, where they had an opportunity of inspecting the arrangements for the supply of meteorological information to pilots in addition to the general organization. By the courtesy of Imperial Airways Ltd. the delegates made a short flight in a three-engined "Argosy," one of the air liners used on the regular Continental services. The following day was devoted to a visit to the Royal Airship Works at Cardington. Here the delegates had an opportunity of inspecting the state airship R.101 now nearing completion, as well as the general arrangements for mooring and operating airships when flying operations begin. The third day was given up to a discussion on the application of the Empire's meteorological resources to aviation. A wide range of subjects was dealt with, including the collection of data to supplement the information already available for projected aeroplane and airship routes, the methods of observation and general organization. Sub-committees were appointed to consider in greater detail certain specific requirements, such as the meteorological organization on the projected air route between Cairo and Cape Town.

Three further days were devoted to marine meteorology, the outstanding problem of which is to reach agreement as to what observations should be collected from sea areas, how and when they should be made and how they should be collated. These problems were dealt with in memoranda presented to the delegates by Captain L. A. Brooke Smith, Marine Superintendent of the Meteorological Office. He described the organization of the Marine Division, which collates observations from a fleet of about 500 regular observing ships, the officers of which are, for the time being, the Corps of Voluntary Marine Observers. Their activities extend wherever the British Ensign is carried at sea, and they are so selected that their sailing schedules provide, as far as possible, a constant network of observations all over the oceans. Reference was also made to the International Conference for the Safety of Life at Sea which met in London in the spring of this year. Under a scheme put forward at this Conference 1,000 ships of all nationalities are to co-operate in a world-wide scheme for the transmission of weather reports by wireless, the number allotted to each country being proportional to its share of the world's tonnage. The discussions which followed dealt with the participation of the various parts of the Empire in the collection of data from different ocean areas, the adoption of a uniform ship's log in all parts of the Empire and the practicability of securing uniformity in the arrangements for transmitting messages by wireless telegraphy from ship to shore and from the shore to ships. The latter involved agreement as to the times at which observations should be taken and despatched, the codes used for transmitting the reports and the general organization which would enable a ship to obtain sufficient data for the construction of a synoptic weather chart on board. The question of gale warnings was also examined and the practicability of adopting a uniform system for visual warnings at coast stations was discussed.

Further subjects which came before the Conference included the meteorological requirements of the Royal Navy and of the Army and the question of the so-called "polar year." In connexion with the latter Dr. Simpson recalled that in the year 1882-3, twelve countries had co-operated in an intensive attack on the problems of polar meteorology by sending expeditions into the Arctic Circle, and that the data then collected still formed an invaluable source of information for all engaged in polar work. A proposal had been made recently to celebrate the Jubilee of this great scientific enterprise by organising special observations in high latitudes in the year 1932-3, and a small international sub-committee had been formed under the chairmanship of Dr. Simpson to consider these proposals. A discussion took place with regard to the co-operation of the British Empire in the forthcoming expedition in both the northern and southern hemispheres.

When it was known that the Conference of Empire Meteorologists was to be held in London, the Ministry of Agriculture asked for two days to be allotted for the discussion of questions relating to meteorology and agriculture, and an Agricultural Section was formed under the chairmanship of Sir Napier Shaw. This Section met on August 29th and 30th under arrangements made by the Ministry of Agriculture. The subjects dealt with included meteorology in relation to plant physiology, light and growth and fruit production; climate and animal distribution; weather and insects; weather and the fungus diseases of plants; and the use of meteorological data in the improvement of crop estimates. On August 31st the Section visited the Royal Horticultural Society's Gardens at Wisley and the Lord Wandsworth Agricultural College at Long Sutton to inspect agricultural meteorological work.

The last meeting of the Conference, which took place on the day before the meetings of the Agricultural Section, was a joint section of the latter and the general Conference. At this meeting the subject of General Climatology engaged the attention of the delegates during the morning. The discussion, which was opened by Mr. R. G. K. Lempfert, was directed to two main points, the contribution made by the Empire to the *Réseau Mondial*, an annual statistical summary of meteorological observations over the whole world, which is prepared in the Meteorological Office, and the arrangements for the distribution of reprints of the meteorological statistics which are contained in the Colonial Blue-books. Dr. C. E. P. Brooks, Superintendent of the General Climatology Division of the Meteorological Office, then opened a discussion on the collection, tabulation and publication of climatological data, in which attention was directed to the methods and hours of climatological observations and the standard form in which they should be published. The afternoon meeting was devoted to the important subject of seasonal forecasting. Dr. Simpson gave an account of a paper prepared at his request by Sir Gilbert Walker describing statistical methods of correlation which the latter had developed, and Dr. Normand, Director - General of Observatories, India Meteorological Department, spoke on the application of Sir Gilbert Walker's methods to forecasting the arrival of the monsoon in India.

Although the programme of work which had been drawn up for the Conference was very heavy, time was found for lighter social intercourse. On the evening of August 20th, Dr. and Mrs. Simpson received the delegates at a soirée held at the Meteorological Office, South Kensington, to which members of the staff of the Meteorological Office were invited to meet them. An interesting display of instruments, models and diagrams was arranged for the occasion. A week later Sir Henry Lyons held a reception for the delegates at the Science Museum, and on the evening of August 23rd the delegates were entertained by H.M. Government at a dinner at which Mr. F. Montague, Under Secretary of State for Air, presided. As time permitted during the course of the Conference, informal discussions of a very useful nature took place betwen certain of the delegates and representatives of the Meteorological Office. It is too early yet to appraise the full value of the work of the Conference, but the very close liaison between representatives of the various Empire meteorological services brought each one of them more closely in touch with the meteorological problems which are of fundamental importance to the Empire than would have been possible otherwise. From this restricted point of view alone, the Conference was well worth while.

OFFICIAL PUBLICATIONS

GEOPHYSICAL MEMOIRS—

No. 47. *Report on Thames Floods* By A. T. Doodson, D.Sc., Tidal Institute, University of Liverpool, and *Meteorological Conditions associated with High Tides in the Thames.* By J. S. Dines, M.A., Superintendent, Forecast Division, Meteorological Office. (M.O. 307g)

The Report on the Thames Floods of January 6-7th, 1928, gives details of the scientific investigations carried out at the Tidal Institute. The conclusions reached indicate that the land water played only a small part near London Bridge, and that the flooding was due to a surge propagated inwards from the North Sea. The progress of this surge is traced from Dunbar, round to Dover and north again, in the continental shores, as far as the Baltic. Several other instances of travelling surges are also discussed. It is also shown that local winds will not be very effective in raising high water, as their principal effects are experienced about two hours after low water. Floods can only occur when the surge arrives in the Thames coincidentally with normal high tide. The frequency of occurrence is discussed and the conclusion reached, that there is no evidence to show that floods are likely to be more frequent in the future than in the past.

In the second part of the memoir an account is given of the inquiry carried out in the Meteorological Office to determine the possibility of forecasting Thames floods. It was found that almost all cases where the water level at Southend was raised much above the height predicted from the astronomical tides were preceded by a strong wind from the NW. or N. over a considerable part of the North Sea. It is, however, only if such a raising of the water level occurs at a time of high tide that there is any danger of flooding. It is not possible to forecast the exact time at which the disturbance will occur and in practice it is found to coincide much more frequently with half tide than with high tide, thus passing without danger. The conclusion is reached that it is not in the present state of knowledge practicable to forecast a Thames flood in the London area with a sufficient degree of certainty to be of service.

Annual Report of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council, for the year ended 31*st March*, 1929.

This report describes the activities of the Meteorological Office during the seventy-fourth year of its existence and the ninth year in which its cost has been borne on Air Ministry votes. It is arranged in the same form as last year, the various practical applications of meteorology being discussed under separate headings. Under the heading "forecasting" is an account of an investigation into the advisability of giving warnings when meteorological conditions likely to cause high tides in the Thames occur. In the section on aviation is a description of the completed arrangements made for the supply of meteorological information to airships, at the Royal Airship Works at Cardington and also at the mooring towers in Egypt and India. The Office co-operated in the Air Defence Command Exercises carried out by the Royal Air Force in August, 1928.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings will be :—

October 28th.—*Fog and haze, their causes, distribution and forecasting.* By H. C. Willett (Monthly Weather Rev. 56, 1928, pp.435-68). *Opener*—Capt. F. Entwistle, B.Sc.

November 11th.—*On the exposure of thermometers in Ceylon.* By A. J. Bamford (Colombo, Ceylon, J.Sci. (Sec. E), Bull., I, 1928, pp. 153-67). *Opener*—Mr. J. E. Belasco, B.Sc.

Correspondence

To the Editor, *The Meteorological Magazine*

The Green Flash

It was my good fortune to witness this somewhat rare optical phenomenon on August 25th. At the time I was on a pleasure steamer in the Bristol Channel midway between Weston-super-Mare and Minehead. Looking down channel the sky was perfectly clear apart from a smoke haze which hung about two degrees above the horizon. Visibility was good, with a fresh NW. breeze going.

The setting sun was of a deep yellow colour, and when partly set was still trying to the sight. As the last segment of the sun disappeared it turned a whitish yellow tinged with a deep orange colour, followed immediately by the green flash of a beautiful emerald shade. This remained visible for a fraction of a second and in shape could best be described as bulbous.

E. D. Cooper.

Sunny Nook, Minehead, Somerset. September 2nd, 1929.

Halo into Circumzenithal Arc.

A very pretty sight was witnessed here by me yesterday morning, June 8th, details of which I thought would be worth sending in to you. The double sun rings I first saw at 6h. 35m. B.S.T. outer circle of colour disappeared at 6h. 40m. May have commenced 5 minutes before I first saw it. Cirrus from westsouthwest fast enough pace for rain. This covered the sky thinly to patchily. Surface wind south, light and variable. Parts of the inside ring remained after occurring off and on at intervals. I have sketched roughly what I saw (Fig. 1). Sunshine prevailed through cirrus, light ground mist or blue thunder mist was present. A little cirro-stratus to the southward. The sight I saw was lovely to look upon. At 6h. 55m. a piece of outside ring appeared on top nearest to zenith. (You will see this in Fig. 2 and Fig. 3.) This small part of ring changed to reverse later. Stratus and cumulus cloud came up later from south, also scud. At the time this part of ring changed reverse all other parts of the outside ring had disappeared. While I was watching the small part of coloured ring nearest zenith I suddenly saw a strange sight: I saw the part change to reverse or the other way about (Fig. 3). I am sure my eyes did not deceive me. May I ask you the cause of this sudden change. Was it due to the change of floating crystals in the upper atmosphere? There may have been a lot of volcanic dust at certain heights to the eastward from the recent eruption. This reverse part of ring in Fig. 3 lasted until 7h. 15m., then gradually faded away, no part of the outside ring was seen again after this time, but the two well and sharply coloured parts of the inside ring opposite the sun were seen until 7h. 38m. disappearing as cumulus clouds came up from south.

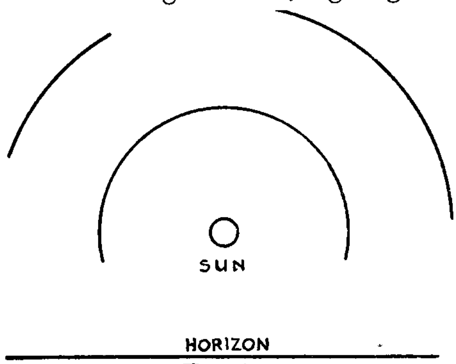


FIG 1.

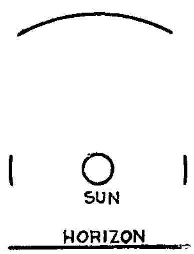


FIG. 2.

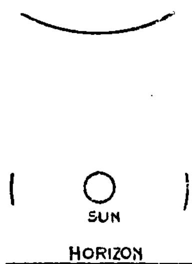


FIG. 3.

R. E. PARKER.

Dale Farm, Great Dalby, Melton Mowbray, Leicestershire, June 9th, 1929.

The phenomenon which Mr. Parker reports, the transformation of a 46° halo into a circumzenithal arc, is most striking. I do not know whether it has ever been put on record before. On the one occasion on which I saw it (I believe on March 15th. 1924, two days after a remarkable sun pillar), the 46° halo lasted but a minute or two before the curvature was reversed. The circumzenithal arc persisted for a quarter of an hour and the parhelia on either side of the sun a little longer. I judge by the distance I walked in the time.

The existence of the halo of 46° implies the presence of ice crystals with faces at right angles, the crystals being oriented at random. For the circumzenithal arc to be found the crystals must be in such a position that each has a horizontal face, the light is refracted through this horizontal face and a vertical face. If crystals of the same type are producing parhelia near the 22° halo, they may be presumed to be hexagonal prisms with their axes vertical.

Mr. Parker's observations (and mine) indicate that hexagonal prisms with flat ends can be floating for some time in the air without any marked tendency to assume the upright position, and that suddenly some force comes into play which pulls the crystals into this position. What the force is I do not know.

F. J. W. WHIPPLE.

Audibility of Thunder

Between 3 and 4 a.m. (B.S.T.), August 28th, I observed flashes of lightning from a southeast point and was somewhat surprised to notice that an interval of 110 seconds elapsed between flash and peal. The thunder, though soft and low, was distinct, and the bright moonlight played upon an anvil-shaped cumulo-nimbus cloud, the upper portion of which appeared above the southeast horizon. This cloud moved very quickly towards the northeast. A second storm following gave a time interval of 90 seconds between lightning and thunder. I have witnesed, or rather heard, long distance thunder in Macedonia (upwards of 20 miles away), but do not recall previously doing so in Great Britain. The night was unusually calm and still for a London suburb.

A. F. HARRISON.

36, *Rosemont Road, Richmond, Surrey. August* 28*th*, 1929.

[Some reports of very long intervals between lightning flash and thunder were quoted in the *Meteorological Magazine* for June, 1928, p. 113, but we cannot recall any reported intervals of so long as 110 seconds in this country.—ED., *M. M.*]

Winter Fog and Relative Humidity

In a recent issue of the *Meteorological Magazine* (February, 1929) I gave, in conjunction with Dr. R. C. Sutcliffe, statistics relating to winter fog and relative humidity at the three selected stations, Birmingham (town), Cranwell (rural) and Gorleston (seaside). In view of the somewhat surprising results obtained it has seemed worth while to repeat the work for three other stations: Kew (town), Ross-on-Wye (rural) and Scilly (seaside), In the present investigation the period brought under review for each station stretched from October 1st, 1923, to March 31st, 1927, and " winter " is defined as before as the months October to March (both inclusive). All the data used were extracted from the *Daily Weather Reports* issued by the Meteorological Office, London. The relative humidities were in every case measured by the use of wet and dry bulb thermometers, and the visibility observations at the sea stations, Scilly, are those taken looking landwards. Fog signifies a visibility of less than 1,100yds., and the observations were taken at 7h., 13h. and 18h. The table attached shows the results obtained. It needs to be noted that in that table the first of the three relative humidity columns contains all readings below 95 per cent. and the second all readings below 90 per cent. :—

	No. of cases of fog	Percentage of such cases when relative humidity was less than		
		95 per cent.	90 per cent.	80 per cent.
Kew	210	42·9	20·5	5·2
Ross-on-Wye	121	18·2	6·6	0·8
Scilly	51	0·0	0·0	0·0

The high percentages of fog at Kew, the town station, with air that is not saturated or even approximately saturated, support those previously obtained for Birmingham as indicative of smoke pollution: while the lower percentages for Ross-on-Wye show the results for a station fairly free from smoke vitiation. The results for Scilly—no fogs at all with relative humidities below 95 per cent.—seem very noteworthy and differ sharply from those obtained for Gorleston in the previous communication. The east coast and the south-west coast, perhaps by reason of shorter sea tracks in the former case for certain winds, appear greatly opposed in this matter of winter fog and accompanying relative humidity.

In view of the discrepancy so clearly shown, the investigation is being continued.

WILLIAM H. PICK.

February 19th, 1929.

March Fogs and May Frosts

To compare with Mr. W. H. Bigg's table of March fogs and May frosts in the August magazine, I have obtained the corresponding figures for Grayshott in the years 1924-9, though six years cannot be regarded as sufficient to prove or disprove the existence of any connexion. There is nothing to decide the range of visibility corresponding with the layman's " fog," but his definition of " frost " is when the grass minimum is

32° or lower, and not 30·4° or lower. For this reason I have put two lines of "frost" figures.

Number of occasions of fog at 9h. G.M.T. during March :—

Visibility less than	1924	1925	1926	1927	1928	1929
110 yards	2	0	0	0	0	0
220 „	4	1	1	0	1	2
550 „	5	1	1	1	2	5
1,100 „	6	6	3	3	9	13

Number of ground frosts in May :—

Year	1924	1925	1926	1927	1928	1929
30·4° or less	4	1	3	9	7	4
32° or less	7	2	5	9	7	7

S. E. Ashmore.

Windwhistle Cottage, Grayshott, Hindhead, Surrey. September 1st, 1929.

Small Upper-Air Velocities at Colombo

A pilot balloon, released at Colombo about 7 a.m. on April 17th, during an international upper-air week, showed a remarkable lack of movement in the uper-air up to 10½ kilometres; at which altitude the balloon was lost into cloud. The mean velocities, in metres per second, and directions, of successive approximately homogenous layers of wind currents are shown in the table below.

Height in km.	0–0·4	0·4–0·9	0·9–2·2	2·2–3·0	3·0–3·6	3·6–4·1	4·1–4·5
Mean Velocity in m/s.	3·9	2·2	1·1	1·8	and light var.	4·6	1·5
Direction	ENE	ESE	NNE	SE		NW	N

Height in km.	4·5–5·0	5·0–5·4	5·4–6·2	6·2–7·2	7·2–7·4	7·4–8·1	8·1–9·2	9·2–10·5
Mean Velocity in m/s.	Calm	1·3	light and var.	2·5	1·1	2·7	3·9	2·2
Direction		N		NE	ESE	SSW	SW	SSE

Although the balloon was followed for 91 minutes, the greatest horizontal distance from the starting point was only 2 miles, while during the last hour of the flight the vertical angle was between 60° and 85°. Heights were computed from readings of a 20-metres tail. Altitudes deduced at such large vertical angles were naturally very irregular, but a straight line drawn as evenly as possibly through the time-altitude graph gave a rise of 115 metres per minute, from the 11th to the 91st minute, and the figures adopted were computed from this value. The theoretical value of the rise, deduced from the lift at the commencement of the flight, was 120 metres per minute.

Another balloon, released about 2.30 p.m. the same afternoon and followed till it burst at 4·0 kilometres, showed a gentle to moderate westerly sea-breeze up to 0·8 kilometre, but above that, the same lack of movement as in the morning persisted up to 3·7 kilometres, while between 3·7 and 4·0 kilometres a NNW. wind of 4 m/s was found, corresponding closely to the NW wind of average velocity 4·6 m/s found at about the same altitude in the morning.

Next morning, with a flight reaching 9·5 kilometres, the wind had increased appreciably, reaching a maximum of 7 to 8 m/s at about 9 kilometres.

The weather over Ceylon at that time was of the usual intermonsoon type, with flat or irregular barometric gradients.

H. JAMESON.

Colombo Observatory, Ceylon. July 30th, 1929.

Temperature and Sunspots

In a letter to the *Meteorological Magazine,* Monsieur H. Mémery raises the question as to whether the anomalies in the August ten-day mean temperature, pointed out in the note on "Ten-day period temperatures" in the June number of this magazine, p. 120, are not due to sunspots. He writes: "Other epochs of the year present similar anomalies, *e.g.*, the five-day mean temperature for June 10th-15th is lower than that for June 1st-5th. The mean annual temperature would only show a uniform variation in the course of the year if the influence of the seasons were the only cause for the variation of temperature. But there are other causes which appear to have a more important influence than the seasons; these causes are to be sought in the variations of solar phenomena. If the daily means of the sunspots are taken over a number of years, annual periodic variations similar to those of the temperature means will be seen. In August there is almost every year an abundance of sunspots during the first fortnight with a noticeable increase towards the 15th, and this increase of sunspots is generally followed by a rise of temperature, which explains the rising of the mean temperature for August 10th-20th. . . . This happened in August, 1929; from the 10th-20th there was an increase in the number of sunspots, which was followed by a rise of temperature towards the 15th. . . . In the same way an explanation of almost all the abnormal variations of the temperature in the countries of western Europe can be given by means of the variations of the sunspots.''

NOTES AND QUERIES

Official Course of Training for Observers

Twenty people attended this course at Kew Observatory on September 23rd and 24th. On Monday the ordinary meteorological instruments appropriate to a climatological station were explained, and also the system of classification of clouds, advantage being taken of a varied display of cloud forms that was visible in the morning during a change from early fog to fine and then dull weather. On Tuesday morning the filling up of returns and the use of hygrometric tables were dealt with. Some climatology was introduced when suitable opportunities arose, but the making of a synoptic chart from coded telegraphic reports, which was done last year, was not repeated. On Tuesday afternoon Mr. R. Corless, Superintendent of the British Climatology Division, explained the anemobiagraph and its management to crop-weather observers, and Mr. F. J. Scrase conducted a party on a tour round the Observatory which was greatly appreciated.

E. V. Newnham.

A Problem of Convection

It is well known that when a deep current of polar air passes over a long stretch of warm sea, the addition of heat and moisture at the base of the current results in showers, generally known as "instability showers." Over the sea they are of course most frequent in autumn and winter, when the sea is relatively warm. In spring and summer they sometimes also develop over the sea, but at these seasons they are far more frequent and heavy over land in the daytime, when they are frequently accompanied by thunder. If the showers happen to be absent over the sea, they often take some hours to develop on land, though the cumulus clouds appear as soon as the air reaches the coast. If there is a fair wind velocity, say 30 miles per hour at 2,000 feet, the air may travel over 100 miles from the coast before the showers form, while the maximum intensity may not be reached for over 200 miles. When there is an old depression over our northwest districts, air of polar origin reaches England from southwest, and one frequently has heavy thundery showers in the Midlands, but fine weather in the southeast if there are no showers over the English Channel. A typical case of this occurred on July 5th, 1929, and the interesting point was that in London, which just escaped the showers, temperature was a few degrees higher than in the showery area further north. After a certain stage it is a question not so much of surface temperature as of the time required for showers to develop.

Where there are hills about 2,000 feet or more in height, the showers develop far more rapidly than over more or less flat countries, but thunder is rare in summer. (This of course only refers to our own hills in the conditions described above.)

Observers who watch the clouds must often have noticed the time which elapses between the first appearance of cumulus clouds and the development of a severe thunderstorm. It is rarely less than two hours and is often much longer, and this is a surprisingly long time when one considers the large vertical velocities known to exist within fully developed cumulo-nimbus clouds. If, for example, one sees thundery looking cumulus clouds gathering overhead, and the wind at the cloud level is 25 miles per hour, the chances of a thunderstorm are much better some 50 miles down this wind than at one's own locality. In London this is especially true for cloud movements from nearly due south or due east, where the sea is nearest. When a storm reaches London travelling at all quickly from the south, it has usually formed over France in the daytime and arrives in the late evening or night. A slow movement from the south (about 10 or 15 m.p.h.) is quite favourable for an afternoon storm in London (*e.g.*, June 16th, 1917, July 11th, 1927).

During the slow development of a thunderstorm, isolated cumulus heads towering upwards are apt to break away and dissolve. Once, however, a storm has formed, cumulus clouds at its boundary may grow rapidly into cumulo-nimbus, joining on to the main storm. In warm weather, the development of a storm may continue long after the surface temperature inversion has formed in the evening, and it is only in such weather that summer storms last far into the night.

The whole problem of instability and convection is difficult and is still only imperfectly understood.

C. K. M. DOUGLAS.

Correlation between the Maize Crop in the Argentine and the subsequent Grain Crops in the United States

Mr. S. S. Gampell calls attention to an apparent similarity in type between the Argentine summer and the ensuing summer in North America. He writes: "The best test of the heat and dryness of an Argentine summer might be the yield per acre of the maize crop. If this is arranged in order for the last

20 years, and the size of the United States crop of wheat for the same year is considered it is seen that the 10 best Argentine maize yields have preceded United States crops of an average of 874 million bushels, while the 10 worst Plate maize yields have preceded United States wheat crops of an average of only 725 million bushels, which is a very striking difference."

The figures for the years 1909 to 1924 for the maize crops of the Plate region and the corn crops of the United States arranged in order of magnitude of the Plate crop are as follows:—

Year	Yield per acre of		Year	Yield per acre of		Year	Yield per acre of	
	Plate maize crop	U.S.A. corn crop		Plate maize crop	U.S.A. corn crop		Plate maize crop	U.S.A. corn crop
	qrs.	bushels		qrs.			qrs.	bushels
1912	4·08	29·2	1921	3·33	29·6	1913	2·42	23·1
1924	3·81	22·9	1919	3·18	28·9	1925	2·38	28·8
1920	3·68	31·5	1926	3·07	27·0	1918	2·29	24·0
1915	3·67	28·2	1914	2·99	25·8	1916	1·89	24·4
1927	3·53	28·1	1922	2·81	28·3	1917	0·76	26·3
1928	3·33	28·2	1909	2·81	26·1	1911	0·41	23·9
			1910	2·76	27·7			
Average yield per acre of U.S.A. corn following 6 best Plate crop years.		28·0	1923	2·62	29·3	Average yield per acre of U.S.A. corn following 6 poorest Plate crop years.		25·1

The correlation coefficient between the two series given above is +0·46, but Mr. Gampell considers that "the fact that the static correlation is low does not of course necessarily prove that the relationship is negligible; a correlation of first differences would possibly give a higher coefficient, if it were possible to remove the errors in both series of crop estimates, which is unfortunately not possible. The static correlation must be low because of the great changes in acreage in the period; when (say) 1909 is compared with 1927, one is comparing the yield on different land; the correlation of first differences removes at least some of this secular variation, and the number of instances given in Table I in which a rise or fall in Plate maize yield was accompanied by a change of similar sense in the total United States wheat crop appears striking.

"The United States wheat crop increased when the yield of Plate maize increased and *vice versa* in 12 out of the 16 cases listed above. The year 1917 can hardly be counted among the exceptions, since even with the negligible increase in the United States crop, it remains one of the worst years of the century for both crops. In fact, consideration of 1917, 1916, 1911 and 1925 shows well the tendency for failures in these two crops to coincide. At present, it appears that the yield of Plate maize will fall some 25% below last year, but this can hardly be taken to portend any shortage in the United States wheat crop, since

TABLE I.

Year	1911	1912	1913	1914	1915	1916	1917	1918	1919
Yield of Plate Maize in quarters per acre	0·41	4·08	2·42	2·99	3·67	1·89	0·76	2·29	3·18
Total United States Wheat crop in millions of bushels	621	730	763	891	1,026	636	637	921	967

Year	1920	1921	1922	1923	1924	1925	1926	1927
Yield of Plate Maize in quarters per acre	3·68	815	2·81	2·62	3·81	2·38	3·07	3·53
Total United States Wheat crop in millions of bushels	833	3·33	867	797	864	676	831	878

even if it is accepted that some reduction in the latter below the big figure of 903 of last year is likely, the increase in wheat carried into the new crop year will probably make the total supply of wheat greater than last year.''

Review

Atmospheric Ozone: its relation to some solar and terrestrial phenomena. By Frederic E. Fowle. Smithsonian Miscellaneous Collections, Vol. 81, No. 11.

Interest has recently been aroused in the ozone in the earth's atmosphere, largely as a result of measurements made by Dr. G. M. B. Dobson and others from 1925 onwards, which have shown that there is a close relation between ozone and upper-air conditions. The method was indicated by Fabry and Buisson in 1921, and depends on the photographic measurement of the intensity of sunlight in the region of the very strong ultra-violet absorption band of ozone.

We now have a paper of great interest by Dr. F. E. Fowle, describing calculations of the amount of ozone based on spectro-bolometric measurements in the visible solar spectrum, in the region of the yellow "Chappuis" absorption band of ozone. The absorption here is very weak, and can hardly be detected in the intensity curves, but it is revealed when atmospheric transmission coefficients are obtained from observations at different altitudes of the sun. When the transmission coefficients are plotted against wave-length, the ozone band appears as a distinct dip in the otherwise smooth curve; from the size of the dip the amount of energy absorbed by the ozone, and hence the amount of ozone, is calculated. The close correspondence between the transmission coefficients thus found, and the ozone absorption curve found in the laboratory by Colange, proves the excellence of the Smithsonian observers' measurements.

This method, according to the author, gives the area of the "Chappuis" band with an accuracy of 1 in 30 at the best, assuming that the amount of ozone does not change during the observations, which extend over more than an hour. Dr. Dobson estimates that the "probable error" of an ozone value obtained from a single photograph by his method is not more than half of this.

The author proceeds to compare the two methods, to the disadvantage of Dr. Dobson. It must be said that the criticisms of Dobson's method show a failure to grasp the ideas which are set out in his original paper.* The fundamental formula underlying both methods is that which expresses the relation between the transmission coefficient of a layer of absorbing medium and the thickness of the layer. If the radiation is in a parallel pencil, the ratio of transmitted to incident intensity (the transmission coefficient) is—

$$I/I_0 = 10^{-ax}$$

$$\text{whence } \log_{10} I = \log_{10} I_0 - a x$$

where x is the length of path of the rays in the medium, and a is called the absorption coefficient of the medium. a is in general a function of wave-length, and it is obvious that the above equations are true only for monochromatic radiation, and do not hold for the total intensity of a number of wave-lengths with differing values of a; only in the former case is the relation between log I and x a linear one. By what seems to me a quite mistaken application of this, the auther purports to prove that the "Chappuis" band, where a is about 0·04 for 1cm. of pure ozone at normal temperature and pressure, "is a more sensitive indicator of changes in atmospheric ozone than that employed by Dr. Dobson," where a is about 2·0 to 2·5. Now this is certainly not so; for although a given change in the amount of ozone might produce a larger absolute change of intensity in the yellow (on account of the much greater initial intensity in that region), the percentage change would be greater in the ultra-violet, in the proportion of the respective absorption coefficients. Dobson does not use, as Dr. Fowle seems to think he does, comparatively wide sections of spectrum, over which a may vary considerably, but very narrow sections over which the variation of a is negligible.

One or two other objections are raised, but they need not detain us, being already answered in the paper referred to.

I have dealt with this at some length because Dr. Fowle finds that his values of ozone at Table Mt., California, have a much greater range than those of Dr. Dobson for the same place and the same two months, and implies that here is additional proof of

* *London, Proc. R. Soc.*, A. 110 (1926), p. 660.

the greater sensitivity of his method. This is, however, open to a different interpretation, for a large "scatter" is not usually taken to indicate great accuracy.

Turning now to the author's results, monthly means of ozone (expressed as the area of the "Chappuis" band) are given for one or more of four stations, for the years 1921-8. These show an annual variation, with maximum in spring and minimum in autumn in both northern and southern hemispheres, in agreement with Dobson's results. The much larger range at the two stations in the northern hemisphere is probably due to the fact that one of the southern stations is in the tropics, while the data for the other are very scanty. The annual means show a connexion with sunspot numbers in the northern hemisphere. but not in the southern, and from this the author concludes that there are two layers of ozone, one formed by the sun's ultra violet light and not varying with the sunspot period, but having an annual variation, the other varying with sunspot period, and formed by positively charged particles emitted from the sun, which are collected in the northern hemisphere by the earth's magnetic field. It will be seen that the supposed positive ions must really be positive magnetic poles! The electrically charged particles which have been suggested as the origin of the aurora are collected equally towards both poles. The author suggests that some difference between the molecular states of the two layers may help to account for the discrepancy between his results and Dobson's, and also between those of Cabannes and Dufay and those of Dobson as regards the height of the ozone layer. He finds support for the theory of two ozone layers in the two ionized layers suggested by Dr. Chapman to account for the variation of the magnetic elements; this is a very interesting section of the paper, and I feel that it is a great pity that we have not more experimental knowledge of the formation of ozone on which to base our speculations.

In the concluding paragraphs the ozone data are compared with Lord Rayleigh's measurements of the intensity of the auroral green line in the light of the night sky.

There are one or two mistakes in the paper, but most of these will be easily detected. It is perhaps worth while to point out that (on p. 6) the energy absorbed by the ozone is $\left(1-\frac{a}{a_a}\right)e$, not $\frac{a}{a_a}e$. (e being the energy at the selected place in the sun's spectrum).

D. N. HARRISON.

Books Received

Meteorology. Extract from Statistics of New Zealand for the Year, 1927. Wellington, 1928.

Everfrozen of Soil in the Boundaries of U.S.S.R. By M. Soumgin. Vladivostok, 1927.

Obituary

We regret to learn of the death of Dr. H. C. Frankenfield, who was in charge of the river and flood service of the United States Weather Bureau, on July 31st.

News in Brief

We are informed that Dr. F. Lindholm has resigned from the Directorship of the Physical Meteorological Observatory at Davos in order to resume his former position in Sweden. He is succeeded at Davos by Dr. W. Mörikofer.

A Geophysical Discussion on "Cyclonic Disturbances of Sea Level" will be held in the rooms of the Royal Astronomical Society at Burlington House, London, W.1, on Friday, November 1st, at 4.30 p.m. Speakers: Dr. Doodson and Prof. Proudman, of the Liverpool Tidal Institute.

In connexion with their advertisement on page iii of this Magazine, Messrs. C. F. Casella & Co., Ltd., wish to call attention to their change of address to Fitzroy Square.

The Weather of September, 1929

Except in the Hebrides, the weather over the British Isles for September was dry, sunny and warm, especially so in the southeast. Mean pressure was high over the British Isles and conditions mainly anticyclonic in the south, with the track of the Atlantic depressions keeping so far to the northwest of this country that our northern and western seaboards were almost the only areas affected by them. On a few occasions, however, a trough of low pressure passing across the country or a depression over France caused local thunderstorms, as on the 3rd, 12th, 17th and 18th. At Jersey thunder and lightning were experienced for the most part of four days from the 15th-18th and the rainfall was heavy on the 17th, 2·77in. falling during the 24 hours ending 17h. on that day. Other heavy falls during the thunderstorms were 0·79in. at Falcondale (Cardigan) on the 3rd, 1·50in. at Molland (Devon) on the 12th, and 0·64in. at Tenterden (Kent) on the 18th. Strong winds and gales were general on the 20th and 21st, especially in the northern midlands of England, Spurn Head reporting force 9 (49m.p.h.) at 13h. on the 21st. The month was notable warm, particularly in the eastern and midland districts, maximum temperatures of over 80°F. being recorded on several days during the first fortnight southeast of a line from Scarborough to Devon, 89°F. was recorded at Greenwich on the 4th, and 88°F. at Cambridge and Norwich on the 4th and 8th. Even towards the end of the month 70°F. was frequently exceeded. During the first few days minimum temperatures did not fall below 60°F. at several places in the south, but later ground frosts were experienced locally. In the northwest of Scotland rainfall was considerably above normal, but elsewhere it was much below. Some places in southeast England and the midlands had practically no rain until the 28th, 29th or 30th, when rain became general over the whole country; 2·03in. falling at Penrhyn Quarry (Carnarvon) on the 28th, and 1·60in. at Tal-y-llyn (Merioneth) and 1·03in. at Brigg (Lincoln) on the 30th. At Kew Observatory the total rainfall constituted a record for September, at least since 1866, and with the dry spell during the latter part of August completed an exceptionally long period of drought (37 days). At Ross-on-Wye it was the driest September since 1865. Sunshine totals were considerably above normal in most places except the extreme northwest of Scotland; among the sunniest days of the month were the 2nd, 4th, 7th, 8th, 16th, 17th and 25th-28th; 12·4hrs. bright sunshine were recorded at Hastings and 12·1hrs. at Falmouth on the 8th, and 12·0hrs. at Brighton on the 2nd and at Jersey on the 4th. The distribution for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs).
Stornoway	85	—30	Valentia	139	+ 6
Aberdeen	157	+33	Liverpool	163	+35
Dublin	151	+12	Falmouth	223	+60
Birr Castle	184	+18	Kew	196	+51

Pressure was below normal over Spitsbergen, Iceland, the northwest coast of Norway, and Portugal, the greatest deficit being 7·7mb. at Jan Mayen, and above normal elsewhere over western Europe and over the North Atlantic, the greatest excess being 4·1mb. at the Scilly Isles. Temperature was above normal generally and rainfall except at Spitsbergen below normal.

Temperature continued high and the weather dry in France during the first ten days of the month and forest fires were frequent in the south. On the 2nd violent thunderstorms were experienced in various parts of Spain and also round Mons. On the 12th and again between the 18th and 20th severe storms passed over various parts of France, and these were in each case followed by floods. Between the 18th-20th severe storms occurred in the Rhineland, where the hailstones did much damage to the fruit trees. Considerable damage and some loss of life was reported from the Basilicata (south Italy) as a result of the thunderstorms and floods which occurred between the 21st and 23rd. Strong gales were experienced in Finland on the 7th. A waterspout occurred off Hospitalet, near Tarragona, Spain, on the 13th.

The Nile flood, which started 20 days early, was still rising at the beginning of this month (which is unusual) owing to the continuation of the rains in the Abyssinian plateau. At Rosaires, in the Sudan, the flood level was 58in. above the normal crest on the 7th and reached the danger limit at Roda on the 11th. Abundant rain fell in Kenya during the month.

On the 16th the worst of the Indus flood was over, but the flood water was still slowly penetrating into fresh tracts of country; by the 23rd, however, the flood was subsiding in parts of Sind. Later in the month heavy beneficial rain occurred in many parts of northern India, but there was a shortage in Gujerat and Kathiawar. Twenty-six people were killed by a typhoon which struck the southern part of the Luzon Islands (Philippines) at the beginning of the month.

Beneficial rains fell generally on the agricultural districts of South Australia.

Abnormally hot weather was experienced in Central Canada and the United States early in the month, but by the 10th conditions were cooler. Generally the weather was dry in Canada throughout the month, but heavy rain occurred in Alberta and Saskatchewan about the third week. About the same time there was heavy rain in the southwestern United States, and torrential rain occurred in Mexico, doing much damage. A hurricane swept over the Bahamas on the 25th and 26th, and the south-eastern coast of Florida from Miami to Key West later on the 27th and all day on the 28th. It reached Tampa on the 29th, and passed to the east of Pensacola on the 30th. Several people were killed, many ships sunk, and much material damage done. The speed of the wind was said to be 90m.p.h. at times. Considerable beneficial rains fell in Argentina about the middle of the month. A southwesterly hurricane passed over Cape Verde Islands on the 21st and 23rd.

The special message from Brazil states that the distribution of rainfall was irregular in the northern and southern regions, with averages 0·16in. and 0·35in. above normal respectively, and scarce in the central regions with an average 0·28in. below normal. Seven anticyclones passed across the country. Crops were generally in good condition. At Rio de Janeiro pressure was 0·3mb. below normal and temperature 1·4°F. above normal.

Rainfall, September, 1929.—General Distribution

England and Wales	37	per cent. of the average 1881-1915.
Scotland	73	
Ireland	38	
British Isles	47	

Rainfall: September, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond.	Camden Square	·28	15	*Leics.*	Belvoir Castle	·66	35
Sur.	Reigate, Alvington	·15	...	*Rut.*	Ridlington	1·39	...
Kent.	Tenterden, Ashenden	1·21	57	*Linc.*	Boston, Skirbeck	·57	32
,,	Folkestone, Boro. San.	·74	...	,,	Lincoln	·43	28
,,	Margate, Cliftonville	·40	22	,,	Skegness, Marine Gdns	·35	19
,,	Sevenoaks, Speldhurst	·20	...	,,	Louth, Westgate	51	25
Sus.	Patching Farm	·84	35	,,	Brigg, Wrawby St.	1·21	...
,,	Brighton, Old Steyne	·72	34	*Notts.*	Worksop, Hodsock	1·34	89
,,	Heathfield, Barklye	1·04	42	*Derby.*	Derby, L. M. & S. Rly.	·54	33
Hants.	Ventnor, Roy. Nat. Hos.	·69	28	,,	Buxton, Devon Hos.	2·23	69
,,	Fordingbridge, Oaklnds	·41	19	*Ches.*	Runcorn, Weston Pt.	1·38	52
,,	Ovington Rectory	...	...	,,	Nantwich, Dorfold Hall	1·90	...
,,	Sherborne St. John	·37	18	*Lancs.*	Manchester, Whit. Pk.	2·06	87
Berks.	Wellington College	·18	6	,,	Stonyhurst College	2·58	68
,,	Newbury, Greenham	·51	25	,,	Southport, Hesketh Pk	1·90	69
Herts.	Welwyn Garden City	·16	...	,,	Lancaster, Strathspey	2·74	...
Bucks.	High Wycombe	·40	21	*Yorks.*	Wath-upon-Dearne	1·10	70
Oxf.	Oxford, Mag. College	11	7	,,	Bradford, Lister Pk.	·63	30
Nor.	Pitsford, Sedgebrook	·80	44	,,	Oughtershaw Hall	2·85	...
,,	Oundle	·54	...	,,	Wetherby, Ribston H.	·62	34
Beds.	Woburn, Crawley Mill	·17	9	,,	Hull, Pearson Park	·76	44
Cam.	Cambridge, Bot. Gdns.	·10	6	,,	Holme-on-Spalding	·51	...
Essex.	Chelmsford, CountyLab	·73	42	,,	West Witton, Ivy Ho.	1·02	...
,,	Lexden Hill House	1·19	...	,,	Felixkirk, Mt. St. John	·77	42
Suff.	Hawkedon Rectory	98	51	,,	Pickering, Hungate	·34	...
,,	Haughley House	·44	...	,,	Scarborough	·26	15
Norf.	Norwich, Eaton	·65	30	,,	Middlesbrough	1·13	68
,,	Wells, Holkham Hall	·75	39	,,	Baldersdale, Hury Res.	1·76	...
,,	Little Dunham	·43	19	*Durh.*	Ushaw College	1·07	53
Wilts.	Devizes, Highclere	·28	14	*Nor.*	Newcastle, Town Moor	·79	39
,,	Bishops Cannings	·41	19	,,	Bellingham, Highgreen	·83	...
Dor.	Evershot, Melbury Ho.	·44	17	,,	Lilburn Tower Gdns.	·46	...
,,	Creech Grange	40	...	*Cumb.*	Geltsdale	1·56	...
,,	Shaftesbury, Abbey Ho.	·65	27	,,	Carlisle, Scaleby Hall	1·26	47
Devon.	Plymouth, The Hoe	·38	15	,,	Borrowdale, Seathwaite	4·68	47
,,	Polapit Tamar	·71	25	,,	Borrowdale, Rosthwaite	3·25	...
,,	Ashburton, Druid Ho.	·83	27	,,	Keswick, High Hill	1·72	...
,,	Cullompton	·89	40	*Glam.*	Cardiff, Ely P. Stn.	·45	14
,,	Sidmouth, Sidmount	·36	16	,,	Treherbert, Tynywaun	3·02	...
,,	Filleigh, Castle Hill	1·70	...	*Carm.*	Carmarthen Friary	1·14	33
,,	Barnstaple, N. Dev. Ath.	·53	20	,,	Llanwrda	1·53	38
Corn.	Redruth, Trewirgie	·76	24	*Pemb.*	Haverfordwest, School	1·32	37
,,	Penzance, Morrab Gdn.	·48	16	*Card.*	Aberystwyth	2·31	...
,,	St. Austell, Trevarna	·50	16	,,	Cardigan, County Sch.	1·56	...
Soms.	Chewton Mendip	·65	21	*Brec.*	Crickhowell, Talymaes	1·90	...
,,	Long Ashton	·74	...	*Rad.*	Birm W. W. Tyrmynydd	2·42	63
,,	Street, Millfield	·35	...	*Mont.*	Lake Vyrnwy	·96	27
Glos.	Cirencester, Gwynfa	·23	10	*Denb.*	Llangynhafal	1·79	...
Here.	Ross, Birchlea	·35	18	*Mer.*	Dolgelly, Bryntirion	4·01	94
,,	Ledbury, Underdown	·55	29	*Carn.*	Llandudno	1·74	76
Salop.	Church Stretton	1·43	70	,,	Snowdon, L. Llydaw 9	5·55	...
,,	Shifnal, Hatton Grange	·93	48	*Ang.*	Holyhead, Salt Island	1·61	60
Worc.	Ombersley, Holt Lock	1·00	56	,,	Lligwy	2·38	...
,,	Blockley	·61	...	*Isle of Man*			
War.	Farnborough	·75	35		Douglas, Boro' Cem.	1·00	31
,,	Birminghm, Edgbaston	·90	50	*Guernsey*			
Leics.	Thornton Reservoir	·83	46		St. PeterP't. GrangeRd.	1·82	70

Rainfall: September, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt	Stoneykirk, Ardwell Ho	·94	34	*Suth*	Loch More, Achfary...	11·80	205
,,	Pt. William, Monreith	·74	...	*Caith*	Wick..........	3·52	141
Kirk	Carsphairn, Shiel.......	1·48	...	*Ork*	Pomona, Deerness......	5·94	204
,,	Dumfries, Cargen......	·76	26	*Shet*	Lerwick..........	4·26	142
Dumf.	Eskdalemuir Obs.......	1·43	39	*Cork*	Caheragh Rectory......	...	...
Roxb	Branxholm..........	·50	22	,,	Dunmanway Rectory...	1·25	30
Selk	Ettrick Manse..........	...	...	,,	Ballinacurra..........	1·00	40
Peeb	West Linton..........	·91	...	,,	Glanmire, Lota Lo......	·80	29
Berk	Marchmont House......	·21	9	*Kerry*	Valentia Obsy..........	1·53	37
Hadd.	North Berwick Res......	·28	13	,,	Gearahameen..........	2·20	...
Midl	Edinburgh, Roy. Obs.	·35	19	,,	Killarney Asylum......	1·71	48
Ayr	Kilmarnock, Agric. C.	1·70	56	,,	Darrynane Abbey.......	1·20	34
,,	Girvan, Pinmore.......	1·46	38	*Wat*	Waterford, Brook Lo...	1·50	54
Renf	Glasgow, Queen's Pk..	1·22	44	*Tip*	Nenagh, Cas. Lough...	·89	32
,,	Greenock, Prospect H.	1·86	39	,,	Roscrea, Timoney Park	·62	...
Bute	Rothesay, Ardencraig.	2·24	55	,,	Cashel, Ballinamona...	1·13	46
,,	Dougarie Lodge.........	2·13	...	*Lim*	Foynes, Coolnanes......	·78	27
Arg	Ardgour House.........	8·68	...	,,	Castleconnel Rec.......	·99	...
,,	Manse of Glenorchy...	5·47	...	*Clare*	Inagh, Mount Callan...	2·11	...
,,	Oban..........	3·48	...	,,	Broadford, Hurdlest'n.	1·06	...
,,	Poltalloch..........	3·45	75	*Wexf.*	Newtownbarry	1·11	...
,,	Inveraray Castle.......	4·27	66	,,	Gorey, Courtown Ho...	1·29	52
,,	Islay, Eallabus.........	2·68	64	*Kilk*	Kilkenny Castle.........	·93	40
,,	Mull, Benmore.........	15·70	...	*Wic*	Rathnew, Clonmannon	·67	...
,,	Tiree..........	3·56	...	*Carl*	Hacketstown Rectory..	·98	35
Kinr	Loch Leven Sluice......	·44	17	*Leix*	Blandsfort House......	·64	24
Perth	Loch Dhu..........	2·60	45	,,	Mountmellick..........	·72	...
,,	Balquhidder, Stronvar	...	...	*Off'ly*	Birr Castle..........	·83	36
,,	Crieff, Strathearn Hyd.	·82	29	*Dubl*	Dublin, FitzWm. Sq...	·38	20
,,	Blair Castle Gardens...	1·28	54	,,	Balbriggan, Ardgillan.	·33	16
,,	Dalnaspidal Lodge......	2·99	64	*Me'th*	Beauparc, St. Cloud...	·32	...
Angus.	Kettins School.........	·54	27	,,	Kells, Headfort.........	·97	36
,,	Dundee, E. Necropolis	·65	31	*W.M*	Moate, Coolatore......	1·24	...
,,	Pearsie House..........	1·00	...	,,	Mullingar, Belvedere..	·53	20
,,	Montrose, Sunnyside...	·57	29	*Long*	Castle Forbes Gdns......	1·18	40
Aber	Braemar, Bank.........	1·29	51	*Gal*	Ballynahinch Castle...	2·31	49
,,	Logie Coldstone Sch....	1·18	51	,,	Galway, Grammar Sch.	1·70	...
,,	Aberdeen, King's Coll.	1·28	58	*Mayo*	Mallaranny..........	2·49	...
,,	Fyvie Castle..........	1·76	...	,,	Westport House.........	1·08	30
Moray.	Gordon Castle..........	1·50	60	,,	Delphi Lodge..........	3·40	...
,,	Grantown-on-Spey......	1·37	55	*Sligo*	Markree Obsy..........	1·13	33
Nairn.	Nairn, Delnies	1·79	81	*Cav'n.*	Belturbet, Cloverhill...	1·53	62
Inv	Kingussie, The Birches	1·66	...	*Ferm*	Enniskillen, Portora...	1·48	...
,,	Loch Quoich, Loan......	...	...	*Arm*	Armagh Obsy..........	1·43	58
,,	Glenquoich..........	10·07	117	*Down*	Fofanny Reservoir......	·96	...
,,	Inverness, Culduthel R.	1·93	...	,,	Seaforde..........	·60	22
,,	Arisaig, Faire-na-Squir	6·00	...	,,	Donaghadee, C. Stn...	·80	33
,,	Fort William..........	5·09	...	,,	Banbridge, Milltown...	·69	...
,,	Skye, Dunvegan........	7·66	...	*Antr*	Belfast, Cavehill Rd...	1·10	...
R & C.	Alness, Ardross Cas ...	2·39	80	,,	Glenarm Castle.........	1·16	...
,,	Ullapool..........	5·35	...	,,	Ballymena, Harryville	1·37	44
,,	Torridon, Bendamph...	8·54	123	*Lon*	Londonderry, Creggan	2·24	68
,,	Achnashellach..........	9·23	...	*Tyr*	Donaghmore..........	1·32	...
,,	Stornoway..........	6·19	156	,,	Omagh, Edenfel.........	1·23	40
Suth	Lairg..........	3·75	...	*Don*	Malin Head..........	1·78	...
,,	Tongue..........	4·77	151	,,	Dunfanaghy..........	2·25	...
,,	Melvich..........	8·14	290	,,	Killybegs, Rockmount.	2·58	56

Climatological Table for the British Empire, April, 1929.

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. ½ max. and min. (°F.)	Temp. Diff. from Normal (°F.)	Mean Wet Bulb (°F.)	Relative Humidity (%)	Mean Cloud Am'nt (0—10)	Precip. Am'nt (in.)	Precip. Diff. from Normal (in.)	Precip. Days	Bright Sunshine Hours per day	Bright Sunshine Percentage of possible
London, Kew Obsy.	1015·9	+ 1·5	69	29	52·3	36·9	44·6	− 2·7	38·3	83	7·2	1·07	− 0·38	12	4·9	35
Gibraltar	1013·2	− 3·3	75	49	68·3	56·7	62·5	+ 1·5	55·1	79	5·4	1·55	− 1·13	11	..	..
Malta	1013·9	− 0·1	79	47	64·6	54·0	59·3	− 1·6	53·8	73	3·9	0·50	− 0·36	5	9·6	73
St. Helena	1012·2	+ 2·0	78	58	67·0	60·4	63·7	− 2·1	61·1	92	7·9	1·11	− 2·76	11	..	..
Sierra Leone	1011·0	+ 0·2	92	70	89·1	74·9	82·0	− 0·4	76·5	75	4·0	0·63	− 3·43	3	..	..
Lagos, Nigeria	1011·7	+ 1·9	89	72	87·7	76·4	82·1	− 0·4	77·5	81	7·8	7·04	+ 1·29	9	..	..
Kaduna, Nigeria	1013·4	+ 2·7	99	63	95·0	69·5	82·3	+ 0·8	68·5	47	..	0·49	− 2·80	3	..	..
Zomba, Nyasaland	1013·4	+ 0·9	85	53	73·5	60·5	67·0	− 2·3	..	83	8·5	3·66	0·00	17	..	..
Salisbury, Rhodesia	1013·3	+ 0·4	84	43	76·6	51·8	64·2	− 1·5	57·2	59	1·8	0·08	− 0·91	2	9·9	85
Cape Town	1016·5	+ 0·2	87	46	70·9	54·2	62·5	− 0·7	56·0	84	5·8	3·24	+ 1·37	9	..	..
Johannesburg	1017·3	+ 0·2	76	35	70·2	49·6	59·9	+ 0·1	50·1	59	1·5	2·29	+ 0·55	5	9·8	85
Mauritius	1012·9	− 1·1	84	64	80·4	70·5	75·5	− 0·3	74·5	72	6·5	14·95	+ 10·48	26	5·3	46
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1007·3	+ 1·0	103	66	95·9	77·4	86·7	+ 1·0	77·6	80	4·9	2·05	+ 0·16	2*	..	..
Bombay	1009·0	+ 0·2	95	76	91·8	79·0	85·4	+ 2·3	76·5	73	3·7	0·04	− 0·01	0*	..	..
Madras	1008·8	+ 0·4	94	74	92·8	77·5	85·1	− 0·2	78·0	74	5·4	0·55	+ 0·02	1*	..	..
Colombo, Ceylon	1009·8	+ 0·7	89	72	87·3	74·5	80·9	− 1·7	77·6	77	6·8	18·66	+ 10·36	25	6·5	53
Hongkong	1014·2	+ 1·5	88	61	76·5	67·8	72·1	+ 1.3	66·0	71	6·7	1·54	− 3·76	6	5·7	45
Sandakan	..	..	90	73	87·7	74·9	81·3	− 1·0	77·9	77	..	2·38	− 1·69	10	..	..
Sydney, N.S.W.	1015·6	− 2·9	89	47	73·0	56·8	64·9	+ 0·2	58·3	69	4·3	5·42	− 0·15	7	6·9	61
Melbourne	1015·9	− 3·5	80	40	66·7	51·3	59·0	− 0·5	53·8	71	7·1	3·91	+ 1·66	13	4·8	42
Adelaide	1018·3	− 1·7	89	41	73·0	53·4	63·2	− 0·7	53·5	46	5·5	0·42	− 1·33	6	7·0	63
Perth, W. Australia	1017·7	− 0·8	92	45	73·6	54·9	64·3	− 2·3	57·3	57	4·2	1·20	− 0·38	9	7·7	68
Coolgardie	1017·0	− 1·5	98	41	79·4	50·8	65·1	0·0	53·6	46	2·1	0·00	− 0·95	0	..	..
Brisbane	1015·2	− 2·4	86	47	78·2	59·8	69·0	− 1·3	62·8	69	3·7	9·84	+ 6·25	11	8·1	72
Hobart, Tasmania	1011·2	− 3·3	84	39	63·0	49·2	56·1	+ 1·0	49·3	69	7·9	4·37	+ 2·48	16	3·6	33
Wellington, N.Z.	1014·3	− 3·8	71	41	60·1	50·1	55·1	− 1·8	52·9	82	8·3	6·77	+ 2·89	16	3·7	34
Suva, Fiji	1011·0	+ 0·4	87	69	84·1	72·8	78·5	− 0·2	74·5	79	6·0	13·64	+ 2·36	13	5·3	45
Apia, Samoa	1009·9	0·0	90	73	86·7	74·7	80·7	+ 1·8	78·4	76	2·7	2·03	− 8·21	7	9·1	77
Kingston, Jamaica	1014·6	+ 0·5	91	65	85·7	69·9	77·8	− 0·6	69·2	81	3·4	0·14	− 1·10	3	5·8	46
Grenada, W.I.	1010·3	− 2·1	89	72	86·4	73·8	80·1	+ 1·2	73·5	78	3·0	1·34	− 0·94	11	..	..
Toronto	1012·3	− 3·2	74	21	53·7	37·5	45·6	+ 4·2	39.2	72	6·5	6·21	+ 3·81	19	4·8	36
Winnipeg	1014·0	− 3·0	66	14	50·2	30·1	40·1	+ 2·3	..	..	5·3	1·13	− 0·36	5	6·9	50
St. John, N.B.	1012·9	− 0·7	57	20	44·7	30·8	37·7	− 1·3	33·1	67	6·9	4·66	+ 1·15	15	4·6	34
Victoria, B.C.	1014·8	− 2·5	61	33	51·9	40·0	45·9	− 1·8	43·2	77	6·0	1·13	− 0·60	14	7·2	53

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

M.O. 313.

The Meteorological Magazine

Vol. 64
Nov. 1929
No. 766

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

Meeting of British and South African Associations, Cape Town, July 22nd to 29th, and Johannesburg, July 30th—Aug. 3rd

By SIR GILBERT WALKER, C.S.I., F.R.S.

The meeting of the British Association in South Africa was arranged in a manner different from that of meetings at home. In any section nearly all the time was allotted to a comparatively few representative workers to speak on broad issues in a manner intelligible to the whole section, instead of devoting most of the time to a number of highly technical papers addressed to a few specialists.

Unfortunately Mr. Stewart, the Head of the Meteorological Department of the Union was unable to attend the meeting, and there was only one professional meteorologist from England, so that only two papers were read, one by Professor J. T. Morrison (University, Cape Town) on "The General Circulation of the Atmosphere," and one by the writer of this paper on "Meteorology in Application," in which he tried to bring home the economic value of a properly organised Weather Department. Interest was aroused by a diagram showing that according to the limited information available it is possible to foreshadow the summer rainfall of South Africa outside Natal with a coefficient of 0·58; but in the absence of fully worked-out data, this result can only be regarded as provisional. In a country where a fixed routine is followed such a forecast might have small value, but in South Africa, the solution of the question whether a large or small number of cattle should be sold, or whether crops shall be grown on higher or lower portions of a farm, must be affected by impressions as to the probable

(86853) P.S. 1602/81 1050. 11/29 M. & S. *Gp. 303*

character of the coming season, so that in years when a fairly reliable indication in general terms can be issued, it would appear to have real worth.

After the meetings of the Associations at Cape Town and Johannesburg there were informal Conferences at Salisbury with the meteorological officers of the South Rhodesian Government and at Pretoria with Mr. G. W. Cox, of the Cape Union Meteorological Service, and members of the staff of the Transvaal University College. At both places there was keen scientific interest and appreciation of the importance of meteorological data in connexion with agriculture and irrigation.

The Influence of Explosive Volcanic Eruptions on the Subsequent Pressure Distribution over Western Europe

A well-known paper by A. Defant* traces a connexion between the occurrence of violent eruptions of an explosive type and the subsequent variations in the strength of the atmospheric circulation over the North Atlantic Ocean. According to Defant's results, in the actual year of such an eruption the strength of

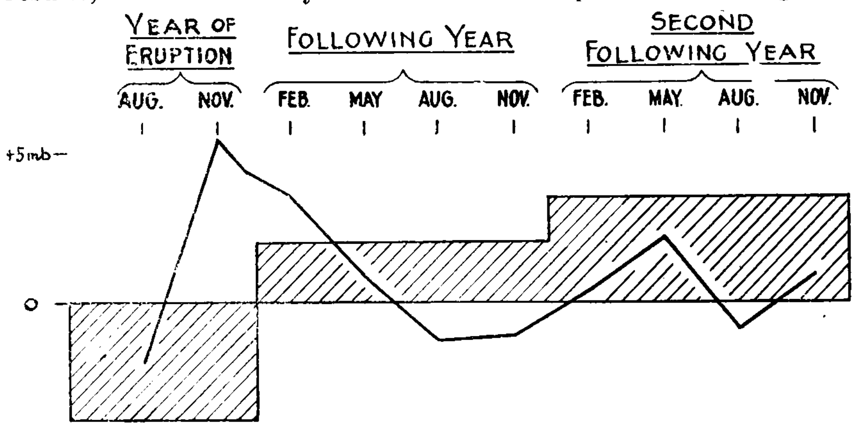


FIG. 1.—Variations in strength of atmospheric circulation following explosive eruption. Shaded area Defant; curve Ponta Delgada – Stykkisholm.

the circulation, measured by the pressure difference between low and high latitudes, is greatly decreased, while in the two following years there is a reaction in the direction of a more vigorous circulation.

If Defant's conclusions are correct, volcanic eruptions may be an important factor in the sequence of weather changes in

* Die Schwankungen der atmosphärischen Zirkulation über dem Nordatlantischen Ozean im 25-jährigen Zeitraum 1881-1905. *Geog. Ann., Stockholm,* 6, 1924, pp. 13-41.

western Europe, and it seemed that the matter was worth further investigation. A list of explosive volcanic eruptions was accordingly prepared, from 1846 to the present day, covering the period for which observations of pressure are available in Iceland. The greater part of this list was taken from a valuable compilation by K. Sapper,* in which the various eruptions were classified according to the quantity of lava and of ash emitted.

In regard to emission of ash, seven series of eruptions of the first order were found within the period :—

Date	*Volcanoes*	*Approximate amount of ash cubic km.*
1875	Askja	1
1883 August	Krakatoa	18
1886 June	Tarawera	1·5
{ 1888	Bandai San	1·2
{ 1888–9	Ritta Island	1·7
{ 1902 May	St. Vincent	1·5
{ 1902 October	St. Maria	5·4
1912 June	Katmai	1
1914	Minami Iwoshima	1

Where the month was not given, it was assumed that the eruption occurred about the middle of the year, and for Stykkisholm and Ponta Delgada the quarterly deviations of pressure from normal were taken out for the second half of the year of eruption and for the two following years, unless another eruption of the first order occurred within that period. The results are shown in table I, and the mean values of the difference Ponta Delgada minus Stykkisholm are shown in figure 1, superposed on a copy of part of an illustration given by Defant to show the variations in the strength of the atmospheric circulation. At first sight it seems that there is little agreement, a surprising result considering that four of the eruptions mentioned above were employed by Defant. It must be remembered, however, that we employed quarterly pressures for two land stations, while Defant employed annual means based ultimately for the most part on marine data. Both curves show an initial weakening of the circulation followed by an increase in intensity, but our more detailed figures suggest that the increase followed more quickly and was over sooner than appears from Defant's illustration.

The partial agreement throws no light on the reality of the phenomenon, which can only be tested statistically, from the similarity or difference of the events following each of the seven eruptions listed. In table I the average difference of pressure from normal at Stykkisholm is 4·2mb. in the quarter October

* Beiträge zur Geographie der tätigen Vulkane. *Zs. Vulkanologie, Berlin,* 3, 1916-7, pp. 150-1.

to December immediately following the eruptions. The standard deviation of the seven values from this average difference is 3·7mb., and the probable error of the difference is therefore ± 1·0mb. The difference from normal is 4·2 times its probable error, and the probability of such a ratio arising by chance in a single trial is one in 200. As, however, table I includes ten quarters, equivalent to ten trials, the probability against the result happening once by chance is reduced to 0·2, or one in twenty, which is only just significant.

We can, however, make use of the fact that there is normally very little relation between the pressure during one quarter and that during the following quarter at Stykkisholm. Hence it is legitimate to employ the differences from normal during the

TABLE I

Date of eruption	1st year Quarters				2nd year Quarters				3rd year Quarters			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.
Stykkisholm												
1875	-	-	+1·3	+3·1	+ 0·1	+0·4	-0·6	+4·0	- 2·9	+3·3	+3·9	-7·7
1883		-	-	-6·7	- 6·4	-0·7	-2·8	-2·6	+ 2·8	-1·1	+0·7	+2·7
1886		-	-3·4	-2·2	- 4·1	+2·7	+2·0	+7·2	+10·9	-	-	-
1888	-	+4·7	+2·6	-9·7	+ 5·7	-4·1	+2·2	-5·2	- 5·6	-1·7	-3·1	-0·8
1902	-	-	+3·9	-3·9	-12·8	+1·7	+1·1	+0·5	- 5·3	-5·6	+0·8	-0·1
1912	-		+4·8	-5·7	- 8·3	-3·9	+2·8	-4·6	- 3·5	-4·0	-	-
1914	-		+0·8	-4·2	+ 2·8	+0·7	+4·7	+6·1	+ 0·4	+1·5	+1·6	+0·7
Mean ..			+1.7	-4·2	- 3·3	-0·5	+1·4	+0·8	- 0·5	-1·3	+0·8	-1·1
Ponta Delgada												
1875			-0·9	-2·2	- 0·4	+3·8	-0·4	-8·0	- 0·9	-3·6	-1·8	+3·1
1883			-	+3·8	- 0·4	-1·6	-0·2	+2·7	- 2·7	+1·3	+0·4	-1·3
1886	-		+1·1	+2·4	- 2·0	-2·7	+0·4	-4·0	- 3·6	-	-	-
1888	-	0·0	-0·9	+0·2	+ 4·9	+1·8	+0·7	+6·0	+ 1·6	+2·7	+2·4	+2·9
1902		-	-1·8	-0·2	+ 0·9	-0·9	+0·7	+2·0	+ 2·0	+1·6	-0·4	-1·6
1912		-	-0·2	+3·6	+ 0·4	+3·1	+0·4	+1·3	+ 0·9	+3·3	-	-
1914	-		+0·7	+0·2	- 2·2	-1·3	-1·1	-2·4	+ 1·1	-0·4	-1·1	-2·2
Mean ..			-0·3	+1·1	+ 0·2	+0·3	+0·1	-0·3	- 0·2	+0·8	-0·1	-0·2

seven quarters October to December and the seven quarters January to March immediately following the eruption as fourteen independent events. The mean difference for these fourteen events is 3·75mb., and its probable error is 0·91mb. The ratio of 4·1 to 1 would also arise by chance only once in 200 trials. It therefore seems probable that there is a real tendency for a violent explosive eruption to be followed during the following six winter months by an intensification of the Icelandic low-pressure area.

The pressure difference Ponta Delgada minus Stykkisholm may be analysed in the same way, and it is found that the average difference from normal in the quarter October to December following the seven eruptions is 5·3mb., with a probable error of 1·4mb., the probability that such a ratio occurring once in ten trials is real is ten to one.

The excess of pressure during the quarter July to September is less certain. The average excess of 1·5mb. is only twice the probable error, and would arise by chance once in five trials. There is therefore a distinct chance that it is accidental.

The deficit of pressure generally persists into the spring quarter (April to June) in the year following the eruption, but with greatly weakened intensity. In one example, however, the deficit continued with little weakening until the end of that year, a period of 15 months. It is perhaps significant that this was the most violent eruption of all, namely, that of Krakatoa in August, 1883, when it is estimated that 18 cubic kilometres of ashes were blown into the air.

On the increase in the strength of the atmospheric circulation in the second year after eruption, shown so markedly in Defant's diagram, the verdict is less certain. The greatest ratio between average difference from normal at Stykkisholm and probable error is less than two, so that the effect might easily arise by chance.

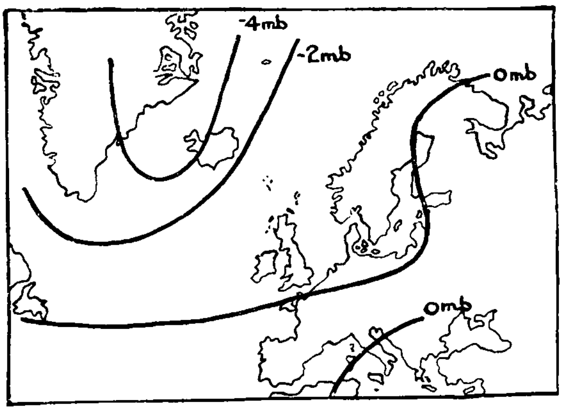


Fig. 2.—Average deviations of pressure from normal October-December following eruptions.

The average deviation of pressure from normal during the quarter October to December following each of the seven eruptions listed is shown in figure 2. It points to a decided increase in the intensity of the Icelandic low and a slight strengthening of the Azores anticyclone. The effect does not resemble very closely any of those due to "local" factors, such as variations in the strength of the Gulf Stream or in the amount of Arctic Ice; it appears to consist purely of an intensification *in situ* of the Icelandic minimum. The corresponding intensification of the Azores anticyclone is probably a secondary effect resulting from the compensation between Iceland and the Azores. The intensification of the Icelandic low is presumably to be attributed to a decrease in the upward lapse of temperature and a resulting increase in storminess.

C. E. P. Brooks.
T. M. Hunt.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings will be:—

November 25th.—*The regeneration of a depression over the North Sea and Baltic Sea.* By Richard Schröder (Leipzig, Geophys. Inst. der Univ. Veröff Ser. 2, Band 4, Heft 2, 1929. pp. 49-116) (in German). *Opener*—Mr. S. F. Witcombe, B.Sc.

December 9th.—*A theory of auroras and magnetic storms.* By H. B. Maris and E. O. Hulburt (Physical Review, Minneapolis, Minn., 33, 1929. pp. 412-31). *Opener*—H. W. L. Absalom, B.Sc., D.I.C.

Royal Meteorological Society

The Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1930 to Dr. G. C. Simpson, F.R.S., Director of the Meteorological Office, Air Ministry. The Medal is awarded for distinguished work in connexion with meteorological science, and will be presented at the annual general meeting on January 15th, 1930.

The Council of the Royal Meteorological Society has awarded the Howard Prize for 1929 to Cadet C. E. Oehley, of S.A.T.S. *General Botha*, South Africa, for the best essay on "Solar and Lunar Halos."

Correspondence

To the Editor, *The Meteorological Magazine*

Summer Thunderstorms

If your correspondent, Mr. R. W. Green, resided in southeast England he would realise that normal cumulo-nimbus can develop at night on a scale comparable to that observed during the day. I refer, of course, to those storms which move northward from the English Channel in connexion with small depressions over the Bay of Biscay. At Cambridge on the night of July 16th this year, a thunderhead was seen to form about 4 miles to the westward at 23h. G.M.T., to tower to a great height, to form an anvil and to produce several heavy discharges to earth. This storm occurred in connexion with one of these small depressions.

On the above occasion a bright moon facilitated observation, and it seems possible that lack of sufficient illumination may be largely responsible for the small number of observations of this type of cloud at night.

C. S. Leaf.

7, Grange Road, Cambridge. October 3rd, 1929.

Smoke from Trees

With reference to Mr. Stanley Single's letter on the above subject, Mr. E. Mann, of Connaught Avenue, East Sheen, Capt.

J. A. Edgell, Assistant Hydrographer to the Navy, and Mr. S. Morris Bower of Manchester, have sent us particulars of analogous instances which support the park-keeper's statement that the apparent " smoke " was actually composed of innumerable insects. We regret that space does not permit us to publish the correspondence in full.

Double Wind Reversal

After the strong wind on Saturday, September 21st, had abated, an interesting spectacle was seen at 6.45 p.m.

Coming from south-southwest direction was a bank of fracto-cumulus clouds at a height of about 3,000 feet; under them were a few scattered cumulus clouds being blown from north-north-east direction about 2,000 feet high, while the smoke of a nearby brickyard chimney was being carried from a south-southwest direction.

L. W. Pye.

Council House, Cleethorpes. September 30th, 1929.

A Direct Vision Dust Counter

According to a note by C. Moran in *Tycos* for October, 1929, a new instrument called a Direct Vision Dust Counter is to be installed at various Weather Bureau Stations in the United States. The instrument consists of a microscope, an air pump, object glasses and mirrors whereby dust from a known quantity of air is collected and counted.

F. J. Whipple.

Sixteenth Century Weather

Mr. Richard Cooke of The Croft, Detling, Maidstone, has sent us the following extracts from Dr. J. C. Cox's book on Chelmsford Church:—

" The serious damage done to the church of Chelmsford by a storm in early Elizabethan days has generally escaped notice. ' The 16th of July 1565 about nine of the clocke at night, began a tempest of lightning and Thunder, with showers of hail, which continued till three of the clocke the next morning, so terrible that at Chelmsford in Essex 500 acres of corn were destroyed: the glasse windowes on the east side of the town and of the west and south sides of the Church were beaten downe with also the tiles of their houses: besides diverse barnes, chimnies and the battlements of the church which were overthrowne. (Stows Annals, 1617, page 568.) ' "

also page 63, 1580

" ' Payed to Boxford the XXVIII of Apperell for 11 boockes of prayers consarning the yerthquacke to be rede in the church Wednesdays and Frydays. VIII d.'

" Note.—An alarming earthquake occurred on April 6 1580 throughout England: it was especially severe in London. Parts of St. Paul's and the Temple Church were cast down, and two apprentices were killed at Christchurch by the fall of a stone. In addition to forms of public prayer to avert God's wrath, a form was also issued to be used by householders with their whole family every evening before going to bed."

The Appearance of the Sun and Moon through a Cloud

In the *Meteorological Magazine* for January, 1929, Mr. C. K. M. Douglas put forward the suggestion that the appearance of the disc of the sun or moon seen through a cloud depends on whether the cloud consists of ice-crystals or water-drops, believing that clouds composed of ice-crystals may give a blurred appearance to the edges of the disc and that clouds composed of water-drops give a sharp appearance, but never a blurred one.

This suggestion seemed one worthy of consideration and one that could readily be put to the test of observation. With this end in view I asked that the Staff of the Meteorological Office at Holyhead should take observations of the sun or moon through clouds whenever this was possible. The request was readily granted and the table hereunder shows the results of the survey for the period March 1st, 1929, to June 30th, 1929. In this table only those occasions when Holyhead reported one type of cloud are taken. In addition, occasions when halos or coronas were reported are treated first, in conjunction with all other occasions, and second, separately.

Cloud type	All occasions			Halo present			Corona present		
	Blurred	Sharp	Very Sharp	Blurred	Sharp	Very Sharp	Blurred	Sharp	Very Sharp
Cirrus	0	6	4	0	0	0	0	0	0
Cirro-stratus	0	26	9	0	14	2	0	0	1
Cirro-cumulus	0	2	0	0	0	0	0	2	0
Alto-stratus	8	2	0	0	0	0	0	0	0
Alto-cumulus	0	4	9	0	0	0	0	0	6
False cirrus	0	1	0	0	0	0	0	0	0
Stratus / Fracto-stratus / Strato-cumulus ...	0	7	4	0	0	0	0	0	0

The table may be allowed to speak for itself. It is to be noticed, however, that alto-stratus cloud alone gives any blurring and this supports Douglas' contention that only ice-crystal clouds are adequate to blur. The point that seems to require more emphasis than was given in the original letter is that thickness is entirely necessary. This is shown by the fact that of 47 cases of cloud of cirrus type, that is to say, of ice structure but thin, none gave any blurring at all.

WILLIAM H. PICK.

33, Brunswick Square, London, W.C.1. July 6th, 1929.

NOTES AND QUERIES

The Level of Underground Water in the Thames Valley.

In the May number of the *Meteorological Magazine* some details were given with regard to the records of the level of underground water at Kew Observatory. It was mentioned that on May 5th, 1929, the minimum reading was 178cm. above mean sea level. The level of the water has fallen month by month since then. The lowest readings for each fortnight are given in the following list:—

Date	Days after new moon	Height above M.S.L. (cm.)	Date	Days after full moon	Height above M.S.L. (cm.)
May 7th	—2	176·6	May 25th	2	173·8
June 8th	1	170·8	June 24th	2	170·2
July 7th	1	165·3	July 24th	3	168·4
Aug. 6th	1	162·4	Aug. 21st	1	163·8
Sept. 4th	2	161·3	Sept. 19th	1	167·3
Oct. 5th	3	161·0			
Nov. 4th	3	154·4			

It will be noticed that the water is generally lowest on the day after new moon. (In May, however, the first minimum preceded the new moon by two days.) There is a rapid rise (averaging 13cm.) in the week after the new moon minimum. The secondary minimum which occurs two days after full moon is followed by a much smaller rise. In June and July the rise was insignificant, only half a centimetre, and in October the secondary minimum did not occur.

Mr. Bilham's analysis* of the records for the summers of the years 1914 and 1915 gave no indication of any striking contrast between the movements of water level in the two halves of a lunar month. He made the two minima fall on the day of new moon and one day after full moon. Mr. Bilham had at his disposal the records of the level of the river at Richmond Lock, and he found that the level at high tide was highest two days after full moon, lowest five days before new moon. Presumably it is because the gravel is being gradually drained during the week of low water in the river that the underground water reaches its lowest stage about the time of new moon. Probably the neap tides of the second half of each lunar month have been exceptionally weak this year.

* *London, Q.J.R. Meteor. Soc.* 44 (1918), *p.* 183.

The notable drop in the water level in October after the end of the drought was unexpected. Whither it is to be explained by some peculiarity of the tides at this season or by the regulation of the flow of the river over Richmond Lock I do not know.

The only periods since the beginning of the record in 1914 with the level below 161cm. above M.S.L. were a few days in September and December, 1921, and a fortnight in January, 1922, when 157cm. was registered.

As to the origin of the underground water an inquiry by Mr. H. G. Lloyd, of the Engineer's Department of the London County Council, led to his taking a sample on June 3rd. The sample was tested by Mr. J. H. Coste, who reported that "The examination of this water gives no indication of the possible flow of water from the river. It is of the general character of water in the Thames Valley." The assumption that the water is continually flowing down stream and is merely dammed back by the tide in the lower river is therefore justified.

F. J. W. WHIPPLE.

A Peculiarity in the Variation of Distribution of the Annual Rainfall

In the course of another investigation it became necessary to find out whether the 35-year means of monthly values of rainfall varied too much for a certain use. Dr. Glasspoole has shown that, in general, the constancy of such means of annual values can be relied upon quite closely.

The variation of the monthly means was found quite large, as shown in table I for Spalding, Lincolnshire, using percentages of the annual means for various 35-year stretches.

TABLE I

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Max.	8·4	6·7	7·7	7·3	8·4	10·0	11·0	11·3	9·6	11·1	9·0	10·0
Min.	6·6	5·6	5·6	5·7	7·0	7·4	9·7	9·8	7·3	9·8	8·2	6·4
Ratio	1·27	1·20	1·38	1·28	1·20	1·35	1·14	1·15	1·32	1·13	1·10	1·56

It was noticed in the case of this station that there was a tendency for months separated by half-year intervals to vary oppositely. This relationship was striking enough that it was felt worth while to compute correlation coefficients to express it, from such stations as have long trustworthy records. The best way to test the relationship appeared to be to compare the rainfall of January in each period, expressed as a percentage of the annual total, with the corresponding figure for July, that of February with August, and so on. From the six sets of figures so obtained one general correlation coefficient for the station was computed. To get sufficient independent points 20-year means were formed. With a rainfall record of 100 years this gave five sets of six pairs of months, or 30 pairs. Where these intervals left remainders of less than 20 years in the recent data, these remainders if greater than ten years were used as additional points. It was assumed that means of different months are independent. This is not quite true, for if one month gains in its percentage of the annual, the others must, on the average, lose a little.

The stations used, the length of the record of each, and the coefficients for the six pairs of months formed as described above are given in table II. In Spalding, for example, there were 30 such pairs used in computing r.

TABLE II

Station	*Years of record*	r
Spalding, Lincolnshire	1829-1928	—0·60
Armagh, Ireland	1854-1928	—0·46
Edinburgh (some early data missing)	1770-1928	—0·40
Greenwich	1815-1928	—0·22
Exeter, Devonshire	1817-1928	—0·04
Start Point, Orkneys	1814-1928	+ 0·04

Certain pairs of months exhibited the negative correlation much more strongly than others. Table III shows the coefficients for each pair, computed from all stations except Start Point, which varied entirely differently.

TABLE III

Month Pair	Jan. July	Feb. Aug.	March Sept.	April Oct.	May Nov.	June Dec.
r	−0·34	+0·03	−0·59	−0·47	−0·01	−0·23

For the five stations there were 162 pairs of months used, giving $r = -0{\cdot}30 \pm 0{\cdot}048$.

The Orkney coefficient would have been —0·15, had the first 20 years been excluded. This part of the record is so far below normal that serious doubt is cast on its accuracy. Combined with the distance of the station from the others there seems evidence sufficient to warrant its exclusion from the mean.

Though it is probably merely an accidental coincidence, it should be noted that the correlation factors become less negative progressively as we go north or south of Spalding.

Many explanations offer themselves for the phenomenon, but at present it is perhaps best to regard it merely as an interesting coincidence which may disappear with longer records. Should it persist, it will be time later to look for causes.

DINSMORE ALTER.

Frequency of Waterspouts in British Waters

Tornadoes and waterspouts are generally looked upon as belonging to or associated with weather phenomena peculiar to the tropical regions. Recent meteorological investigations have tended towards the view that both tornadoes and waterspouts occur under conditions present during or simulating those of a line squall. Should this view be the correct one it is rather striking that so few tornadoes or waterspouts should be reported in the British Isles where line squalls are not infrequent. It may be that tornadoes do occur frequently but on a minor scale in comparison with those of lower latitudes and in sparsely populated localities. With reference to waterspouts, they occur at sea, and have less chance of being observed. In order to arrive at an approximation as to the frequency of waterspouts alone round the British Isles I have been able to trace 16 occurrences since 1920 in the daily press and have obtained two other cases from a collection being made by Mr. Giblett. These 18 cases do not necessarily include all the cases which have occurred during daylight nor even all those which may have been reported in the press. Two of these were observed off the Lancashire coast, four in the North Sea and twelve in the English Channel and the Thames Estuary.

None occurred in the period from January to March in any year, the months of July, August and September accounted for ten, while there were two in each of April, May and October, and one in June and November.

Brief details of the above 16 waterspouts, taken from the daily press are given below and are arranged in order of occurrence :—

1. *Daily Mail*, July 27th, 1920. Observed on July 26th. 1920, off the Kent coast.
2. *Daily Mail*, July 29th, 1920. Observed during the previous 2 or 3 days off the Kent coast, on the North Sea and off the southern coast of France.
3. *Daily Mail*, August 30th, 1920. Observed on the evening of August 29th, 1920, $1\frac{1}{4}$ miles from Blackpool. Storms raged in parts of Blackpool at the same time while other parts of the town escaped.
4. *Daily Mail*, September 8th, 1922. Observed on September 7th, 1922, off the Kent coast between Deal and South Foreland. Five appeared one after another within 75 minutes, the first just after 10 a.m. Each successive one appeared greater than the previous one.
5. *Daily Mail*, July 19th, 1923. Observed on July 18th, 1923, about noon. Two seen from beach at Herne Bay, Kent.
6. *Daily Mail*, August 20th, 1923. Observed on August 18th,

1923, 2 miles out at sea from Brighton; estimated height 700-1,000ft.

7. *Daily Mail*, September 6th, 1923. Observed on September 1st, 1923, over the North Sea. The weather had previously been stormy but was fair at time of occurrence. Caused a wave 40ft. high.
8. *Daily Mail*, May 8th, 1925. Observed on May 7th, 1925, during thunderstorm near Goodwin Sands Lightships. It was travelling in a north-easterly direction.
9. *Morning Post*, April 22nd, 1926. Observed on April 21st, 1926, off Folkestone.
10. *Daily Telegraph*, October 28th, 1926. Observed over North Sea and reported by trawler skipper on arrival at South Shields on October 27th, 1926. Velocity estimated at 40m.p.h. and height as 1,200-1,400ft. As the spout approached the trawler the wind dropped and the spout altered course.
11. *Evening News*, November 6th, 1926. Observed off Sandgate, after thunderclap, on November 6th, 1926. It was followed by whirlwind.
12. *Daily Mail*, September 13th, 1927. Observed on September 11th, 1927, approaching Bootle from north-west.
13. *Morning Post*, April 14th, 1928. Observed on April 13th, 1928, between the Islands of Alderney and Guernsey by a pilot of Imperial Airways Ltd., who described it as being suspended from the flat base of a huge black cloud.
14. *Daily Mail*, June 12th, 1928. Five waterspouts observed at Hayling Island and Isle of Wight on June 11th, 1928. First seen near Nab Tower and travelled towards Spithead.
15. *Daily Chronicle*, August 23rd, 1928. Observed off Woolacombe on August 22nd, 1928. Whirling mass of water from sea to clouds a few minutes after a thundershower—the whirling mass raced from Baggy Point to Morte Point—struck the cliffs—ended in a huge wave.
16. *Daily Mail*, September 26th, 1928. Observed about 4½ miles off Deal on September 25th, 1928. Reported as an immense waterspout with a large rainbow circling its conical shaped top. Remarkable background formed by heavy rolling clouds in which the sun was setting; spout lasted for about 10 minutes.

Of the two other cases mentioned above, one was observed at 4.45 p.m. on August 13th, 1928, off the Dorset coast, and the other on October 6th, 1928, south of Cattewater.

J. Crichton.

[For descriptions of other waterspouts that have been observed round the British Isles, see the *Meteorological Magazine*, Vols. 55-63, 1920-8.—Ed., *M.M.*]

Ink Feed for Instrument Pens of the Crowquill Type

We have received from the Meteorological Office, Heliopolis, particulars of a method suggested by Mr. C. Vaughan-Starr, and adopted at Amman, Trans-Jordan, for ensuring that the crowquill pens fitted to the pressure tube anemograph are kept adequately supplied with ink. A Dines anemograph recording velocity and direction was erected at Amman in 1928 and, at first, great difficulty was experienced in obtaining satisfactory records. The flow of ink from the pens was spasmodic, and loss of record occurred through the ink failing to reach the extreme tips of the recording pens, which were of the usual crowquill type. The problem was finally solved by inserting a second crowquill nib inside the nib which actually traced the record. The point of the second nib came within one-tenth millimetre of the recording point and its function was somewhat similar to that of the ordinary feed fitted to fountain pens. By capillary action between the inner and outer pens, a good supply of ink was maintained at the point of the recording pen and a uniform flow of ink was obtained. Before fitting the feed nib, it was thoroughly cleaned free of grease, and the cylindrical portion was squeezed so as to make one edge of its split overlap the other, and the point of the feed nib was then pushed through the cylindrical part of the writing nib, keeping the two splits of the two nibs in alignment. With this arrangement good records were obtained for days at a time without attention to the pens.

The requirements of the pressure tube anemographs are exceptionally severe so far as the recording pens are concerned, and custodians of these instruments will welcome the description of a method which appears to have given very satisfactory results under unusually trying conditions.

Mr. Starr has also reported that improved recording has been obtained by rubbing the charts with a piece of muslin dipped in French chalk. This preparation counteracts any slight greasiness tending to prevent the ink flowing freely on to the paper.

Experience at home stations has shown that slight greasiness of the pen is the main trouble in obtaining good marking. The practice has been to advise custodians to prepare new pens for anemographs by holding them for a moment in the flame of a match and then dipping the points in the recording ink while still hot. This procedure, followed if necessary by pressure on the points to open them out slightly, usually suffices to make the pen work well. Mr. E. S. Tunstall has recently informed us that the same result can be obtained by dipping new pens in a weak solution of sulphuric acid and then carefully washing off the acid.

The Chilean Meteorological Service

The Chilean Government announces the reorganisation of meteorological services of the country under the name of "Chilean Weather Office," which will be a branch of the Ministry of Marine. The old "Central Meteorological and Geophysical Institute" will be incorporated in the new service.

A regular series of publications will be issued, including a daily weather bulletin, while observations and forecasts will be broadcast daily, and in addition full meteorological information will be given when required for international flights.

Reviews

Die Regeneration einer Zyklone über Nord-und Ostsee. By Richard Schröder, Leipzig. Veröff. Geoph. Inst. Univ. 2nd Series. Vol. iv, Part 2. pp. 49-116. 1929.

This publication is based on a very detailed examination of the synoptic data for the period September 29th to October 3rd, 1912, carried out on the lines of the Bergen School. Observations from over 1,000 stations were used, including autographic records from about 150 stations, and also upper air data on October 2nd and 3rd. A number of barograms and thermograms are reproduced. It would have been an improvement to have included some anemometer records, but these were evidently scarce on the Continent in 1912.

The problem dealt with is the important one of the "regeneration" of a cyclonic depression. The simplest type of depression has a period of deepening of about one to three days, followed by a period of dissolution of about two to five days, after the warm sector has been displaced. Some depressions, however, have a much longer life history, owing to one or more "regenerations." The example discussed in the paper had two such "regenerations." The first of these took place over England and the southern North Sea between September 30th and October 1st, and was due to a new centre forming further south and amalgamating with the old centre. This is a common development whose real character may escape detection unless the network of observations is fairly close. The second regeneration was of a less common type, and took place over southern Sweden and the Baltic during the night of October 1st. It was due to a fresh burst of polar air from the north, much colder than the maritime polar air surrounding the old depression. The air circulation round a typical old depression is of a type not easily penetrated by new masses of air from outside, except in a shallow layer near the ground, where the influence of surface friction is large. In the present instance the cold current cut across the isobars into the centre of the depression, and formed a large temperature discontinuity, where formerly there had been none.

At one place the temperature fell 7°C. (13°F.) in about an hour. The regeneration of the depression followed at once, and pressure at the centre dropped from 980 to 965mb. during the night of October 1st. The new warm sector was itself displaced within 24 hours, and the depression then filled up. It is important to know to what extent the movement across the isobars was confined to the lower layers under the influence of surface friction. Unfortunately there were no upper air observations north of the centre, so that the vital point remains undetermined. The sounding balloon observations were all 500 miles or more from the centre on its southern side.

The latter part of the paper is devoted to a detailed discussion of the supply of energy. Reasons are given for supposing that the increased kinetic energy during the regeneration was supplied by the displacement of the warmer by the colder air mass, according to Margules's well-known scheme, but in the absence of the necessary upper air data many assumptions have to be made. This part of the paper is open to criticism in several respects.

The work under review gives us probably the most detailed investigation yet made of a cyclonic depression, but it might with advantage have been shorter. One is impressed by the fact that even the completest possible examination of a well-chosen case leaves us far short of that knowledge of the life history of a depression in three dimensions, required to form the basis of any important advance in synoptic meteorology.

C. K. M. DOUGLAS.

Spitsbergen Papers, Volume 2. Scientific Results of the Second and Third Oxford University Expeditions to Spitsbergen in 1923 and 1924. Size 10 x 7in. *Illus.* H. Milford, Oxford University Press, London, 1929. 30s. net.

This volume consists of a series of 25 excerpts from various scientific periodicals, such as the *Geographical Journal* and the *Quarterly Journal of the Geological Society*, bound together in one volume with a short preface. The sources of the papers are not all of a uniform size, and the appearance of the volume is in consequence somewhat ragged, but it will be a great convenience to students of the Arctic to have all the various papers collected in this way. The book is thus a weighty argument in favour of the policy, advocated by Mr. J. F. Pownall in his book on "Organised Publication" (London, 1926), of a standard size for scientific publications to replace the innumerable shapes and sizes at present collected under the general term "octavo."

The series contains three papers definitely dealing with the meteorological results. Capt. F. Tymms describes the general results of the meteorological observations in an appendix to a paper by Mr. F. G. Binney in the *Geographical Journal*. Associated with this are two very interesting papers by the same author on "Aerial Navigation in the Arctic" and "Aerial Survey." The second paper, No. 7 in the list of contents, is a summary reprinted from the *Meteorological Magazine*, vol. 60, p. 187. The third meteorological paper is by Mr. K. S. Sandford, entitled: "Summer in North-East Land, 1924: the Climate and Surface Changes," and is from the *Geographical Journal*. It contains a remarkable study of the surface wind directions over the ice sheet in relation to changes of pressure, the general winds, except those associated with very deep depressions, being modified or "cushioned off" by the air over the cap of ice. The wind system is therefore described as "a type of 'intermittent glacial anticyclone'." Great interest attaches also to the discovery on August 8th of numerous living insects in North-East Land, which were subsequently shown to have been carried by the wind a distance of at least 800 miles from the forest belt of northern Europe.

The Climate of the Netherlands Indies. Vol. II, Part 2, *Java and Madoera*, and Part 3, *The Archipelago without Sumatra and Java.* By C. Braak. K. Magn. Meteor. Obs., Batavia, Verh. No. 8. Size 11 × 7½in. English Summaries. *Illus.*, Batavia, 1928.

In previous numbers of the *Meteorological Magazine* we have noticed the first or general volume of *The Climate of the Netherlands Indies* and the first part of the second volume, dealing with Sumatra. The second part, Java and Madoera, surpasses even the high standard of the earlier sections, and Dr. Braak is to be congratulated on the thoroughness and completeness of the work. Java is not a very large island, being only 600 miles long by 40 to 120 wide, but the amount of material available was so great that even in a volume of this size (the Dutch text alone runs to 243 pages) it was impossible to use all the stations. As in previous parts, there is a very full English summary, almost a translation, running to 116 pages, with references to the tables in the Dutch text. The style of the English is a testimonial to the author's linguistic ability, and the following passage shows its vigour and attractiveness:—

"Another phenomenon of the dry season is the haze, which covers the blue sky with a whitish tint, obstructs the view and envelopes the distant mountains in a bluish veil or makes them invisible, obliterating at the same time the fresh colours of the landscape. Who wants to see Java at its best and is not afraid of a bit of rain should see it in the west monsoon, or better still, in the months following it, before the really dry season, when the transparent air gives full credit to the colour effects of the luxurious landscape."

The volume opens with a description of the monsoons and local winds, but for the most part the treatment is particular, the generalisations having been set out in the first volume. The islands are divided up into a number of sections or representative stations—Batavia, Buitenzorg, Mount Gedeh-Pangerango, &c., and the climate of each is set out in detail, with a wealth of tables. The section dealing with the Royal Observatory at Batavia is naturally the most complete, covering 25 pages, with no fewer than 18 tables showing the annual and diurnal variations of the means and extremes—a mine of reference. A curious diagram facing page 196 shows that temperature at Batavia has a rough periodicity of eleven years, being high at sunspot minimum and low at sunspot maximum. This cyclic variation is, however, dominated by a remarkable secular rise, as a result of which the coldest year since 1895 has been warmer than the warmest year before 1895. The author states that the cause of this rise of temperature is unknown. A similar rise has been in progress at St. Helena, and (until the present year) in the winter temperature of western Europe, and it seems probable that all three are to be attributed to some slow change in the general circulation.

The tables are amplified by the frequent reproductions of thermograms and hygrograms, which are of very great interest. Incidentally one wonders whether the inclusion on page 221 of a hygrogram from the summit of Mount Pangerango was due to a sense of humour or to the absence of such a sense, coupled with a desire for completeness. The humidity curve is a straight horizontal line at 100 per cent. These mountain stations, at heights up to 10,000ft., are an important part of the network, and are very thoroughly equipped.

In addition to the meteorograms, the work is illustrated by a number of very fine photographs. A series of notable interest is that facing page 275, taken from a high level station at intervals from 7 a.m. to 9 a.m., which shows the gradual break up of a sheet of fog in the valley beneath, and the simultaneous formation of cumulus clouds above the surrounding mountains. Details of this nature, possibly only to the man on the spot, clothe the dry bones of meteorological statistics with living flesh, and instil them with the breath of life.

Part 3 completes the second volume of Dr. Braak's excellent treatise on the climate of the Dutch East Indies, the area described including Borneo, the smaller islands eastward thereof and part of New Guinea. For the scattered islands the observational material is less complete and is supplemented by ships' observations and by information from the sailing directions; the result is a remarkably detailed account of the climate of the region in question.

Indexes to the Dutch and English parts of Vol. II are included. These are very complete, "local winds," for example, giving some twenty entries, several of which refer to winds of föhn type. An interesting effect of the föhn appears in the results of pilot balloon ascents at Koepang. There the assumption of a constant rate of ascent leads to abnormally high wind velocities up to about 3,000 feet during the east monsoon, the balloons being " pulled down by the descending movement of the wind." The wind circulation at the surface during the monsoons is illustrated on a map of the area large enough to be really useful.

Some of the mountain peaks of New Guinea rise to a height of over 15,000 feet, " the eternal snow, though an attractive and remarkable phenomenon in a tropical country, covers a very small area only."

Dr. Braak's work may be regarded as indispensable in any study of equatorial climate.

Books Received

Observations des Stations Météorologiques du Réseau de l'Observatoire Geophysique à l'Orient Lointain. Année 1916. Vladivostok, 1928.

Résumés mensuels et annuels des Observations Météorologiques faites aux Stations de 11 *ordre du Réseau de l'Observatoire Geophysique à l'Orient Lointain.* Année 1917. Vladivostok, 1928.

Obituary

We regret to learn of the death of Cav. Prof. Ludovico Marini on October 6th, 1929, after a long illness. He was professor of terrestrial physics at the Universities of Rome and Naples and had published many valuable papers on the climatology of the Mediterranean, among which may be mentioned Charts of pressure and winds over the Mediterranean Basin and Climatic Notes on the principal coastal towns of the Adriatic.

We regret to learn of the death of Professor Polis, director of the Meteorological Observatory at Aachen.

We regret to learn of the death on October 9th at Iombar, Guildford, of Mr. Elliott Kitchener, formerly of Rugby and of the Golden Parsonage Preparatory School, aged 63 years.

The Weather of October, 1929

The weather of October was mainly unsettled with rainfall above normal except in the eastern districts and sunshine above normal except in the extreme west. Pressure, too, was below normal over the whole country, the deficit amounting to 9.0mb. at Aberdeen and 3.4mb. at Kew. The month opened with a 9-day spell of generally unsettled stormy weather; rain fell on most days, but there were many bright intervals, for example, Aberdeen had 9.9hrs. bright sunshine on the 2nd, Durham 9.9hrs. on the 3rd and Cork 9.6hrs. on the 6th. Gales occurred in Scotland and Ireland on the 2nd and 3rd and in England on the 5th and 6th, when the rainfall was unusually heavy; 4·00 in. fell at Goytre (Monmouth), 3·81 in. at Holne (Devon), and 3·56 at Wheddon Cross (Somerset) on the 5th. A further moderately heavy rainfall with a southerly gale occurred in the south on the night of the 7th-8th. Thunderstorms were reported from numerous places over the country generally on the 2nd to 6th and from southern England on the 8th. From the 9th to 17th an anticyclone to the south of the British Isles brought fairer weather to the southern districts generally and also on a few days to the north and west as well although these areas remained chiefly under the influence of depressions centred further north. Many hours' bright sunshine was recorded on the 11th and 14th over the country generally, but rainfall was heavy in Ireland on the 10th and in Scotland on the 13th and 16th. During the first half of the month temperature was somewhat above normal for that period maxima ranging between 55°F. and 65°F., while 67° was recorded at Greenwich on the 16th. On the 18th, however, in the rear of a depression moving east there was a sharp fall of temperature and hereafter maxima were generally below 60°F. and even fell to 41°F. at Inverness, Fort Augustus and Stonyhurst on the 25th. Minimum temperatures on the ground fell to 20°F. and below at several places on the 19th and 25th-27th, 12°F. being reached at Burnley on the 26th and 27th. On the 20th and 21st a deep depression moved south over the country giving rain generally and northwesterly gales on our western coasts. At Scilly force 9 (49m.p.h.) was registered at 1h. on the 21st. This was followed by an interval of fair to fine weather but on the evening of the 23rd and on the 24th moderate rain again occurred over the kingdom generally and gales were experienced at most exposed places in southern England. Thunderstorms were reported from various parts of England on the 25th and snow was seen on the hills above 800ft. locally in Scotland. For the rest of the month the weather was unsettled with bright intervals.

Pressure was below normal over the whole of northern and western Europe, Spitsbergen and Iceland, the greatest deficits being 9·8mb. at Aberdeen and Utsire (Norway), and above normal over most of the North Atlantic, the Iberian Peninsula and southern Italy, the greatest excess being 5·2mb. at Horta. Temperature was above normal generally and rainfall below normal except in parts of Sweden and of the British Isles. In central Sweden the rainfall was twice the normal.

Heavy rain occurred in Switzerland on the 5th, heavy gales in western Norway on the 6th and gales and heavy rain followed by local floods in France on the 6th. On the same day, after six weeks of fine weather a cloudburst was reported from the Italian Riviera where there were several landslides; parts of Savona were flooded. Bad weather continued throughout Italy the next day when the neighbourhood of Genoa and parts of Sardinia were flooded. Heavy rain fell in Switzerland on the 9th and 10th causing the rivers to rise and extinguishing the forest fires on the Calanda. Snow fell on the Little and Great St. Bernard passes on the 8th and on the Alpine regions of Switzerland generally on the 10th. In consequence of a storm in the eastern Baltic the river Neva overflowed its banks at Leningrad on the 15th and much damage has resulted. Thunderstorms occurred on the Riviera on the 18th and in various parts of France on the 19th and 20th and a heavy fall of snow was reported from the Vosges on the 21st. A severe gale swept across the Gulf of Genoa on the 26th and storms were experienced off north-west France on the 26th and 27th. Gales were experienced near Salonika on the 30th.

A violent storm struck the suburbs of Turffontein and Kenilworth (South Africa) on the 6th. Three people were seriously injured and the roofs were blown off hundreds of houses.

Storms were experienced in Western Australia on the 5th.

Severe gales occurred on the Great Lakes on the 21st-22nd and on the 29th and dense fog on the 30th. Blizzards swept across New Mexico and Arizona on the 28th-29th. Temperature was generally below normal over the United States during the first fortnight but after this it rose above normal. Heavy rain occurred in the Atlantic States during the first week, in the Mississippi-Missouri region during the second and in the south Atlantic States during the third week. The river Uruguay flood interrupted train services between Buenos Aires and Asuncion on the 23rd.

The special message from Brazil states that the rainfall was scarce in the northern regions with 0·20in. below normal, very scarce in the central regions with 2·13in. below normal, while the distribution was irregular in the southern regions with 0·16in. below normal. Seven anticyclones passed across the country. Crops were generally in good condition except for the cane and tobacco crops of some regions which were suffering from lack of rain. At Rio de Janeiro pressure was 0·6mb. below normal and temperature 2·9°F. above normal.

Rainfall, October, 1929.—General Distribution

England and Wales	120	per cent. of the average 1881-1915.
Scotland	144	
Ireland	127	
British Isles	128	

Rainfall: October, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square.........	2·72	103	*Leics* .	Belvoir Castle...........	2·70	100
Sur .	Reigate, Alvington.....	3·71	...	*Rut* .	Ridlington..............	3·15	...
Kent .	Tenterden, Ashenden...	3·28	94	*Linc* .	Boston, Skirbeck........	2·70	98
,, .	Folkestone, Boro. San..	3·92	...	,, .	Lincoln..................	2·59	101
,, .	Margate, Cliftonville...	2·83	97	,, .	Skegness, Marine Gdns	2·29	84
,, .	Sevenoaks, Speldhurst	3·36	...	,, .	Louth, Westgate........	2·73	84
Sus .	Patching Farm.........	4·90	124	,, .	Brigg, Wrawby St.....	3·56	...
,, .	Brighton, Old Steyne..	3·41	88	*Notts* .	Worksop, Hodsock.....	3·07	117
,, .	Heathfield, Barklye....	4·69	113	*Derby* .	Derby, L. M. & S. Rly.	3·06	117
Hants .	Ventnor, Roy. Nat. Hos.	5·56	141	,, .	Buxton, Devon Hos....	6·59	134
,, .	Fordingbridge, Oaklnds	5·15	124	*Ches* .	Runcorn, Weston Pt...	5·21	151
,, .	Ovington Rectory.......	...	...	,, .	Nantwich, Dorfold Hall	5·87	...
,, .	Sherborne St. John.....	3·45	98	*Lancs* .	Manchester, Whit. Pk.	5·17	157
Berks .	Wellington College.....	2·50	76	,, .	Stonyhurst College.....	6·74	150
,, .	Newbury, Greenham...	3·26	93	,, .	Southport, Hesketh Pk	4·52	128
Herts .	Welwyn Garden City...	2·52	...	,, .	Lancaster, Strathspey	6·10	...
Bucks .	High Wycombe.........	3·95	126	*Yorks* .	Wath-upon-Dearne.....	2·40	87
Oxf . .	Oxford, Mag. College..	2·97	106	,, .	Bradford, Lister Pk....	3·63	104
Nor .	Pitsford, Sedgebrook...	2·98	111	,, .	Oughtershaw Hall......	9·81	...
,, .	Oundle..................	2·37	...	,, .	Wetherby, Ribston H.	2·21	74
Beds .	Woburn, Crawley Mill	3·19	119	,, .	Hull, Pearson Park.....	2·10	70
Cam .	Cambridge, Bot. Gdns.	2·83	120	,, .	Holme-on-Spalding.....	2·56	...
Essex .	Chelmsford, CountyLab	3·47	141	,, .	West Witton, Ivy Ho.	4·38	...
,, .	Lexden Hill House....	2·67	...	,, .	Felixkirk, Mt. St. John	2·73	95
Suff .	Hawkedon Rectory.....	2·89	107	,, .	Pickering, Hungate....	2·36	...
,, .	Haughley House........	2·67	...	,, .	Scarborough............	1·82	58
Norf .	Norwich, Eaton.........	3·19	102	,, .	Middlesbrough..........	2·22	74
,, .	Wells, Holkham Hall	...	...	,, .	Baldersdale, Hury Res.	...	...
,, .	Little Dunham..........	3·43	110	*Durh* .	Ushaw College..........	2·02	59
Wilts .	Devizes, Highclere......	4·30	138	*Nor* .	Newcastle, Town Moor	1·73	54
,, .	Bishops Cannings.......	4·61	139	,, .	Bellingham, Highgreen	3·73	...
Dor .	Evershot, Melbury Ho.	6·35	137	,, .	Lilburn Tower Gdns....	2·78	...
,, .	Creech Grange..........	4·85	...	*Cumb* .	Geltsdale................	5·69	...
,, .	Shaftesbury, Abbey Ho.	4·38	112	,, .	Carlisle, Scaleby Hall	4·50	135
Devon .	Plymouth, The Hoe...	5·93	150	,, .	Borrowdale, Seathwaite	18·25	152
,, .	Polapit Tamar..........	7·91	165	,, .	Borrowdale, Rosthwaite	13·57	...
,, .	Ashburton, Druid Ho.	8·48	140	,, .	Keswick, High Hill.....	7·53	...
,, .	Cullompton..............	5·92	143	*Glam* .	Cardiff, Ely P. Stn.....	6·32	132
,, .	Sidmouth, Sidmount...	4·37	117	,, .	Treherbert, Tynywaun	13·72	...
,, .	Filleigh, Castle Hill....	7·99	...	*Carm* .	Carmarthen Friary.....	8·04	141
,, .	Barnstaple.N.Dev.Ath.	6·49	143	,, .	Llanwrda................	9·01	142
Corn .	Redruth, Trewirgie.....	8·65	165	*Pemb* .	Haverfordwest, School	6·96	129
,, .	Penzance, Morrab Gdn.	7·16	153	*Card* .	Aberystwyth............	7·72	...
,, .	St. Austell, Trevarna...	8·70	165	,, .	Cardigan, County Sch.	6·65	...
Soms .	Chewton Mendip.......	7·96	165	*Brec* .	Crickhowell, Talymaes	7·30	...
,, .	Long Ashton............	6·76	...	*Rad* .	BirmW.W.Tyrmynydd	8·62	130
,, .	Street, Millfield	4·70	...	*Mont* .	Lake Vyrnwy...........	7·92	137
Glos. .	Cirencester, Gwynfa....	4·40	133	*Denb* .	Llangynhafal............	4·49	...
Here .	Ross, Birchlea...........	4·83	146	*Mer* .	Dolgelly, Bryntirion...	10·18	194
,, .	Ledbury, Underdown..	4·21	137	*Carn* .	Llandudno...............	4·19	117
Salop .	Church Stretton........	4·04	111	,, .	Snowdon, L. Llydaw 9	23·05	...
,, .	Shifnal, Hatton Grange	3·66	129	*Ang* .	Holyhead, Salt Island	6·16	154
Worc .	Ombersley, Holt Lock	3·67	137	,, .	Lligwy....................	4·69	...
,, .	Blockley..................	4·08	...	*Isle of Man*			
War .	Farnborough............	3·14	99		Douglas, Boro' Cem....	7·73	170
,, .	Birminghm, Edgbaston	4·11	83	*Guernsey*			
Leics .	Thornton Reservoir....	3·86	137		St. PeterP't. GrangeRd.	5·84	130

Rainfall: October, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	5·47	151	*Suth* .	Loch More, Achfary...	14·76	189
,, .	Pt. William, Monreith	6·65	...	*Caith* .	Wick....................	4·41	149
Kirk .	Carsphairn, Shiel.......	10·26	...	*Ork* .	Pomona, Deerness......	6·13	162
,, .	Dumfries, Cargen......	6·43	147	*Shet* .	Lerwick	8·70	220
Dumf.	Eskdalemuir Obs.......	6·89	128	*Cork* .	Caheragh Rectory......	6·35	...
Roxb .	Branxholm	3·66	113	,, .	Dunmanway Rectory...	5·82	97
Selk .	Ettrick Manse...........	...	...	,, .	Ballinacurra..............	3·02	74
Peeb .	West Linton............	4·56	...	,, .	Glanmire, Lota Lo......	3·58	86
Berk .	Marchmont House......	2·90	76	*Kerry*.	Valentia Obsy..........	6·29	113
Hadd.	North Berwick Res.....	2·25	76	,, .	Gearahameen.............	11·30	...
Midl .	Edinburgh, Roy. Obs.	3·05	117	,, .	Killarney Asylum......	...	...
Ayr .	Kilmarnock, Agric. C.	5·07	144	,, .	Darrynane Abbey.......	6·00	119
,, .	Girvan, Pinmore..	6·51	130	*Wat* .	Waterford, Brook Lo...	3·41	87
Renf .	Glasgow, Queen's Pk. .	5·08	156	*Tip* .	Nenagh, Cas. Lough...	5·63	166
,, .	Greenock, Prospect H.	8·78	163	,, .	Roscrea, Timoney Park	4·24	...
Bute .	Rothesay, Ardencraig.	7·66	174	,, .	Cashel, Ballinamona...	3·60	100
,, .	Dougarie Lodge.........	5·32	...	*Lim* .	Foynes, Coolnanes......	5·15	136
Arg .	Ardgour House	16·24	...	,, .	Castleconnel Rec.......	5·02	...
,, .	Manse of Glenorchy...	13·05	...	*Clare* .	Inagh, Mount Callan...	9·80	...
,, .	Oban......................	8·95	...	,, .	Broadford, Hurdlest'n.	5·68	...
,, .	Poltalloch	8·53	173	*Wexf*.	Newtownbarry	...	...
,, .	Inveraray Castle...	12·65	180	,, .	Gorey, Courtown Ho...	3·37	95
,, .	Islay, Eallabus.........	9·21	193	*Kilk* .	Kilkenny Castle.........	3·05	97
,, .	Mull, Benmore.........	12·50	...	*Wic* .	Rathnew, Clonmannon	2·45	...
,, .	Tiree	7·05	...	*Carl* .	Hacketstown Rectory..	3·88	102
Kinr .	Loch Leven Sluice......	3·75	109	*Leix* .	Blandsfort House......	4·05	115
Perth .	Loch Dhu...............	10·00	140	,, .	Mountmellick...........	4·87	...
,, .	Balquhidder, Stronvar	8·77	...	*Off'ly* .	Birr Castle..............	4·06	139
,, .	Crieff, Strathearn Hyd.	5·37	137	*Dubl* .	Dublin, FitzWm. Sq...	2·38	89
,, .	Blair Castle Gardens...	4·17	134	,, .	Balbriggan, Ardgillan.	2·85	106
,, .	Dalnaspidal Lodge.....	10·29	180	*Me'th* .	Beauparc, St. Cloud...	3·29	...
Angus.	Kettins School.	3·73	131	,, .	Kells, Headfort.........	4·69	140
,, .	Dundee, E. Necropolis	2·86	107	*W.M* .	Moate, Coolatore......	4·40	...
,, .	Pearsie House...........	3·85	...	,, .	Mullingar, Belvedere..	5·21	167
,, .	Montrose, Sunnyside...	2·73	99	*Long* .	Castle Forbes Gdns......	4·76	146
Aber .	Braemar, Bank...	3·72	99	*Gal* .	Ballynahinch Castle...	7·68	128
,, .	Logie Coldstone Sch....	2·34	72	,, .	Galway, Grammar Sch.	5·30	...
,, .	Aberdeen, King's Coll.	3·20	107	*Mayo* .	Mallaranny..............	3·88	...
,, .	Fyvie Castle.............	4·41	...	,, .	Westport House.........	5·07	113
Moray.	Gordon Castle...........	3·49	110	,, .	Delphi Lodge............	11·94	...
,, .	Grantown-on-Spey......	4·30	145	*Sligo* .	Markree Obsy............	5·67	138
Nairn.	Nairn, Delnies	3·41	145	*Cav'n* .	Belturbet, Cloverhill...	5·40	186
Inv .	Kingussie, The Birches	4·89	...	*Ferm* .	Enniskillen, Portora...	4·36	...
,, .	Loch Quoich, Loan.....	...	...	*Arm* .	Armagh Obsy...........	5·55	202
,, .	Glenquoich..............	23·84	239	*Down* .	Fofanny Reservoir......	6·74	...
,, .	Inverness, Culduthel R.	3·55	...	,, .	Seaforde..................	3·84	108
,, .	Arisaig, Faire-na-Squir	9·21	...	,, .	Donaghadee, C. Stn...	3·45	119
,, .	Fort William...........	13·97	...	,, .	Banbridge, Milltown...	2·89	...
,, .	Skye, Dunvegan........	9·80	...	*Antr* .	Belfast, Cavehill Rd...	4·86	...
R & C.	Alness, Ardross Cas ...	4·87	126	,, .	Glenarm Castle.........	6·23	...
,, .	Ullapool	8·17	...	,, .	Ballymena, Harryville	6·75	183
,, .	Torridon, Bendamph...	13·86	173	*Lon* .	Londonderry, Creggan	5·55	151
,, .	Achnashellach..........	16·02	...	*Tyr* .	Donaghmore.............	6·96	...
,, .	Stornoway...............	7·61	147	,, .	Omagh, Edenfel.........	6·00	163
Suth .	Lairg.....................	4·78	...	*Don* .	Malin Head..............	5·18	...
,, .	Tongue	7·04	167	,, .	Dunfanaghy.............	4·64	...
,, .	Melvich..................	8·26	222	,, .	Killybegs, Rockmount.	7·95	142

Climatological Table for the British Empire, May, 1929.

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.	1015·9	0·0	81	31	63·1	45·0	54·1	+ 0·7	47·0	80	5·9	1·27	− 0·45	11	7·9	50
Gibraltar	1016·9	+ 0·8	80	45	72·8	56·2	64·5	− 1·0	54·9	76	3·5	0·18	− 1·55	3	..	..
Malta	1013·4	− 1·6	84	54	69·6	60·0	64·8	− 1·1	60·0	78	4·0	0·30*	− 0·11	1	10·1	72
St. Helena	1013·3	+ 2·1	67	56	63·8	58·1	60·9	− 2·7	60·4	97	8·3	3·11	− 1·04	15	..	..
Sierra Leone	1011·2	0·0	90	70	86·8	74·3	80·5	− 1·0	77·3	82	3·3	8·44	− 3·03	19	..	..
Lagos, Nigeria	1012·1	+ 1·1	89	70	86·0	76·0	81·0	− 0·8	77·3	83	8·3	10·78	+ 0·31	20	..	..
Kaduna, Nigeria	1013·7	+ 0·6	96	..	91·0	..	..	..	69·2	54	..	4·29	− 1·65	12	..	..
Zomba, Nyasaland	1015·0	− 0·1	84	50	75·9	56·0	65·9	+ 0·1	..	71	4·4	0·35	− 0·69	2	..	..
Salisbury, Rhodesia	1016·1	+ 0·3	83	43	74·6	48·4	61·5	+ 0·9	54·7	55	1·8	0·26	− 0·28	4	8·8	78
Cape Town	1018·4	+ 0·4	85	44	64·9	52·4	58·7	− 0·2	53·5	90	6·8	2·31	− 1·44	10	..	..
Johannesburg	1019·3	+ 0·3	75	38	66·4	48·5	57·5	+ 3·1	47·3	55	2·1	1·22	+ 0·46	4	9·1	83
Mauritius	1015·5	− 0·9	80	60	77·5	66·6	72·1	− 0·5	69·4	76	4·7	8·02	+ 4·99	19	7·3	65
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1002·9	− 0·6	102	73	97·5	81·3	89·4	+ 3·4	81·0	79	5·2	1·54	− 4·21	4*	..	..
Bombay	1007·3	− 0·1	95	80	93·2	82·2	87·7	+ 1·8	79·1	73	3·5	0·00	− 0·55	0*	..	..
Madras	1004·8	− 0·6	108	75	99·4	81·8	90·6	+ 0·7	78·6	63	4·5	0·75	− 0·32	1*	..	..
Colombo, Ceylon	1009·2	+ 0·6	88	69	86·8	77·5	82·1	− 0·4	78·6	79	8·5	15·46	+ 2·78	23	5·0	40
Hongkong	1008·7	− 0·7	90	67	82·6	75·0	78·8	+ 1·4	74·9	82	8·4	6·62	− 4·98	17	5·0	38
Sandakan	..	..	90	73	88·4	75·6	82·0	− 0·6	78·3	83	..	13·31	+ 7·40	13	..	..
Sydney, N.S.W.	1018·4	− 0·2	80	47	66·3	51·8	59·1	+ 0·3	53·0	76	4·3	10·35	+ 5·22	13	6·1	58
Melbourne	1019·2	− 0·3	72	36	62·0	46·3	54·1	0·0	49·3	79	7·2	1·85	− 0·33	18	4·5	45
Adelaide	1020·0	− 0·1	79	42	66·6	49·8	58·2	+ 0·3	50·4	58	6·3	1·40	− 1·36	14	4·7	46
Perth, W. Australia	1015·0	− 3·5	77	46	66·5	53·2	59·9	− 0·7	54·6	73	7·2	11·50	+ 6·56	22	4·4	42
Coolgardie	1016·7	− 3·1	87	41	66·3	48·5	57·4	− 0·2	51·2	70	5·6	2·84	+ 1·48	10	..	..
Brisbane	1018·4	− 0·4	82	47	72·6	53·0	62·8	− 1·7	55·8	65	3·2	0·42	− 2·41	4	8·2	77
Hobart, Tasmania	1017·1	+ 1·5	74	36	58·1	45·3	51·7	+ 1·3	46·1	75	6·4	1·58	− 0·28	14	4·3	44
Wellington, N.Z.	1019·2	+ 3·6	65	39	56·0	45·0	50·5	− 2·2	48·1	80	5·1	3·48	− 1·20	11	5·4	55
Suva, Fiji	1011·9	− 0·9	86	66	82·1	72·3	77·2	+ 0·7	73·7	80	6·4	6·84	− 3·32	17	3·9	35
Apia, Samoa	1010·5	− 0·6	89	69	85·5	74·2	79·8	+ 1·4	76·7	71	4·0	4·51	− 1·00	15	7·3	63
Kingston, Jamaica	1014·6	+ 1·5	89	68	87·3	71·5	79·4	− 0·3	70·9	77	4·9	0·63	− 3·76	7	5·1	39
Grenada, W.I.	1010·0	− 2·5	90	71	85·6	73·0	79·3	− 0·3	73·5	80	5·3	8·56	+ 3·97	24	..	..
Toronto	1016·6	+ 1·8	91	33	62·2	43·8	53·0	+ 0·3	46·0	60	5·0	3·77	+ 0·79	12	7·2	49
Winnipeg	1017·0	+ 2·7	83	22	59·0	36·4	47·7	− 3·9	..	..	6·0	2·69	+ 0·39	8	7·7	50
St. John, N.B.	1016·3	+ 2·3	68	33	56·4	40·8	48·6	+ 0·9	44·0	68	6·1	4·23	+ 0·52	16	6·7	45
Victoria, B.C.	1018·6	+ 2·2	71	42	58·9	45·6	52·3	− 0·8	48·7	81	5·8	0·95	− 0·35	8	8·9	59

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

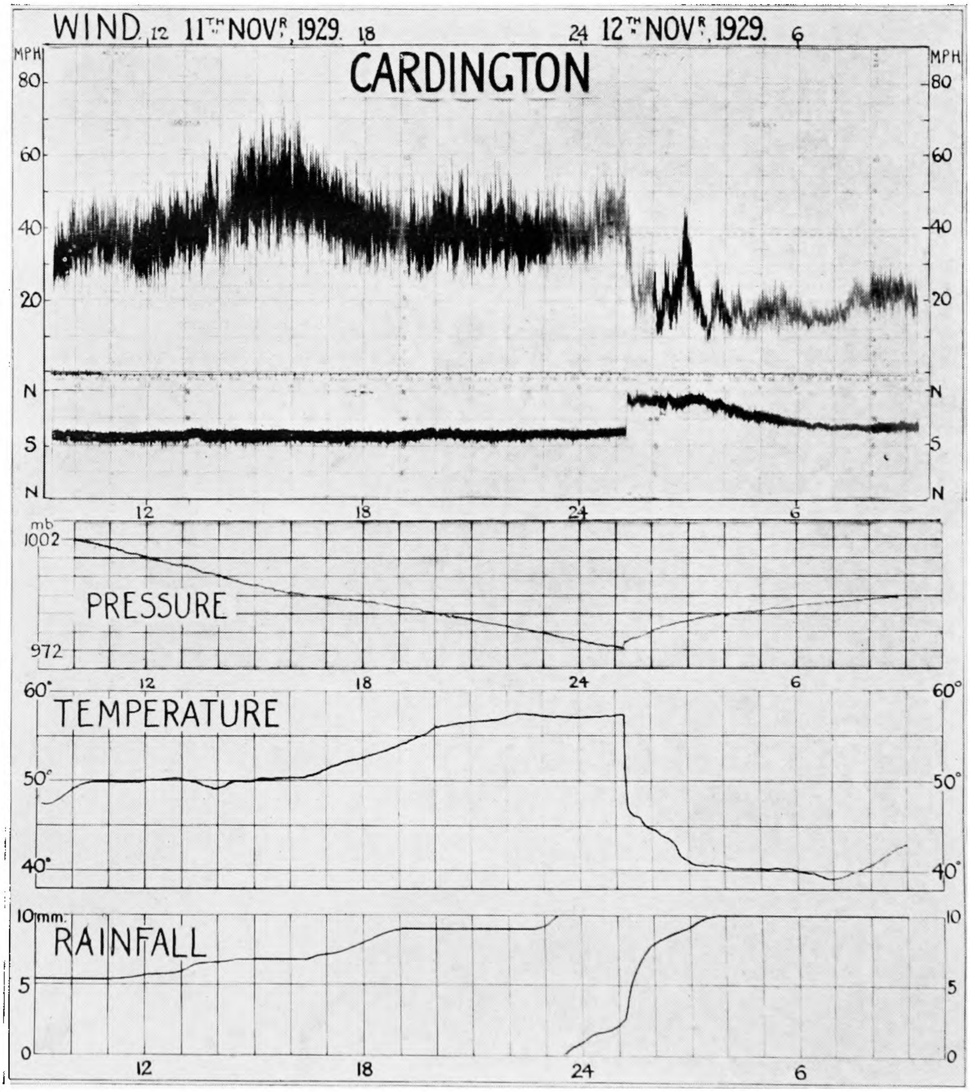


FIG. 1—Autographic Records at Cardington, Nov. 11th—12th, 1929.

M.O. 313.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 64

Dec. 1929

No. 767

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

The Storm of November 11th—12th, 1929

By H. W. L. ABSALOM, B.Sc., D.I.C.

Over the British Isles generally the weather of Armistice Day, 1929, was the wildest experienced on that anniversary since its inception. Strong winds and gales accompanied by considerable falls of rain occurred in most districts. The very special associations of the day itself and the loss of life, loss of and damage to property on both land and sea resulting from the storm ensure the occasion a place in public memory. Meditations on "A Night of Storm" form the subject of a characteristically elegant and erudite leading article in *The Times* of November 13th.

During Sunday, November 10th, relatively cold air spread eastwards over the country, and at 6 p.m. G.M.T. barometric pressure had still an upward tendency even in extreme western districts. Although the rather scanty weather information received from the Atlantic at 1 p.m. and 6 p.m. indicated that a fresh depression would affect us before long, there was no very definite evidence of the great activity which was revealed subsequently. At 1 a.m. on November 11th a strong southwesterly wind and a brisk fall in pressure were reported from the southwest of Ireland, and the synoptic chart suggested that a depression was centred probably not less than 400 miles southwest of the Hebrides. The main centre, travelling at 50 or 60 miles per hour on a northeasterly course reached the Hebrides at

(87260) P.S. 1602/81 1,050 12/29 M. & S. *Gp.303*

about 1 p.m. and the Shetlands by 6 p.m., while between 7 a.m. and 6 p.m. the barometric pressure at the centre decreased by probably more than 15 millibars. During the forenoon pressure fell at the rate of from 10 to 15 millibars in three hours in northern England and in Scotland. In the course of the day a secondary depression arrived from the west giving rise to a considerable trough-like extension of the main depression. The passage of this trough across the country during the night hours was associated with a noteworthy example of a line squall.

Strong winds or gales from a southwesterly direction occurred in most districts, except perhaps in the northern half of Scotland. The gale was of relatively short duration in the southwest of Ireland and ceased before 10 a.m. With the advance of the depression the wind increased generally and had reached gale force at places on the east coast of England by the early afternoon. The gale lasted for 13, 14 and 16 hours respectively at Lympne, Falmouth and Scilly. Gusts well above 50 miles per hour were registered at several places. The highest gusts which have come to notice are those of 82 and 83 m.p.h. at Scilly and Cardington (see Fig. 1), respectively. Other stations at which a momentary speed of 70 m.p.h. or more occurred are Falmouth and Holyhead. At Falmouth the average speed was between 50 and 60 m.p.h. from 10 a.m. to 1 p.m.

The day was sunless apart from small amounts of sunshine in the morning in the southeastern districts of England. Rain commenced late on the 10th in the southwest of Ireland, extending to Wales and the western parts of England and Scotland, reached London by 11 a.m. and continued to spread eastwards. During the storm rain fell in all parts of the country, though locally in eastern districts of Scotland and in northeastern England the amounts were comparatively small. In southern and western districts falls of between one and two inches were of fairly general occurrence. Heavier falls occurred locally, *e.g.*, in south Wales, resulting in disastrous floods. An outstanding fall of 8·3 inches in twenty-four hours is reported from Mardy Reservoir, Glamorgan. Mr. R. G. C. Sandeman, Dan-y-Park, Crickhowell, south Wales, writes that between 9 a.m. and 10 p.m. the reading of the barometer decreased from 29·8 to 28·975 inches. He says: "It rained in torrents at that time (10 p.m.); I have only once seen such a downpour. The River Usk rose during the night to a height which I think is a record for about 30 years. The valley was like a sea, the peak of the flood being reached about 7 a.m. on the 12th. The raingauge showed 2·02 inches."

The depression had a considerable warm sector, the warm air at ground level reaching western Ireland an hour or two after 7 a.m. and the western districts of England, Wales and Scotland early in the afternoon, by which time somewhat cooler air had spread over northern and western parts of Ireland.

The approximate positions of the boundaries, at ground level, between the chief air masses at 6 p.m. are shown by broken lines in Fig. 2, A denoting the warm and B the cold front. As a result of the sweep of the warm air across the country temperature reached a high level for the season, maximum readings between 55° and 60°F. being numerous, while 60°F. was exceeded locally in north Wales and northwest England. In most parts of England and Wales the highest temperature was registered during the night hours of the 11th-12th shortly or immediately before the arrival of the cold air in the rear of the trough line.

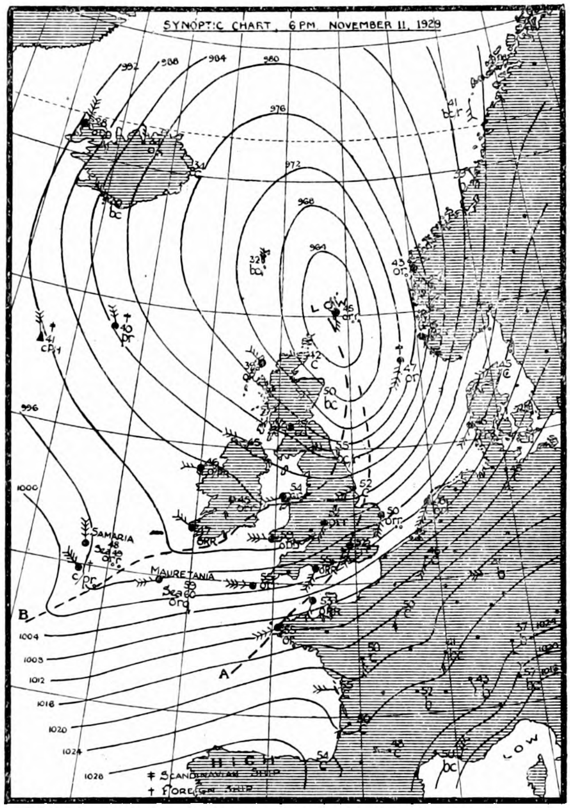


FIG. 2.

During the night hours the trough of low pressure became sharper than is indicated in Fig. 2 and at places in the Midlands and in the southern districts of England the transition from the warm to the invading cold air was marked by a sudden and considerable veer in wind direction, a rapid fall in temperature and an abrupt rise in barometric pressure. The times of passing of the cold front as shown by those autographic records which have been examined were: Cranwell, 10.30 p.m.; Scilly, 10.50 p.m.; Falmouth, 11.27 p.m.; Cardington, 1.10 a.m.; Calshot, 1.47 a.m.; Croydon, 2.25 a.m.; Felixstowe, 2.57 a.m.; Lympne, 3.40 a.m. The front thus passed in a general southeasterly direction across the country, the rate of travel being greater in southwestern than in eastern districts. By 7 a.m. on the 12th this front extended from west of Denmark through northern Holland to Belgium and northwestern France.

The autographic records obtained at Cardington, where the sequence of changes during the storm were typical in main features of those at many places in England, are reproduced in Fig. 1, the wind record being that of the anemometer at 150 feet above the ground. As the cold front passed this station the wind veered from southwest to northnorthwest in the course of a very few minutes and the average speed decreased from about 45 to about 25 m.p.h; temperature fell 11°F. in about fifteen minutes and a further 6°F. by 3 a.m.; pressure rose 1·8 millibars in about two minutes and an additional millibar in the ensuing eight minutes; the rate of precipitation, part of which was in the form of hail, was accelerated. Reference has been made in the daily press to the effects of this line squall on the airship R.101, which was riding at the mooring tower at Cardington.

Serious loss was sustained during the gale by the Scottish fishing fleet whilst off East Anglia. Lives and drifters were lost after the onset of the southsouthwesterly gale on the afternoon of the 11th, and events consequent upon the sudden veer of wind during the night hours resulted in the loss of nets valued at tens of thousands of pounds sterling.

It was stated in an evening journal that the Thames tide was unusually low during the latter part of November 11th. Similar occurrences in association with strong southwesterly winds over the North Sea are noted in a recent memoir by Dr. Doodson and Mr. J. S. Dines on floods and high tides in the Thames.* From information kindly supplied by the Port of London Authority it seems that at Tower Pier low water on the afternoon of the 11th was one foot below the predicted value and of much longer duration than usual, and that at the succeeding high water in the evening the level was as much as 6 feet 4 inches lower than that predicted.

Raingauges in Winter

By E. G. Bilham, B.Sc., D.I.C.

With the onset of winter every rainfall observer is liable to be confronted with difficulties which do not arise at other seasons. Snow and frost each bring their own problems, but it is with the latter that it is desired to deal more particularly in the present note. Methods of dealing with the occasions when the observer finds his gauge full of snow are described in official publications such as the *Observer's Handbook* and *Rules for Rainfall Observers*, and no doubt every experienced observer has adopted his own special methods of meeting such a contingency. It is hardly possible to say anything new on this aspect of the subject. There are, however, other winter problms on which some remarks may be profitable.

We may consider, first, the problem of combating the effects of frost on mountain raingauges, visited only once a month. Here we are not concerned with the problem of measuring a

* *Geophysical Memoirs*, No. 47.

month's precipitation, some or all of which may be in the form of snow, but of protecting the gauge itself from damage. The worst case will be that in which heavy rain during the early part of the month is followed by intense frost. The normal result in these circumstances is that the expansion of the water in freezing bursts the seams of the can. In March, 1928, Mr. F. Hudleston, of Hutton John, Penrith, suggested that this type of accident might be prevented by corrugating the sides of the can, with a view to giving it a certain amount of freedom to expand under the pressure. A can with corrugated sides was constructed and tested by filling it with water and subjecting it to freezing temperatures down to 18° F. The can survived five tests of this kind, but failed at the sixth attempt, when the sides bulged and the joints started. It occurred to the present writer that a can built on the lines of an elongated domestic bucket might prove better. One was made of heavy galvanised iron with riveted joints. It was 18 inches high and tapered from a diameter of 7·5 inches at the top to 5 inches at the bottom. The tests were applied as before and the results were similar; the seams burst and the rivets were forced apart. The can was repaired and strengthened by strapping a steel band round it half way up, but it again failed to survive the tests.

At this stage information was received with regard to a successful device used by Dr. F. J. W. Whipple, at Kew Observatory to protect glass water containers in Stevenson screens from fracture by frost. The device consists simply of a length of rubber tubing inserted in the container, in the water, the ends of the tubing being above the water level and open to the air. When the water freezes, the expansion simply causes the rubber tube to be pressed flat and the pressure on the container is thus relieved. It was decided to try this device in a raingauge can. A sufficient length of ½-inch rubber tubing to give an air space equal to ten per cent. of the capacity was inserted in the can of an ordinary 5-inch copper gauge with the two open ends projecting from the top. Freezing tests down to zero Fahrenheit were then applied. The result was completely successful, neither the can nor the rubber tubing showing any signs of injury.

We seem, therefore, to have arrived at a method by means of which damage to mountain or other gauges by frost can be completely prevented. When we seek to apply the method in practice, however, certain difficulties appear. In the Bradford gauge, the can has a closed top with small apertures for the admission of the funnel tube and dip rod, and for pouring out the water. The introduction of a considerable length of rubber tubing, free from kinks, is almost impracticable unless a considerable portion of the top is cut away. Again, the adherence of water to the tubing is likely to introduce appreciable errors of measurement and the dip rod cannot be used unless the tubing is taken out before measurement. The Seathwaite gauge, in which the can is open at the top, is easier to deal with, and it would be a simple matter to design a frame on which the tubing would be permanently wound, but there still would be the undesirable feature of the large mass of metal and rubber to which water drops would adhere.

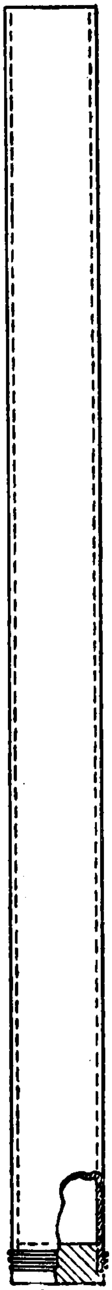


FIG. 1.

On consideration, it seems probable that the least objectionable form of " frost protector " would be that sketched in Fig. 1. It consists simply of a length of stout rubber hosing secured at the bottom to a lead plug heavy enough to keep it under water. The internal cross sectional area of the tube must be one-tenth the cross sectional area of the can. For a Bradford gauge the internal diameter works out at 1·4 inches, and the lead plug should weigh about $1\frac{1}{4}$ lbs. The joint between the plug and the tube must be absolutely watertight, and the tube itself must be stout enough not to collapse under the pressure of the water. The length should be about one inch more than the height of the can. The plate at the top of the can must be cut away to admit the tube, and as the tube will project through the hole so formed, no other support should be necessary. A device of this kind can readily be made locally and it would be interesting to learn the results obtained by observers who decide to try it.

The next problem for consideration is that of running a self-recording raingauge (or " rain recorder " as we now prefer to call it) in wintry weather. Here we are faced with two quite distinct questions: (*a*) the protection of the recorder from damage; (*b*) the conversion of solid precipitation into water in order that its rate of fall and duration may be recorded just as if it were rain. The latter includes the former, because if we are able to heat the gauge so effectively that snow is converted into water as fast as it falls, the main source of damage (the freezing of the contents of the gauge) is eliminated. It is, however, of great importance that excessive heating be avoided otherwise evaporation will occur. There can be no doubt that electrical heating is the form to use wherever possible. By so doing numerous difficulties which arise in connexion with lamps and night-lights are avoided. These difficulties include smoking of the flame, over- or under-heating and extinction of the flame by wind or by the accumulation of products of combustion. Assuming that electric current is available, the best procedure is to mount the recorder in a wooden case to which access may be gained by means of a weather-proof lid or door. This case should be so designed that (*a*) the funnel projects above it about a foot to avoid errors due to insplashing of rain; and (*b*) the base of the recorder is elevated just sufficiently above the floor of the case to permit of the insertion of an electric lamp plugged into a "batten" holder mounted on a small wooden block. The electric line should be brought up to a wall socket and switch screwed to the inside of the case, and the lamp mount should have a short length of waterproof twin cable terminating in a plug. An ordinary 40-watt or 60-watt lamp will be found capable of giving sufficient heat to keep the inside of the gauge well above freezing point. In severe weather snow may remain unmelted round the rim of the gauge. This cannot be cured without heating up the whole recorder to an undesirable extent, and must, therefore, be endured. The simple arrangement described above will prove effective provided the observer is able to attend and switch on the lamp when circumstances justify it. It would be possible, and not very difficult, to arrange for the lamp to be switched on automatically when the temperature fell to freezing point. To obtain the necessary "quick break" it would be necessary to employ a relay which might be operated by a bimetallic spiral.

If electric current is not available, the whole problem becomes vastly more difficult. Trials of various lamps have been made, but the results have not justified an official recommendation in favour of any particular type or make. It is felt that individual observers must have accumulated much useful data on this point, and it would be of great value to have particulars of any lamp which has been found really effective. Unfortunately, certain lamps which have been designed for the protection of motor-car radiators are too large for the present purpose, though otherwise suitable. In the meanwhile, commercial night-lights burning for 14 hours seem to be the least objectionable form of heater.

In the absence of some heating arrangement, it is very desirable that water should not be left in the float chamber of a rain recorder during frosty weather. Observers having such instruments are advised, therefore, to make a practice of starting each morning with the gauge empty and the recording pen at zero. With natural syphon recorders this can be done by pouring in just sufficient water to make the syphon operate before putting on the new chart.

The Relations between Annual Rainfall and the Average Amount of Cloud

Rainfall is associated with cloud, and without fear of contradiction one can make the general statement that the greater the cloudiness the heavier is likely to be the annual rainfall. Beyond that the relation between the average cloudiness of any particular locality and its average rainfall does not seem ever to have been investigated. Dr. G. C. Simpson accordingly suggested that a brief examination of the question on broad lines would serve a useful purpose.

The investigation must obviously be limited to land areas, and in order to ensure that the data selected as a basis should have a fairly uniform distribution, one station was selected for each ten-degree square from the network employed in the Réseau Mondial, the average cloudiness in tenths and hundredths being written down against the average rainfall in units of 50 millimetres. In addition, a few blank squares were filled by including stations not in the Réseau Mondial. For each ten-degree zone in which at least 15 stations were available the best-fitting equation was then calculated in the form

$$R = a + bC + cC^2$$

where R is the annual rainfall in millimetres and C the cloudiness in tenths of the sky. The values of c proved however to be small and very irregular—5 were positive, 1 zero and 4 negative—and the equations were re-calculated omitting the third term. The constants a, b, and the number of stations employed in each zone are shown in table 1.

TABLE 1.—VALUES OF THE CONSTANTS a AND b IN THE EQUATION $R = a + bC$.

Zone of Latitude. N.	No. of Stations.	a	b	Zone of Latitude. S.	No. of Stations	a	b
70-60	22	+ 37	70	70-60	—	—	—
60-50	25	—381	173	60-50	—	—	—
50-40	21	—609	240	50-40	—	—	—
40-30	22	—416	265	40-30	—	—	—
30-20	18	—400	290	30-20	17	—289	267
20-10	18	—595	370	20-10	20	+353	205
10- 0	19	+617	257	10- 0	17	+557	175

The values of a are rather irregular; positive values occur between 10° N. and 20° S. latitude, and again from 60 to 70° N., while in the intermediate zones the values are negative. Over the whole area from 70° N. to 30° S. the average value is -113. A positive value of a implies that a fairly heavy rainfall occurs even when the average cloudiness is small, while a negative value implies that the cloudiness may be considerable without giving any appreciable rainfall.

The constant b is on the whole more regular, and varies comparatively little with latitude; the values, as would be expected, are all positive, and an increase of one-tenth of the sky covered is roughly equivalent to an increase of about 240 millimetres of rainfall. The fact that the coefficients of C^2 in the full equations proved to be small shows that this increase is fairly constant whatever the cloudiness. It is, however, obvious that the equations cannot apply in extremely wet areas. The values of the constants *a* and *b* are plotted in Figs. 1 and 2. Finally, the

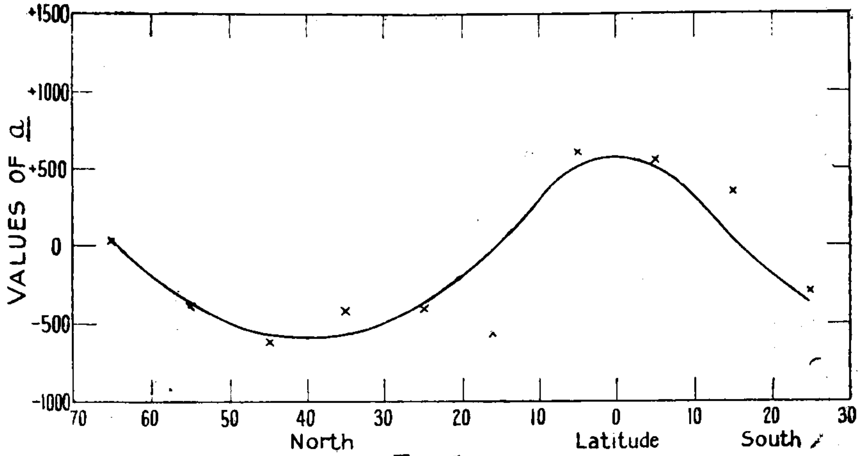


FIG. 1.

smooth curves represent an attempt to smooth the data by general equations connecting the constants with the latitude.

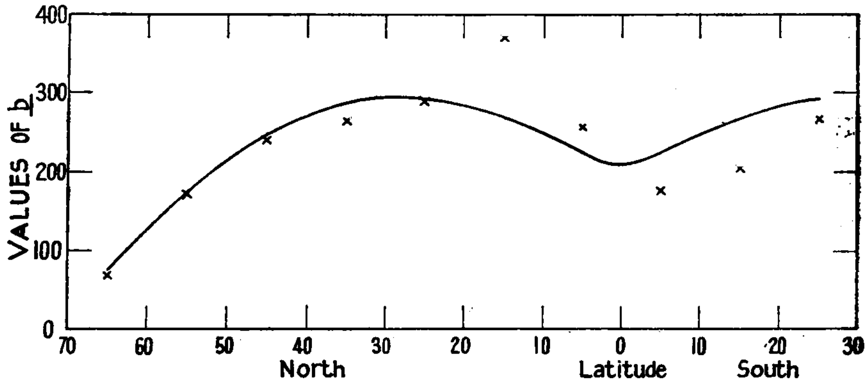


FIG. 2

Since the constant *a* obviously reaches a minimum about latitude 45°, these general equations must include a term 2ϕ, where ϕ is the latitude. The equations deduced were:—

$$a = 770 + 835 \sin\phi - 1930 \sin 2\phi$$
$$b = 203 - 445 \sin\phi + 360 \sin 2\phi$$

The following figures give the rainfall in each latitude, employing values of the constants *a* and *b* calculated from these equations, corresponding with a cloudiness of five tenths:—

Latitude	65	55	45	35	25	15	5
Rainfall ... ... (in millimetres)	420	520	670	870	1100	1360	1630

The values of the mean rainfall over the land, calculated from the mean cloudiness and the smoothed constants *a* and *b* are shown in table 2. For comparison is given the average rainfall

TABLE 2.—RAINFALL OVER THE LAND, CALCULATED FROM CLOUDINESS, AND ESTIMATED BY KERNER.

Zone of Latitude. N.	Rainfall. Calculated.	Rainfall. Estimated.	Zone of Latitude. S.	Rainfall. Calculated.	Rainfall. Estimated.
70-60	509	380	70-60	—	—
60-50	691	560	60-50	—	—
50-40	670	600	50-40	868	870
40-30	582	600	40-30	812	675
30-20	630	630	30-20	746	690
20-10	1092	1010	20-10	1253	1190
10- 0	1674	1680	10- 0	1808	1790

over the land, obtained from a paper by F. Kerner.* It will be noticed that the calculated rainfall is on the whole in excess of the estimated amounts, but the differences nowhere reach 150mm.

C. E. P. BROOKS.

OFFICIAL PUBLICATIONS

PROFESSIONAL NOTES—

No. 52. *Bumpiness on the Cairo-Basra Air Route.* By J. Durward, M.A. (M.O. 2731).

Everybody who has been on the sea is familiar with the sensation caused by the motion of the boat as it rises and falls on the waves. Travellers by air become accustomed to a rather different sensation which, to the air pilot, is known as a "bump." This sensation is due to the involuntary rise or fall of the aeroplane as it flies through the air, caused by up and downward currents in the atmosphere. Unlike the motion of a boat, however, bumps are irregular, and for this reason many people, on whom sea travel has an adverse effect, find no discomfort in flying, even on a relative bumpy day.

Some interesting facts regarding bumpiness on the Cairo-Basra section of the England-India air route are brought out in this paper by J. Durward of the Meteorological Office, Heliopolis. The data are based on the reports of pilots of Imperial Airways Ltd., who fly regularly along this route. An analysis of these reports has enabled the author to compare the various subsections of the route between Cairo and Basra as regards bumpiness, and also to discuss the relation which bumpiness bears to the time of day at which flying takes place, and to special meteorological conditions. The route between Baghdad and Basra lies over the Mesopotamian desert and as this route is subject to dust and sand storms, one would expect flying to be

*Revision der zonaren Niederschlagsverteilung. *Wien, Mitt. K.K. Geogr. Ges.*, 1907, pp. 139-64.

very bumpy. The report, however, is reassuring from this point of view. In fact, the author finds that the worst part of the route from the point of view of bumpiness is the belt of country known as Trans-Jordan, where the surface is very irregular and, owing to its nature, readily becomes heated by the sun's rays during the day. Even along this portion of the route there may be complete absence of bumps in certain meteorological conditions. Speaking generally the air is more bumpy near the ground, and frequently the pilot is able to avoid the bumps altogether by climbing to a sufficient height. On occasions, however, the air is found to be bumpy, even at a height of 12,000ft. Interest is added to the paper by references to particular experiences of individual pilots.

Discussions at the Meteorological Office

The subjects for discussion for the next meeting will be:—

January 13th.—*The distribution of excessive precipitation in the United States.* By A. J. Henry (Washington, D.C., Monthly Weath. Rev., 56, 1928, pp. 355-363); and *The weather map story of the flooding rainstorm of New England and adjoining regions, November 3rd-4th,* 1927. By J. H. Weber and C. F. Brooks (New London, Conn., J. New England Water Works Ass., 42, 1928, pp. 91-103). *Opener*—Prof. Dinsmore Alter.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, November 20th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, D.Sc., President, in the Chair.

M. G. Bennett, M.Sc.—The physical conditions controlling visibility through the atmosphere.

In this paper, a theory is developed to show how the visibility of an object is affected by the optical properties of the matter suspended in the air between the observer and the object; and this theory received experimental verification from a series of special observations carried out at Leafield and Cranwell. The theory, briefly, may be described thus. The visibility of any (large) object is a function of its brightness, and its contrast with the background. When dispersed matter is introduced between the observer and object, the apparent values of these variables are modified, and thus the visibility is altered. The modification is the result of three different processes, the relative importance of which depends on the circumstances. These processes are: (1) Screening or absorption, (2) Glare or superposition of scattered light, (3) Diffusion or reduction of definition.

The experimental work was a matter of determining the data involved in this theory, so that certain conclusions could be drawn, which could be tested in practice. As an example of such conclusions, the following may be quoted. It was deduced that the obscuring power of a cloud of opaque (carbon) particles was mainly due to screening, whilst that due to water drops was due to diffusion. This should result in a certain difference between the falling off of visibility of an object as an observer recedes from it in a dry dusty atmosphere, as compared with a humid clean atmosphere. This difference was satisfactorily verified by the observations at Leafield.

L. F. Richardson, D.Sc., F.R.S.—The reflectivity of woodland, fields and suburbs between London and St. Albans.

The paper gives a record of measurements made from aeroplanes, using a white-wedge photometer, showing the reflectivity of different types of surface—woodland, bare earth, standing wheat and a water surface, for red, green and blue.

Thora C. Marwick.—The electric charge on rain.

The paper describes the method used to measure the electric charge on rain and gives the results obtained over a period of several months. These are briefly as follows:—Thunderstorm rain showed a high positive charge per cubic centimetre. Of the total quantity observed 94·6 per cent was positively charged. Non-thunderstorm rain showed a lower charge per cubic centimetre and a lower percentage of positively charged rain, 79·5 per cent. Hail and rain mixed showed a large excess of negatively charged drops, 39·4 per cent of the total quantity being positive. The charge per cubic centimetre was approximately the same as for non-thunderstorm rain.

Correspondence

To the Editor, *The Meteorological Magazine*

A Peculiarity in the Variation of Distribution of the Annual Rainfall

With reference to the letter on the above subject on p. 234 of the November magazine, Mr. Alter might with advantage give a short explanation to make it clear that the result is not merely another way of expressing that the spring months are usually dry and the autumn months wet. As it stands at present the article leaves that impression in the reader's mind.

E. Gold.

It should be stated explicitly that the correlations were based on the variations of the means of twenty year stretches for each of the months, from the means of the same months for other twenty year stretches. The fact that March might have 8 per cent. of the annual rainfall and September 10 per cent. would have no bearing, but if when March decreased to 7 per cent., September increased its percentage during the same twenty years there would be established a negative correlation. If such a negative relationship held consistently, the one month increasing its percentage during any given twenty years and the other decreasing, the negative correlation coefficient would be high. This was found to be true in general.

DINSMORE ALTER.

Summer Thunderstorms

With reference to the correspondence under the above title in the October and November magazines, surely the question is sufficiently answered by the strong tendency there undoubtedly is for thunderstorms in hot weather to develop at night. It is in cool weather that thunderstorms only very rarely occur in the night; and it is the habit of mixing up all types of storm together that has caused so much stress to be laid upon the statistical afternoon maximum. Statistics are very necessary, but they undoubtedly cover a multitude of sins!

L. C. W. BONACINA.

27, Tanza Road, Hampstead. November 21st, 1929.

Smoking Sea

On November 1st, 2nd and 4th the sea on the south side of Mount Batten presented the appearance of smoking or steaming, and the steam produced accumulated to a mist or fog over the sea. The time of observation was 7h.

The formation of this mist or fog appears to bear a similarity to that off the Newfoundland Banks for the sea temperature was between 50°F. and 55°F. and the air temperature between 34°F. and 36°F. The wind was from a northerly point, was cold, blowing as it did from the cooled land, and was passing over a stretch of warm water; thus fulfilling all the conditions for Newfoundland fogs formation. The mist or fog did not persist however, and it cleared by 10h. or soon afterwards when the air temperature had increased considerably.

T. H. APPLEGATE.

R.A.F. Station, Mount Batten, Plymouth, Devon. November 9th, 1929.

Colouring of Evening Sky

To-day I observed a phenomenon which I have never before seen, viz., about 4 o'clock and just before the light faded the whole sky was suffused with a red colour, notwithstanding that it was quite heavily overclouded. No clear sky showing. The brickwork shone with an added glow of red as one sometimes sees in a brilliant sunset.

The most noticeable fact was that the sky showing this red light penetrating or suffusing the blue-grey expanse of cloud was not much, if any, more brilliant (or dull) in one direction than in another, whether east, west, north or south or on the horizon or overhead.

H. W. SOUTHCOMBE.

5, Crescent Road, Kingston-on-Thames. December 2nd, 1928.

The Atmosphere as a Colloid

In a review under this heading on the September number of the *Meteorological Magazine*, Dr. F. J. W. Whipple states that one of the outstanding puzzles is to discover how and why cloud particles combine to form raindrops, and among other things, if the age of the cloud is a factor.

I have long made a study of the rain-bearing clouds of cyclonic disturbances; some of my observations were published some years ago,* but since they bear directly on this subject, I may perhaps be permitted to recapitulate them briefly.

Rain appears to condense in the tenuous indefinite cloud which forms between the fracto-stratus and alto-stratus of cyclones. (By the word " cyclone " I mean to cover all varieties of cyclonic disturbance producing steady rain.) Difficult to detect, because if not masked by the former, it is seen against a featureless grey background of the latter, it may occasionally be observed when a break near the horizon allows it to be seen in elevation. It then appears as a vague indefinite mass, often merged into fracto-stratus at its base, while alto-stratus or alto-cumulus may lie clean edged and definite far above.

The rain of cyclones is undoubtedly caused by dynamical cooling *en masse*, and the indefiniteness of this cloud is readily attributable to a process which cannot bring about the sudden discontinuities of water content to which turbulence clouds owe their hard outlines. It has another feature however which is not so easily explained; that is extreme transparency.

The cyclonic clouds frequently break before the rain has finished entirely. When they do so, the upper clouds generally appear hazy, while the blue of the sky is grey and dirty looking instead of clean. This is a sure sign that more rain is to come, and many observations during the breaking up of rain clouds have shown that this grey appearance is due to the intervention of this transparent nimbus. Moreover, I have frequently known rain to fall when this grey appearance of the blue sky overhead has been the only sign of cloud, though other clouds may have formed soon after.

Curiously enough, the day after reading Dr. Whipple's notes I witnessed this phenomenon in a striking form. On September 21st at 8h. 30m. G.M.T. a rainbow appeared. It was broad and diffuse, and its colours were pale and watery. The sky at

**London, Q.J.R. Meteor. Soc.* XLVII., 1921, p. 271.

the time was 9/10 covered with thin indefinite cirro-cumulus, while a few wisps of fracto-stratus were beginning to form in the rising westerly breeze. Apart from these there was no sign of cloud lower than the cirro-cumulus, but the sky had the greyish appearance already referred to. A few drops of rain were reaching the earth at the time, and by 10h. drizzle was falling which increased to steady rain by 10h. 45m., the sky in the meantime becoming clouded over with fracto-stratus. The rainbow was formed against a background of cirrus and therefore was not due to rain falling from definite low clouds to the windward, and since light rain was falling at the time of observation the sun must have been shining through the layer in which the rain was formed.

The transparency of this rain-producing cloud is remarkable when compared with the opacity of the slightest turbulence cloud, whose heaviest masses can at the most precipitate fine drizzle. There can be but one explanation. The water particles in this nimbus must be very much larger and more widely separated than those in the turbulence cloud. That this should be so is only in part explained by the larger amount of water available. How is it that this can condense into rain without the prior formation of a dense cloud of small droplets? And how is it that the dense clouds formed by turbulence will remain for days on end without their droplets running together and falling?

It is here that the study of colloids may give a clue. Colloids are suspensions of finely divided particles in a fluid medium, the particles and the medium being mutually insoluble. Their stability (*i.e.*, the reluctance of the particles to coalesce and settle) is due to forces which are only effective on very finely divided matter. In smoke, a typical colloid, the smaller particles are kept in suspension and hindered from coagulating to a great extent by Brownian movement which keeps them in ceaseless agitation. Another potent factor is the electric charge they bear, whose neutralization will cause the smoke to flocculate and settle.

Water clouds are not colloids, but if their droplets are below a certain size, they may be susceptible to similar forces. Their particles may be as small as 0.4 microns, while Brownian movement becomes evident on particles from 3-5 microns in diameter. Also, in droplets of this size, the electric charge present on one ion might be effective in checking coalescence, while its repulsive force would be overcome by the inertia of heavier drops. It would be interesting to know if an appreciable number of the droplets in a turbulence cloud bear an electric charge, and if a fair proportion of them are less than 5 microns in diameter.

If there is anything in these speculations one would expect to find that below a certain size cloud particles would be very reluctant to coalesce, but when this was once passed, they might do so very readily. In turbulence clouds, the growth of the drops when once formed must be very slow. In rain clouds all evidence points to the fact that it can be very rapid. My own observations have shown that, although it varies in degree, the transparency is a most consistent property. The proportion of small drops present probably varies to some extent inversely with the rate of condensation.

R. F. T. GRANGER.

Attenborough, Notts. November 4th, 1929.

Weather Lore amongst the Italian Peasantry

From time to time attention has been called in the *Meteorological Magazine* to the strange beliefs about the weather held by various uncivilised peoples or by the inhabitants of Europe in the Middle Ages. A recent book, *Through the Apennines and the Lands of the Abruzzi*, by Estella Canziani (Heffer and Sons, 1928), reveals the fact that the twentieth-century Italian peasant can quite hold his own as regards fantastic ideas about the weather.

Take, for example, the ideas current about hail. According to the peasants, hail is formed by clouds joining, one the male, making the rain wind pass between them; the other, the female, freezing the rain into hail. "Once a priest who was passing the Palena mountain saw a male and female spirit making hail, and to stop them he put the largest hailstone he could find on the palm of a child under seven years old (the most innocent of the family) because he believed the tempest would last only the time the hailstone took to melt." In Lanciano, devils and bad spirits make the hail, and the more snow there is on the mountains the more hail there will be because the devils have more material to work on! Lightning is the work of lost souls.

Whirlwinds arise on the spot where anyone has been murdered. Or else they are the work of *La mazzamarelle*, which apparently correspond to the English elves. Innocent children can see them. Waterspouts are the work of mischievous spirits (*li scijjinne*). When sailors see one coming, the correct procedure is to turn towards it uttering certain words and to cut the air with a knife with a black handle, also to make the sign of the Cross. The story goes that one St. Peter's Day, a certain boat encountered a waterspout, one fisherman tried to cut it with his knife, but failed, and the boat capsized. When the man who had cut the air returned home, he found his wife with a cut finger. He was convinced that she was the waterspout and that now she was "*libera*," liberated from that form, he so ill-treated her that she died!

This information was collected by Signora Canziani in 1913.

CICELY M. BOTLEY.

Guildables, Holmesdale Gardens, Hastings, June 19th, 1929.

Ancient Hindu Meteorology

The *Vedas*—the most ancient work of recorded human experiences—are full of astronomical notes, *e.g.*, the comparison of the motion of the heavens to that of a wheel and the rotation of the celestial vault round an axis pointing to the pole overhead. The idea which is widespread in Indian literature is the six months' duration of the day and the night of the Gods and descriptions of long tantalizing dawns. These accounts suggest an arctic home of the ancient Aryans. The migrations to the south are illustrated by the gradual increase in the number of months during which the sun was visible. There were seven months in very ancient texts, but this number increased to ten and finally to twelve in later literature. Evidences of the glacial destruction of this polar home at the end of the last interglacial epoch are abundant in the oriental scriptures, and are recorded as deluge or continuous rain and snow which drove the primitive Aryans to more congenial homes southwards.

There are references in the Parsi Scriptures to the effect that after the destruction of the first paradise of the Arctic the second best habitation had to be established in the south. Fifteen such creations, each corresponding to the different countries of settlement are mentioned. From each of these the unfortunate people were eventually turned out by the pranks played by the Devil, until at last a safe haven in the sixteenth, *i.e.*, Persia, was found.

The arctic theory of the polar home of the ancient Aryans is of general interest because it implies that in the past an equable climate prevailed in that region salubrious enough to make it one of the centres of human evolution. The explanations of long-period climatic changes given by astronomers and by meteorologists like Humphreys, Brooks and Wegener may be supplemented by the researches of Mr. Tilak given in his book entitled "The Arctic Home in the *Vedas*," published by Messrs. Tilak Brothers, Gaikwar Wada, Poona City, India.

M. V. UNAKAR.

Meteorological Dept., Ganeshkhind Road, Poona, June 14*th*, 1929.

NOTES AND QUERIES

Sir John Moore

Sir John Moore, M.A., M.D., D.Sc., of Dublin, who recently attained his 84th year, may be regarded as one of the G.O.M. in both Medicine and Meteorology. To his many other distinctions he has just added that, a very rare one, of reaching his diamond jubilee as an observer for the Meteorological Office. For a period of 60 years Sir John has contributed, almost without a break, a complete second order return, and for well over

50 years has sent in a weekly return. His meteorological activities did not commence with his official connexion with the Office. The rainfall measured at Fitzwilliam Square in 1868 was published in *British Rainfall*, and for the three previous years, that measured at South Anne Street.

Although for some Irish stations, such as Phœnix Park and Markree Castle, observations extend over a longer period than those of Sir John Moore, Dublin has the distinction of being probably the only station which has been under the direct supervision of, and where most of the observations have been taken by one and the same person at the same place for so long a period.

Among Sir John's published works, mention may be made of *Meteorology, Practical and Applied*, which appeared in 1904, and of which a second and enlarged edition was published in 1910.

C. A. Bracey.

An Old Weather Diary and a Tornado in Dublin in 1850

Sir John Moore has recently brought to the Meteorological Office for inspection a manuscript book kept by his father, William D. Moore, A.B., M.B., at Dublin from October 2nd, 1848, to March 24th, 1851. The book is entitled *Chemical Analyses—Book No.* 2, and contains for the most part notes of chemical tests of a medical nature. From the beginning, however, readings of a thermometer and of a barometer are given at intervals, together with general remarks on the weather, whenever this was at all abnormal.

From October 2nd, 1849, the observations of temperature, barometer and weather are made regularly every day, usually early in the morning at from 6 a.m. to 8 a.m. The genesis of these notes is explained by one dated October 28th, 1849, which reads as follows:—

> "Last night at 10½ o'c, thermometer stood in this room, all doors and windows being open and no fire or gas alight, at 59°. The extreme cold at the commencement of the month induced me to mark the temperature daily, and the great warmth is now equally remarkable."

At the beginning of 1850, there is a remark "Thermometer placed outside"; and thereafter the daily observations consist of readings of a thermometer outside, a thermometer inside, a barometer and remarks on the weather. It is clear that the observations of temperature made in 1849 were readings of a thermometer placed indoors. In this connexion two remarks are of interest, viz., "Dec. 3rd, 1849. Fires begun," and "No fires since 25th March, 1850." From the week commencing January 6th, 1850, a printed meteorological journal for each week containing daily values of maximum and minimum temperature, barometer, rainfall and wind direction made by George Yeates, 2, Grafton Street, Dublin, and extracted from some newspaper are pasted in the volume.

The meteorological observations of Dr. William Moore can be regarded as the beginning of the series which has been continued ever since in Dublin, either by himself or his son, the present Sir John Moore.

One of the most interesting of the phenomena referred to in the volume is a remarkable tornado, full descriptions of which are contributed, one by Dr. William Moore in his own handwriting, the other (a newspaper cutting) by the Rev. Dr. Lloyd, D.D., President of the Royal Irish Academy.

The tornado occurred on April 18th, 1850, and passed over Dublin. The following is an extract from Dr. Moore's account. "At about 3.30 p.m. the sky got dark, distant peals of thunder were heard, shortly after flashes of lightning succeeded each other in extremely rapid succession, followed by heavy rain. Large hail stones began to fall, and a terrific hurricane, at one time apparently blowing from east to west, then from west to east, set in. This continued for about an hour when it completely subsided; the sun shone out, and the evening was very fine. The damage done was enormous—the glass in almost all windows looking towards the west was nearly all destroyed; slates, tiles, &c., were blown off the houses, many chimnies blown down, and the tents erected for the Cattle Show at the Royal Dublin Society were prostrated, killing one man and seriously injuring two others. The cattle broke loose and became furious, leading to fearful confusion. Many houses lost from 100 to 150 panes of glass. Several trees were blown down in the College Park, Leinster Lawn, &c., and the ground in Stephen's Green was covered with leaves and branches of trees. Several of the hail-stones were as large as pigeons' eggs. . . . . . This dwelling house D.G. escaped almost entirely—stable roof much injured, laboratory skylight blown in—study, 2 panes of glass (broken), little laboratory 5, house 1. Every house on east side of green lost probably every front pane. The appearance of the city is awful, as if it had been sacked. Several chimnies down and roofs carried off. The storm was very partial; nothing of it was known at Merrion—in Merrion Square, Lower and Upper Fitzwilliam Street, it committed great damage—from Lower Mount Street to about Mr. Nun's house every pane of glass was broken, from that up scarcely one was broken."

Dr. Lloyd, in his paper before the Royal Irish Academy, stated that the tornado arrived at 4 p.m., that the gale sprang up from the SE., and then suddenly and apparently in an instant, shifted to the point of the compass diametrically opposite and blew with increased violence from the NW. "In less than 10 minutes the storm had passed. The wind returned to a gentle breeze from the SW. and the weather became beautiful. All the phenomena—the direction of the gale perpendicular to that in which the storm cloud was advancing and the sudden reversal of that direction, seem to prove that it was a true tornado, whose centre passed directly over the place of observation. It is evident, on comparing the direction of the wind when the whirl first reached this part of the town with that of the progressive motion of the vortex itself, that its rotatory motion was retrograde, or in an opposite direction to that of the hands of a watch."

Dr. Lloyd goes on to state that in the College Park and adjoining garden 19 trees were rooted up and prostrated, of which ten fell from the southeast and nine from the northwest. The transition of wind direction from SE. to NW., it is concluded, must have been immediate. In one place two large trees were found lying side by side although they had fallen from opposite directions.

Eye observations of the barometer gave the following values:—

1 p.m.	29·964 inches.
4 p.m.	29·930 ,,
7 p.m.	29·944 ,,

but Dr. Lloyd adds that he has good authority for stating that a sudden and considerable fall of the barometer took place shortly before the storm. "The fall of rain and melted hail amounted only to 0·596 inch; but it is probable that the hail was driven out of the receiver of the gauge by the wind."

Tornadoes, though rare in these islands, are by no means unknown. A full description of one which occurred on October 27th, 1913 in south Wales and the west of England, was published by the Meteorological Office as *Geophysical Memoirs* No. 11. It is there stated that the *Meteorological Magazine* gives references to forty tornadoes, more or less violent, which occurred in the British Isles in the years 1866 to 1895.

R. Corless.

The Rainfall of November, 1929

While the rainfall of November, 1929, exceeded twice the usual amount over the greater part of southern and central England and Wales, there was less than the average over much of the northern half of Scotland and at Newcastle. The monthly percentage values showed a remarkable range, varying from 350 in parts of Devon, Dorset and Sussex to 75 in the neighbourhood of the Moray Firth. Practically the whole of the south-west of England and Wales, stretching as far inland as Birmingham and Wellingborough, recorded more than 250 per cent of the average.

Over England and Wales the total rainfall during November exceeded 4 inches everywhere, except in east Anglia and along the north-east coast from Hull to Berwick. More than 10 inches was recorded over practically the whole of the Devon-Cornwall peninsula, most of Wales and the English Lake District and, what is more remarkable, in view of their normally lighter rainfall, in parts of Dorset, Hampshire and Sussex. More than 30 inches was recorded locally in Snowdonia and the English Lake District.

November, 1929, was the wettest November during the last 60 years at practically every station to the south of a line drawn roughly from Crewe to Lincoln (but excluding both the east coast of England and the west coast of Wales), as well as in the English Lake District and the south-east corner of Ireland. At stations as far apart as Ashburton, St. Austell and Ross, November, 1929, was the wettest month of any name during the last 60 years. At Southampton, Cardiff and Church Stretton (in Shropshire) there was only one wetter month in a similar period.

Over the British Isles as a whole November, 1929, with 188 per cent of the average, was easily the wettest November in the last 60 years, the next wettest Novembers being those of 1926 and 1877 with 155 per cent. Over England and Wales, November, 1929, with 232 per cent was also the wettest November on record. Over Scotland with 130 per cent there were 8 wetter Novembers, while over Ireland, with 151 per cent, only those of 1900 and 1890 were wetter, with 154 and 169 per cent respectively.

It will be recalled that the total rainfall over the British Isles for the 9 months, January to September, 1929, was less than that of any similar period in the last 60 years (although there was very little more in 1870, 1887 and 1921). By the end of September the general rainfall over the British Isles was 20·4 inches, or 7·9 inches short of the average of that period. October was moderately wet and November very wet, so that by the end of November the general rainfall was 33·8 inches and only 2·9 inches short of the average of that period. In order to wipe out completely the deficiencies of the earlier months, December, 1929, will require therefore a general rainfall of about 8 inches or 170 per cent of the average of that month.

At Camden Square (London) the total for November, 1929, of 5·47 inches, was the largest recorded in any previous November, but there were 11 wetter months in the record back to 1858. The total rainfall, January to November, 1929, was 18·36 inches, or 3·72 inches short of the average for that period.

J. GLASSPOOLE.

The Formation of Surface Inversions of Temperature with Clear Skies in Egypt

The *Meteorological Magazine* for February, 1929 (Vol. 64, p. 8), contains an account of the discussion of a paper by R. Steiner

"On the formation of surface inversions of temperature with clear skies and land breezes." In this paper it was stated that isothermal conditions up to about 600 metres were found about sunset, and that inversions did not form even at the ground until after sunset, but some diagrams exhibited by Mr. Heywood from Leafield showed quite clearly that inversions may form at the ground a considerable time before sunset.

Mr. W. D. Flower now sends us an analysis of some results obtained with the Vertical Temperature Gradient Recorder at Ismailia, Egypt, between February 18th and March 31st, 1929. Only four suitable occasions were found during this period. Details of these are given in Table 1, which shows the numbers of minutes before or after sunset at which the vertical temperature gradient became zero during the process of formation of an inversion. A minus sign indicates that the inversion began to form before sunset, a plus sign that it began to form after sunset.

TABLE I.

Date. 1929.	*Time of zero gradient (minutes from sunset).* 50 *ft.*	150 *ft.*	200 *ft.*
February 18th ...	−18	−3	+1
February 19th ...	−30	−15	−12
February 28th ...	−18	+7	+71
March 19th ...	−10	+26	+59

A typical example of the formation of an inversion occurred on February 19th, 1929, and is illustrated in Figure 1. Between 12h. and 15h., G.M.T., the dry adiabatic lapse rate was exceeded between 4 feet and 150 feet, but between 150 feet and 200 feet the lapse rate was about equal to the dry adiabatic. After 12h. the lapse rate decreased rapidly near the ground, but between 150 and 200 feet the decrease was very slow until just before sunset. The inversion set in about 15h. 10m. between 4 feet and 50 feet, just before 15h. 30m. between 50 and 150 feet and about 15h. 30m. between 150 and 200 feet. At sunset the inversion was continuous up to 200 feet, but was most marked between 4 feet and 50 feet and very slight above 150 feet.

It therefore appears that in Egypt on clear afternoons surface inversions can form before sunset.

Review

Climatology and Some of Its Applications. By Prof. Robert De C. Ward. Sci. Monthly, Feb., 1929, vol. 28, pp. 156-171.

The main part of this interesting paper, which was delivered as the introductory lecture in a course on "Man and his climate," given before the Lowell Institute at Boston in 1928, is concerned with the practical applications of climatology. Several striking instances are given, relating both to peace and war, and it is clearly shown that much loss and suffering might have been avoided had the available information about local climate been taken into consideration.

News in Brief

We regret to learn that the American non-magnetic yacht *Carnegie* was destroyed as a result of a petrol explosion on board on November 30th. According to *The Times*, Captain Ault, the commander, died of burns, the cabin boy is believed to be killed, and four members of the crew are in hospital suffering from burns.

The *Carnegie* was especially built for magnetic researches twenty years ago, and at the time of the accident was engaged on a three years' cruise.*

**See Meteorological Magazine* 63, 1928, pp. 156-60.

We are informed that at the annual general meeting of the London Mathematical Society, held on November 14th, Prof. S. Chapman was elected President of this Society.

Mr. T. Davys Manning, of Newlands, Seaford, Sussex, writes to say that the rainfall at Seaford on November 15th and 16th " is a record reading for this station with the exception of July 9th, 1923." A total of 2·21in. fell in the 24 hours ending 15h. on the 16th. " During the forenoon of the 16th a heavy swell was observed though there was little wind and waves were not crested. At high water, the sea was washing over the sea front opposite the Esplanade Hotel, a very unusual occurrence. At 15h. . . . the wind was NW., force 7-8."

The Weather of November, 1929

The weather of November was unsettled and wet, the month in the southern half of the British Isles, being one of the wettest Novembers on record. At Ross-on-Wye 8·94in. constitutes the largest total fall for any month since rain records began there in 1818, and 9·80in. at Valentia is a November record since 1870. The average pressure for the month was markedly below normal. For the first 9 or 10 days appreciable rain was experienced in the west and north, but in the south and east the falls were usually small and the sunshine records good. The 3rd was a sunny day over the kingdom generally, over 8hrs. bright sunshine being recorded in most parts of the south and only slightly smaller amounts in the north. Among the larger amounts of rain recorded during this time may be mentioned 1·20in. at Aspatria on the 9th and 1·05in. at Falmouth on the 5th. Gales occurred on the morning of the 6th and evening of the 9th in the south. Day temperatures were mostly a little above normal during this period, but sharp ground frosts occurred at night, 14°F. being recorded on the ground at Burnley on the 1st. A secondary depression forming a trough-like extension to a main depression to the north passed across the country on the 11th,* causing a line squall and heavy rain over a wide area. Among the heaviest rainfalls recorded on that day were: 8·3in. at Mardy Reservoir (Glamorgan), 5·25in. at Treherbert (Glamorgan), and 3·17in. at Holne (Devon). With the passing of the line squall there was a considerable drop of temperature and much colder weather supervened until the 18th and the 19th. Maximum temperature failed to exceed 32°F. at several places on the 15th, 30°F. was the maximum at Renfrew and 32°F. at Cranwell, while a minimum of 10°F. was registered on the ground at Burnley and of 12° at Rhayader on the 18th. Snow fell heavily in Scotland, north Ireland, north England and the Midlands and lay to a considerable depth in some districts; rain occurred often further south, but sunshine records were good on many of the days, *e.g.*, over 7hrs. in south England and Ireland on the 17th. Thunderstorms occurred locally on the 10th to 14th and widespread morning mist and fog were experienced on the 14th to 18th, occasionally persisting all day. During the 18th a deep depression spread in from the Atlantic causing a complete change to unsettled mild weather which lasted until the end of the month. Gales and heavy rain were experienced at most places on either the 18th or 19th, rain measurements exceeding 3in. in various places, notably in the southwest, 4·59in. between noon on the 18th and noon on the 19th at Holne (Devon), 3·79in. at Treherbert (Glamorgan). Gales were again experienced at many places on the 23rd and 25th and rain fell over the country generally on most days between the 19th and 30th; the 24-hour totals frequently exceeding 1in. in the south and west; severe flooding resulted in the west. From the 19th onwards the temperature was considerably above the normal, maximum temperature in the south rarely falling below 50°F. and reaching 60° at Greenwich on the 22nd. The distribution of sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs).
Stornoway	55	−12	Valentia	47	−18
Aberdeen	80	+25	Liverpool	53	− 6
Dublin	70	− 1	Falmouth	71	− 5
Birr Castle	55	− 9	Kew	66	+14

Pressure was below normal over Iceland, Greenland and the whole of western Europe with the exception of the extreme north-east of Norway and the south of the Iberian Peninsula, the greatest deficit being 14·1mb. at Thorshavn (Faroë Islands). Pressure was also above normal at the Azores, Bermuda and Newfoundland. Temperature was above normal over western

* *See* p. 249.

Europe but slightly below normal at Spitsbergen. In parts of central and northeastern Sweden it was as much as 10°F. above normal. Rainfall was deficient in central Europe, northern Scandinavia and Spitsbergen, but abundant in the British Isles and parts of southern Scandinavia, being double the normal in northwestern Gothaland and eastern Norrland.

Gales and heavy rains were experienced in northern France on the 8th. The dry weather which had prevailed in Switzerland since the middle of November ended on the 12th, when there were abundant rains in the low country, and snow fell heavily on the hills down to a level of 2,500 feet. The snowfall continued on the 14th down to a level of 1,500ft. and over a foot of snow is reported from the Engadine and Bernese Oberland. Gales were again experienced in northern France on the 14th.

Rain fell over the northwest and northeast pastoral areas of South Australia during the first fortnight of the month, thus breaking the long drought. Good rainfalls also occurred over the whole wheat belt, greatly enhancing the prospects of the wheat crop and also of grazing, dairying and fruit growing in that area.

Severe gales were frequently experienced over the North Atlantic. At Madeira shade temperatures of over 70°F. were registered during the first fortnight.

In the United States temperature was generally above normal east of the Mississippi river and along the Pacific coast, and below normal in the Plains and Rocky Mountain States for the first three weeks of the month. Later it was below normal over the whole country. Rainfall was heavy except in parts of the mountain regions and along the Pacific coast during the early part of the month and again in the week ending the 19th. Towards the end of the month the distribution was irregular.

The special message from Brazil states that the distribution of rainfall in the northern regions was irregular with an average 0·24in. above normal and that the rainfall was scarce in the central and southern regions with averages 0·51in. and 1·22in. below normal respectively. Four anticyclones passed across the country and the continental depression was unusually active. The crops were generally in good condition except that the tobacco crop in Bahia and the cereals in Rio Grande do Sul were affected by the lack of rain. At Rio de Janeiro pressure was 0·1mb. above normal and temperature, owing to the persistence of southerly winds, 2·2°F. below normal.

Rainfall, November, 1929.—General Distribution

England and Wales	232	per cent of the average 1881-1915.
Scotland	130	
Ireland	151	
British Isles	188	

Rainfall: November, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	5·47	232	*Leics* .	Belvoir Castle	4·46	200
Sur .	Reigate, Alvington	7·35	236	*Rut* .	Ridlington	5·16	...
Kent .	Tenterden, Ashenden	6·37	211	*Linc* .	Boston, Skirbeck	4·06	203
,, .	Folkestone, Boro. San.	5·26	...	,, .	Lincoln	4·33	230
,, .	Margate, Cliftonville	3·46	143	,, .	Skegness, Marine Gdns	3·32	154
,, .	Sevenoaks, Speldhurst	7·15	...	,, .	Louth, Westgate	4·03	156
Sus .	Patching Farm	9·01	253	,, .	Brigg, Wrawby St.	4·24	...
,, .	Brighton, Old Steyne	8·11	253	*Notts* .	Worksop, Hodsock	4·31	220
,, .	Heathfield, Barklye	10·28	346	*Derby* .	Derby, L. M. & S. Rly.	5·06	232
Hants .	Ventnor, Roy. Nat. Hos.	6·91	215	,, .	Buxton, Devon Hos.	9·20	197
,, .	Fordingbridge, Oaklnds	9·76	285	*Ches* .	Runcorn, Weston Pt.	5·47	197
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	5·82	...
,, .	Sherborne St. John	7·22	253	*Lancs* .	Manchester, Whit. Pk.	6·46	244
Berks .	Wellington College	4·80	188	,, .	Stonyhurst College	7·85	174
,, .	Newbury, Greenham	8·22	294	,, .	Southport, Hesketh Pk	6·22	198
Herts .	Welwyn Garden City	4·43	...	,, .	Lancaster, Strathspey	8·06	...
Bucks .	High Wycombe	7·37	296	*Yorks* .	Wath-upon-Dearne	4·23	207
Oxf .	Oxford, Mag. College	5·91	267	,, .	Bradford, Lister Pk.	6·18	211
Nor .	Pitsford, Sedgebrook	5·65	257	,, .	Oughtershaw Hall	12·19	...
,, .	Oundle	3·00	...	,, .	Wetherby, Ribston H.	3·32	144
Beds .	Woburn, Crawley Mill	5·78	258	,, .	Hull, Pearson Park	3·71	169
Cam .	Cambridge, Bot. Gdns.	4·09	211	,, .	Holme-on-Spalding	4·19	...
Essex .	Chelmsford, CountyLab	4·52	201	,, .	West Witton, Ivy Ho.	5·10	...
,, .	Lexden Hill House	4·34	...	,, .	Felixkirk, Mt. St. John	3·38	138
Suff .	Hawkedon Rectory	4·01	177	,, .	Pickering, Hungate	3·39	...
,, .	Haughley House	2·92	...	,, .	Scarborough	2·66	108
Norf .	Norwich, Eaton	3·43	133	,, .	Middlesbrough	2·48	117
,, .	Wells, Holkham Hall	3·71	173	,, .	Baldersdale, Hury Res.	...	...
,, .	Little Dunham	4·71	182	*Durh* .	Ushaw College	2·71	107
Wilts .	Devizes, Highclere	6·38	240	*Nor* .	Newcastle, Town Moor	2·28	94
,, .	Bishops Cannings	6·61	231	,, .	Bellingham, Highgreen	3·57	...
Dor .	Evershot, Melbury Ho.	15·61	356	,, .	Lilburn Tower Gdns.	3·75	...
,, .	Creech Grange	9·45	...	*Cumb* .	Geltsdale	5·25	...
,, .	Shaftesbury, Abbey Ho.	6·58	204	,, .	Carlisle, Scaleby Hall	4·77	159
Devon .	Plymouth, The Hoe	12·22	335	,, .	Borrowdale, Seathwaite	29·60	213
,, .	Polapit Tamar	12·30	290	,, .	Borrowdale, Rosthwaite	22·74	...
,, .	Ashburton, Druid Ho.	21·20	374	,, .	Keswick, High Hill	12·58	...
,, .	Cullompton	10·50	305	*Glam* .	Cardiff, Ely P. Stn.	10·99	263
,, .	Sidmouth, Sidmount	10·73	344	,, .	Treherbert, Tynywaun	27·11	...
,, .	Filleigh, Castle Hill	10.85	...	*Carm* .	Carmarthen Friary	13·93	280
,, .	Barnstaple. N. Dev. Ath.	8·77	223	,, .	Llanwrda	15·68	265
Corn .	Redruth, Trewirgie	14·09	289	*Pemb* .	Haverfordwest, School	13·50	...
,, .	Penzance, Morrab Gdn.	12·33	270	*Card* .	Aberystwyth	9·69	...
,, .	St. Austell, Trevarna	13·09	258	,, .	Cardigan, County Sch.	11·02	...
Soms .	Chewton Mendip	10·29	240	*Brec* .	Crickhowell, Talymaes	13·00	...
,, .	Long Ashton	9·92	...	*Rad* .	BirmW. W. Tyrmynydd	14·42	217
,, .	Street, Millfield	7·31	...	*Mont* .	Lake Vyrnwy	15·13	272
Glos. .	Cirencester, Gwynfa	8·31	279	*Denb* .	Llangynhafal	6·23	...
Here .	Ross, Birchlea	8·55	338	*Mer* .	Dolgelly, Bryntirion	14·37	232
,, .	Ledbury, Underdown	8·50	348	*Carn* .	Llandudno	5·17	167
Salop .	Church Stretton	8·15	277	,, .	Snowdon, L. Llydaw 9	34·40	...
,, .	Shifnal, Hatton Grange	5·33	223	*Ang* .	Holyhead, Salt Island	7·16	173
Worc .	Ombersley, Holt Lock	6·80	298	,, .	Lligwy	7·53	...
,, .	Blockley	8·16	...	*Isle of Man*			
War .	Farnborough	7·45	272		Douglas, Boro' Cem.	7·47	158
,, .	Birminghm, Edgbaston	7·12	299	*Guernsey*			
Leics .	Thornton Reservoir	5·59	247		St. PeterP't. GrangeRd.	9·38	223

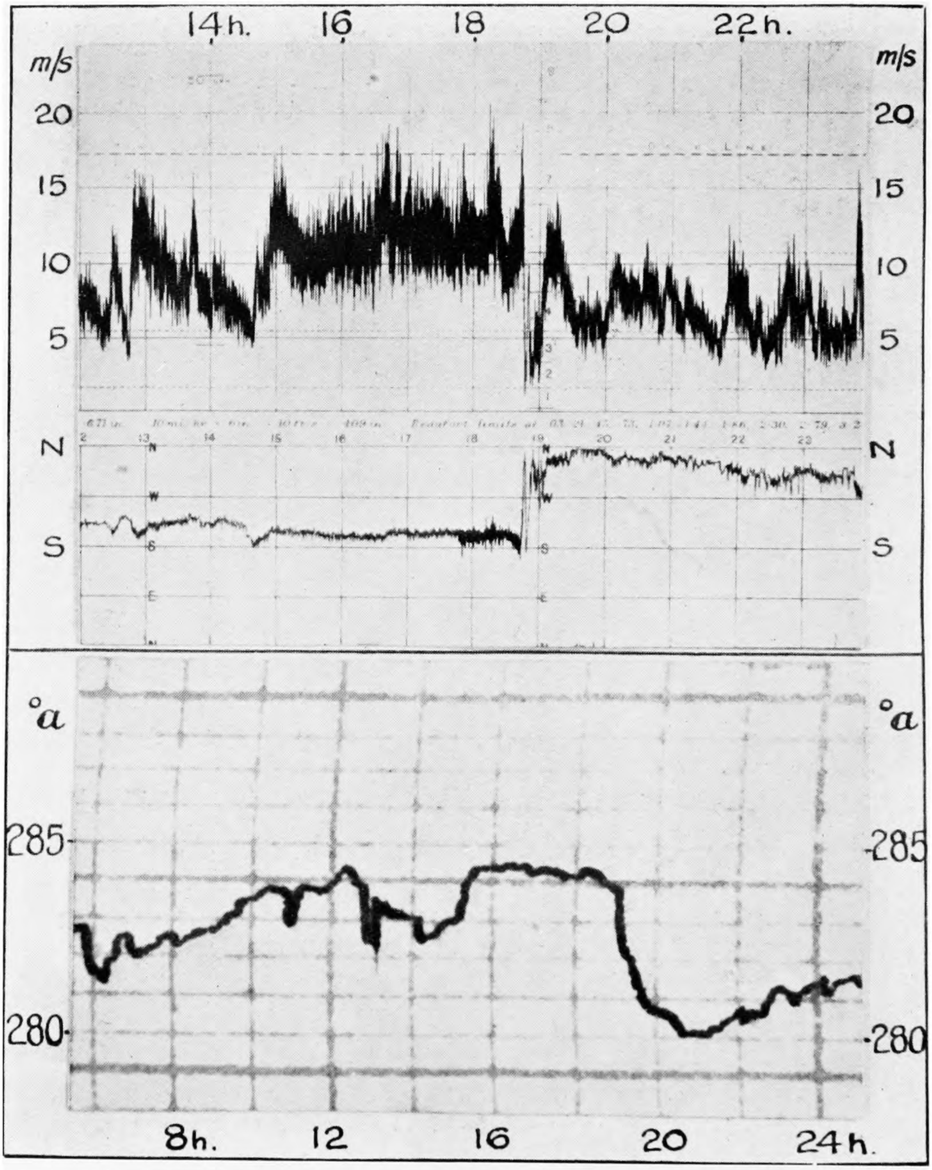
Rainfall: November, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Wigt .	Stoneykirk, Ardwell Ho	6·58	165	*Suth* .	Loch More, Achfary...	9·45	111
,, .	Pt. William, Monreith	6·36	...	*Caith* .	Wick......	3·20	102
Kirk .	Carsphairn, Shiel......	14·68	...	*Ork* .	Pomona, Deerness......	4·45	113
,, .	Dumfries, Cargen......	8·33	184	*Shet* .	Lerwick......	7·89	186
Dumf.	Eskdalemuir Obs.......	10·92	188	*Cork* .	Caheragh Rectory......	11·58	...
Roxb .	Branxholm	5·26	158	,, .	Dunmanway Rectory...	12·25	198
Selk .	Ettrick Manse......	...	...	,, .	Ballinacurra......	6·59	164
Peeb .	West Linton......	4·96	...	,, .	Glanmire, Lota Lo......	7·25	169
Berk .	Marchmont House......	3·61	120	*Kerry*.	Valentia Obsy......	9·80	179
Hadd.	North Berwick Res.....	2·42	108	,, .	Gearahameen......	16·60	...
Midl .	Edinburgh, Roy. Obs.	3·60	167	,, .	Killarney Asylum......	7·27	129
Ayr .	Kilmarnock, Agric. C.	6·36	169	,, .	Darrynane Abbey......	10·04	197
,, .	Girvan, Pinmore..	7·45	140	*Wat* .	Waterford, Brook Lo...	6·90	183
Renf .	Glasgow, Queen's Pk. .	6·26	168	*Tip* .	Nenagh, Cas. Lough...	5·53	137
,, .	Greenock, Prospect H.	10·47	163	,, .	Roscrea, Timoney Park	4·04	...
Bute .	Rothesay, Ardencraig.	7·78	154	,, .	Cashel, Ballinamona...	4·98	142
,, .	Dougarie Lodge......	7·21	...	*Lim* .	Foynes, Coolnanes......	6·39	157
Arg .	Ardgour House	12·86	...	,, .	Castleconnel Rec......	5·64	...
,, .	Manse of Glenorchy...	10·61	...	*Clare* .	Inagh, Mount Callan...	10·09	...
,, .	Oban......	7·04	...	,, .	Broadford, Hurdlest'n.	6·18	...
,, .	Poltalloch	7·99	144	*Wexf*.	Newtownbarry	...	...
,, .	Inveraray Castle...	12·67	150	,, .	Gorey, Courtown Ho...	7·38	211
,, .	Islay, Eallabus......	8·59	159	*Kilk* .	Kilkenny Castle......	4·83	157
,, .	Mull, Benmore......	14·60	...	*Wic* .	Rathnew, Clonmannon	6·70	...
,, .	Tiree	...	...	*Carl* .	Hacketstown Rectory..	6·65	171
Kinr .	Loch Leven Sluice......	5·50	153	*Leix* .	Blandsfort House......	4·67	140
Perth .	Loch Dhu......	11·40	131	,, .	Mountmellick......	4·95	...
,, .	Balquhidder, Stronvar	...	...	*Off'ly* .	Birr Castle......	3·98	128
,, .	Crieff, Strathearn Hyd.	5·43	125	*Dubl* .	Dublin, FitzWm. Sq...	4·85	181
,, .	Blair Castle Gardens...	3·61	103	,, .	Balbriggan, Ardgillan.	4·08	142
,, .	Dalnaspidal Lodge.....	10·49	158	*Me'th* .	Beauparc, St. Cloud...	3·92	...
Angus.	Kettins School.	3·75	134	,, .	Kells, Headfort......	4·60	135
,, .	Dundee, E. Necropolis	3·78	155	*W.M* .	Moate, Coolatore......	3·68	...
,, .	Pearsie House......	4·27	...	,, .	Mullingar, Belvedere..	3·84	113
,, .	Montrose, Sunnyside...	3·79	143	*Long* .	Castle Forbes Gdns......	5·02	139
Aber .	Braemar, Bank...	3·58	93	*Gal* .	Ballynahinch Castle...	9·09	152
,, .	Logie Coldstone Sch....	2·25	73	,, .	Galway, Grammar Sch.	5·71	...
,, .	Aberdeen, King's Coll.	3·55	120	*Mayo* .	Mallaranny......	...	...
,, .	Fyvie Castle......	2·79	...	,, .	Westport House......	7·19	147
Moray.	Gordon Castle......	1·88	65	,, .	Delphi Lodge......	13·94	...
,, .	Grantown-on-Spey......	...	...	*Sligo* .	Markree Obsy......	6·52	157
Nairn.	Nairn, Delnies	1·35	57	*Cav'n* .	Belturbet, Cloverhill...	3·73	120
Inv .	Kingussie, The Birches	3·71	...	*Ferm* .	Enniskillen, Portora...	4·38	...
,, .	Loch Quoich, Loan.....	...	...	*Arm* .	Armagh Obsy......	3·51	124
,, .	Glenquoich......	14·20	117	*Down* .	Fofanny Reservoir......	12·14	...
,, .	Inverness, Culduthel R.	2·50	...	,, .	Seaforde......	6·05	160
,, .	Arisaig, Faire-na-Squir	5·78	...	,, .	Donaghadee, C. Stn...	4·00	131
,, .	Fort William......	10·10	...	,, .	Banbridge, Milltown...	2·60	...
,, .	Skye, Dunvegan......	6·80	...	*Antr* .	Belfast, Cavehill Rd...	5·21	...
R & C.	Alness, Ardross Cas ...	3·38	84	,, .	Glenarm Castle......	6·64	...
,, .	Ullapool	4·39	...	,, .	Ballymena, Harryville	5·11	126
,, .	Torridon, Bendamph...	9·16	99	*Lon* .	Londonderry, Creggan	5·09	124
,, .	Achnashellach......	8·90	...	*Tyr* .	Donaghmore......	4·35	...
,, .	Stornoway......	5·86	101	,, .	Omagh, Edenfel......	4·26	112
Suth .	Lairg......	3·55	...	*Don* .	Malin Head......	4·26	...
,, .	Tongue	3·21	70	,, .	Dunfanaghy......	5·04	...
,, .	Melvich......	4·95	124	,, .	Killybegs, Rockmount.	8·07	128

Climatological Table for the British Empire, June, 1929.

STATIONS	PRESSURE		TEMPERATURE									PRECIPITATION			BRIGHT SUNSHINE	
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values				Mean	Relative Humidity.	Mean Cloud Am'nt	Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
			Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb							
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	in.	in.			
London, Kew Obsy.	1016·7	0·0	79	43	66·7	49·8	58·3	— 0·9	51·4	77	6·4	0·88	— 1·27	11	7·0	42
Gibraltar	1017·4	0·0	86	57	80·2	63·5	71·9	+ 1·4	61·3	76	3·0	0·02	— 0·46	1	..	..
Malta	1015·9	+ 0·3	90	63	78·6	66·9	72·7	0·0	66·9	76	3·4	0·00	— 0·09	0	11·1	76
St. Helena	1015·2	+ 2·2	65	55	60·5	56·7	58·6	— 2·4	58·2	98	8·2	3·19	— 0·88	14	..	..
Sierra Leone	1013·3	+ 1·3	87	..	84·5	..	..	..	75·9	89	5·8	27·10	+ 7·06	28	..	..
Lagos, Nigeria	1013·0	+ 0·1	83	70	81·1	73·9	77·5	— 1·8	74·7	88	9·3	19·93	+ 1·28	21	..	..
Kaduna, Nigeria	1015·4	+ 1·6	90	64	85·0	67·0	76·0	— 0·5	69·5	76	..	6·68	— 1·17	21	..	..
Zomba, Nyasaland	1016·5	— 1·0	81	47	73·6	53·3	63·5	+ 0·6	..	70	3·6	0·00	— 0·48	0	..	..
Salisbury, Rhodesia	1018·0	— 0·1	76	39	71·1	44·9	58·0	+ 1·1	51·0	50	0·9	0·01	— 0·04	1	9·5	86
Cape Town	1021·1	+ 1·0	76	39	65·4	49·8	57·6	+ 1·9	50·4	89	3·7	2·85	— 1·65	7	..	..
Johannesburg	1023·0	+ 0·3	71	28	60·4	42·8	51·6	+ 0·9	42·2	56	3·2	2·38	+ 2·24	6	7·9	75
Mauritius	1019·8	+ 0·8	77	58	74·8	63·0	68·9	— 0·5	65·8	76	3·8	2·54	— 0·26	20	7·4	68
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	1·97	+ 1·50	..	..	..
Calcutta, Alipore Obsy.	998·7	— 1·0	101	76	93·0	79·8	86·4	+ 1·3	80·1	84	7·6	6·74	— 5·16	10*	..	..
Bombay	1003·0	— 1·0	94	73	87·6	77·6	82·6	— 1·3	77·9	86	7·6	25·45	+ 5·58	15*	..	..
Madras	1003·3	— 0·5	105	75	100·3	81·2	90·7	+ 0·6	74·9	57	6·7	1·42	— 0·47	4*	..	..
Colombo, Ceylon	1009·5	+ 0·8	87	72	85·2	77·1	81·1	— 0·6	77·4	80	9·1	9·62	+ 1·65	20	5·0	40
Hongkong	1005·7	— 0·4	91	75	87·1	79·4	83·3	+ 1·9	78·1	78	7·4	4·19	— 11·90	13	6·9	51
Sandakan	..	..	91	73	88·5	74·7	81·6	— 0·1	77·3	83	..	10·93	+ 3·63	14	..	..
Sydney, N.S.W.	1019·0	+ 1·2	74	40	63·1	47·4	55·3	+ 0·7	48·1	70	4·3	2·81	— 1·96	7	6·4	65
Melbourne	1018·8	+ 0·3	64	31	56·7	43·7	50·2	— 0·2	44·3	75	5·9	1·12	— 0·97	14	4·7	49
Adelaide	1020·3	+ 1·3	75	37	61·2	47·5	54·3	+ 0·8	48·2	71	7·9	3·40	+ 0·25	18	3·9	40
Perth, W. Australia	1018·3	+ 0·4	73	38	62·6	48·9	55·7	— 1·1	50·4	74	6·4	9·23	+ 2·31	17	4·4	44
Coolgardie	1018·9	— 0·2	70	33	61·0	41·3	51·1	— 1·6	45·2	70	3·5	1·36	+ 0·13	6	..	..
Brisbane	1018·9	+ 0·8	77	40	68·5	49·7	59·1	— 1·1	52·5	68	4·9	4·40	+ 1·77	9	6·1	59
Hobart, Tasmania	1012·7	— 1·6	62	34	52·5	39·9	46·2	— 0·6	41·1	76	6·2	2·26	+ 0·06	14	4·7	52
Wellington, N.Z.	1011·1	— 3·8	60	37	54·6	45·7	50·1	+ 0·7	47·3	83	6·3	5·56	+ 0·79	15	3·5	38
Suva, Fiji	1014·0	+ 0·4	87	64	80·2	71·3	75·7	+ 0·8	72·9	83	7·0	11·26	+ 5·11	24	3·1	28
Apia, Samoa	1011·6	0·0	87	70	83·9	74·2	79·1	+ 1·3	75·7	74	4·5	3·77	— 1·39	13	5·8	51
Kingston, Jamaica	1013·7	— 0·1	91	72	87·8	74·8	81·3	0·0	72·8	77	6·1	0·44	— 3·66	4	..	..
Grenada, W.I.	1010·5	— 2·6	88	71	86·0	73·6	79·8	+ 0·9	74·6	80	4·7	12·94	+ 4·62	26	..	..
Toronto	1013·7	— 0·6	92	37	74·2	53·4	63·8	+ 1·2	56·5	68	4·0	1·45	— 1·31	8	8·9	58
Winnipeg	1011·6	— 0·9	94	32	74·9	50·2	62·5	+ 0·3	52·0	78	3·9	1·37	— 1·89	10	10·3	63
St. John, N.B.	1013·0	— 1·0	84	41	65·4	48·5	56·9	+ 0·4	52·2	77	7·2	1·95	— 1·32	13	6·7	43
Victoria, B.C.	1015·5	— 1·4	77	44	63·8	49·8	56·8	— 0·2	52·6	75	6·4	0·99	+ 0·06	8	6·9	43

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



ANEMOGRAM AND THERMOGRAM, VALENTIA OBSERVATORY, NOV. 9TH, 1929.
(See p. 291.)

M.O. 313.

The Meteorological Magazine

Vol. 64

Jan. 1930

No. 768

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; YORK STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 15, DONEGALL SQUARE WEST, BELFAST; or through any Bookseller.

The Weather of 1929

Temperature, Sunshine and Wind

By P. I. Mulholland, B.Sc.

The year 1929 will long be remembered for the remarkable variety of its weather and the number of new records created. The abnormal wetness of the last three months and the drought of the preceding months, the severe frosts of the early months and the abnormal warmth of September and the mildness of the latter end of November and most of December, the quiet dry conditions at the beginning of the year and the wet and tempestuous weather at its close provided violent contrasts seldom exhibited in the weather records of this country. The remarkable fluctuations in temperature, however, balanced out on the year and in all districts annual mean temperatures differed only slightly from the normal. Sunshine aggregates, however, exceeded the normal in most districts, the excess being considerable in many parts of England; at Rothamsted 1,854 hours' sunshine were recorded during the year, which is the largest amount recorded since observations commenced at that station in 1852, exceeding by 5 hours the previous record total for the sunny year 1893. Bidston (Liverpool) with an annual total of 1,726 hours and Richmond (Kew Observatory) with an annual total of 1,707 hours had respectively 19 and 16 per cent. more than the normal.

In England and Wales the summer was fine, although the

(87631) P.S. 14/89 1,050 1/30 M. & S. *Gp.303*

lack of rain caused some anxiety to water authorities, farmers and gardeners. In nearly all districts, fine weather was enjoyed on the Public Holidays. Brilliant warm weather prevailed generally on Good Friday (March 29th) and the following day, whilst Easter Sunday and Monday, although cool, were fine, apart from some local showers. Brilliant weather prevailed in all districts on Whit-Monday (May 20th), more than 14 hours' sunshine being recorded in many districts in southern England. The August holiday (August 5th) was fine in the southeast of England with more than 10 hours' sunshine in eastern and south-eastern coastal districts and cloudy in other parts of Great Britain with slight rain or showers. The year will be remembered with mixed feelings amongst agriculturists: the intense frosts of the early months, while beneficial to arable land, were fatal to young and susceptible plant life. Although pastures and meadows suffered from the prolonged drought, the brilliant and abundant sunshine greatly benefited cereal crops.

Cold, northerly and easterly winds occurred with considerable frequency in January and February and in both months mean temperatures were below the normal in all districts; January, 1929, was the first really cold January since 1917 and the coldest in London since 1895. The coldness of January, however, was eclipsed by that of February, and in the central and eastern districts of England mean temperatures for the month were from 7°F. to 8°F. below the normal and over the eastern half of England were below freezing point. The cold was most intense during the period 11th to the 17th and the severest experienced generally since February, 1895. The temperature remained continuously below freezing point from the 11th to the 17th over large areas of Great Britain and in some eastern districts from the 11th to the 20th. The temperature in the screen fell to −1°F., at Ross-on-Wye and at Usk (Monmouth) on the 14th and at Houghall (Durham) on the 17th. In contrast to February, March provided many warm days, but low temperatures were frequently recorded at night, the unusually large diurnal range of temperature being a noteworthy feature of the month. During the last few days, the temperature reached an unusually high level, maximum temperatures of 70°F. and over being recorded in several places from the 27th to the 30th and in some places, *e.g.*, at Oxford (72°F. on the 30th) and Meltham, Yorks (71°F. on the 29th), the values recorded were the highest reported in March for half a century. At Wakefield (Yorks) the temperature rose to 77°F. on the 28th, the highest temperature recorded in March in the British Isles since at least 1881. The extreme range in temperature for March was remarkably large in many districts, amounting to as much as 63°F. at Wakefield, 62°F. at Roden, Wellington (Shropshire), and to 60°F. at Mayfield (Stafford). There was a marked prevalence of cold northerly and easterly winds in April and mean temperatures were below the normal in most places. Monthly mean temperatures were mostly above the normal in May and in several districts in England temperatures in the neighbourhood of 80°F. were recorded about the 23rd. June was mostly cool, although on the 19th the temperature attained or exceeded 80°F. locally in the southeast and east of England.

Although mean temperatures in July and August were generally within a degree Fahrenheit of the normal, there were two notable hot spells; the first was of short duration and occurred about the middle of July whilst the second occurred during the last few days of August and continued until nearly mid-September. During the hot weather in July the temperature rose to 81°F. on the 16th as far north as Strathpeffer (Ross and Cromarty) and to 80°F. on the 15th and 16th at Achnashellach (Ross and Cromarty). In the southeast of England the highest temperatures in July occurred on the 20th, exceeding 85°F. on that date in most places and reaching 89°F. at London (Camden Square) and at Wisley and Newport (Isle of Wight). During the second hot spell 90°F. was recorded in London and at Margate on August 31st and at Newport (Isle of Wight) on September 5th. In London (Camden Square) the temperature rose to 75°F. or over on 5 consecutive days from August 23rd to 27th, and again on 18 consecutive days from August 30th to September 16th. September was abnormally warm and in several places the warmest September for half a century. In the Greenwich records extending back nearly 100 years there was only one hotter September. At Rothamsted September with a mean temperature of 62·0°F. (6·4°F. above the normal) was the warmest month of the year, and by far the warmest September since regular observations commenced there in 1852. Apart from cold weather at the latter end of October, about the middle of November and during the third week of December, the last three months of the year were mild, particularly from November 19th to mid-December.

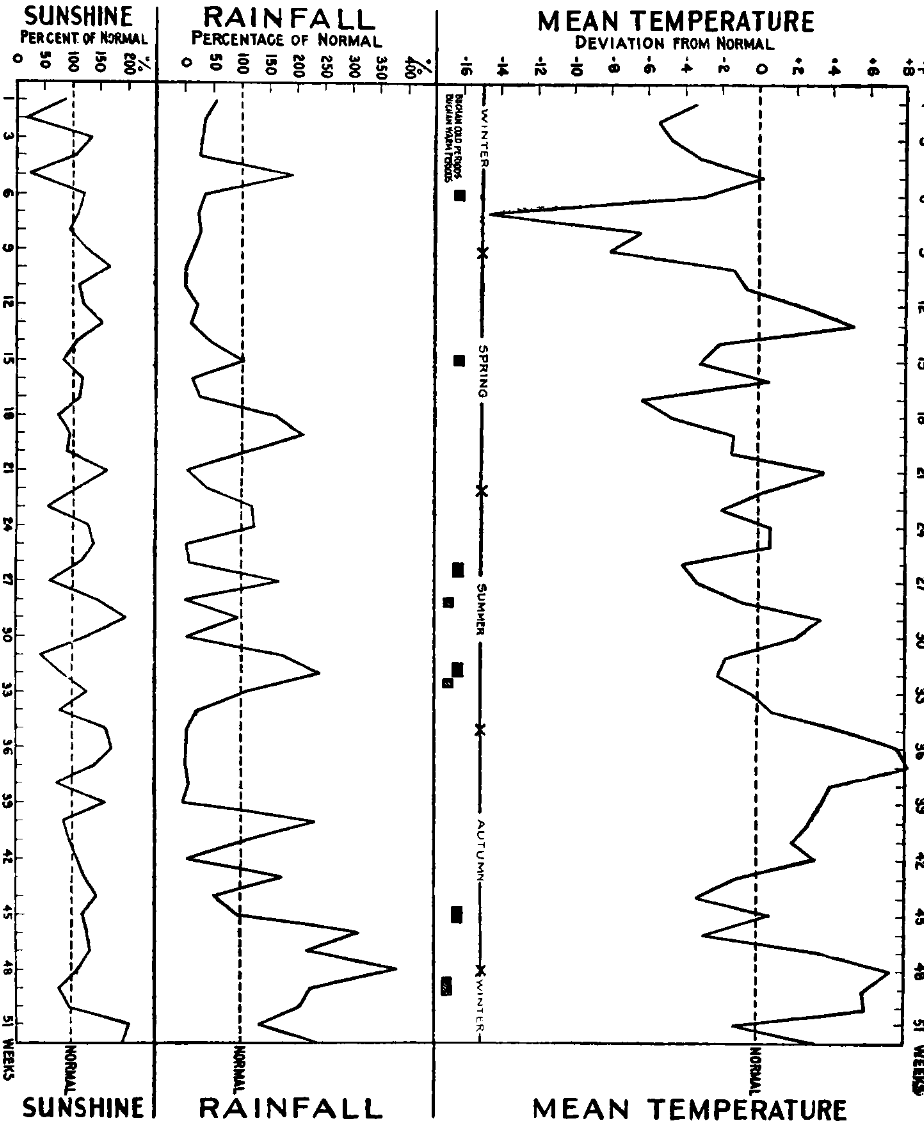
A singularly pleasant feature of 1929 was the excess of sunshine. March and September were conspicuously sunny; the month was the sunniest March for over 20 years at such widely scattered places as Aberdeen, Eastbourne and Teignmouth, for 34 years at Southport and for over 45 years at Strelley (Nottingham) and Cahirciveen (Kerry). Sunshine aggregates were considerably above the normal in September, except in the extreme northwest of Scotland. Daily records of between 11 and 12 hours' bright sunshine were obtained frequently during the first half of the month while during the last week abundant sunshine was recorded in the south and east of England. In the western districts of England and Wales and in the Channel Isles April was the sunniest month of that name since 1921.

There were considerable sunny periods in May in all districts, and in the northwest of England the month was the sunniest May for at least 20 years. There was a considerable excess of sunshine in western districts in June and in some places, *e.g.*, Hoylake, West Kirby, Rhyl, and Pembroke, the total sunshine represented an average of more than 9 hours per day.

In July the only districts with an appreciable deficiency were northern Scotland and southern Ireland. Abundant sunshine was recorded in the southeast of England. The period 12th to the 25th was remarkably sunny and over a large part of England the sunniest fortnight of the year. During this fortnight Rothamsted recorded an average of just under 12 hours. At Hastings (Sussex) the total sunshine recorded during the period July 12th to 17th represented a daily average of 14·5 hours, while at Richmond (Kew Observatory) a daily average of 13·4 hours' sunshine was recorded during the period July 11th to 19th. Except in coastal districts in the south and east of England sunshine aggregates for August were deficient in most places. In spite of the excessive wetness of the last three months of the year sunshine aggregates during this period exceeded the normal in most districts, notably in the central and eastern districts of Great Britain. At Copdock (Suffolk) December was the sunniest month of that name in records extending back to 1901.

Not the least memorable feature of a remarkable year was the storminess of the last three months. Gales occurred frequently in October and November and wind velocities in gusts of 70 m.p.h. and over were widely recorded, notably during the first week of October and on October 23rd and 24th and on November 11th and 24th and 25th. To December, however, belongs the distinction of being the stormiest month of the year. The period December 5th to 12th was unusually stormy, the wind in exposed places in the west and southwest frequently exceeding momentarily 80 m.p.h.; 94 m.p.h. was recorded at Pendennis in the early morning of the 5th. The severest gale of the year was associated with the passage of a vigorous depression on the 6th to 7th, the wind in a gust attaining a velocity of 111 m.p.h. at Scilly on the 6th, the highest on record in Great Britain, and 103 m.p.h. at Pendennis also on the 6th. The gales were responsible for much structural damage, an unusually large number of casualties amongst shipping and loss of life. The storminess of the last month of 1929 was in marked contrast to the quietness of the first month which at Southport, for example, was the calmest January in 58 years.

The diagram reproduced on page 281 shows the variations in weekly district values of temperature, rainfall and sunshine in southeast England during 1929. The district values are expressed as deviations from or percentages of the normal for the period 1881-1915, and are computed as the means of the



THE WEATHER OF 1929 IN SOUTHEAST ENGLAND.

corresponding deviations and percentages for each of the following stations:—Richmond, Margate, St. Leonards, Southampton and Marlborough. Buchan's cold and warm periods have been added to the diagram, and readers will be able to judge for themselves how far the experience of 1929 supports the suggestion that cold and warm periods occur at more or less well-defined periods of the year. In this connexion the reader is referred to the article, "The First Cold Spell of the Year," which appears on page 285 of this magazine.

Rainfall

By J. Glasspoole. Ph.D.

1929, the Year of Extremes of Rainfall.—In considering the rainfall of 1929 over the British Isles it is difficult to decide whether the dry period January to September or the wet October to December was the more remarkable. The rainfall of the first 9 months of the year, over the British Isles as a whole, was less than that of any other January to September in the last 60 years (although there was very little more in the similar periods of 1870, 1887 and 1921). On the other hand the rainfall of the last 3 months was greater than that of any other October to December, the general amount of 21·9in. being as much as 2·6in. more than that of the next wettest October to December, viz., that of 1872 with 19·3in. The computed values for the general rainfall for 1929, together with the averages for the period 1881 to 1915, are set out below:—

	January—September		October—December	
	Average	1929	Average	1929
	in.	in.	in.	in.
England and Wales	23·8	15·0	11·4	20·3
Scotland	34·2	27·9	16·1	23·8
Ireland	30·0	24·6	13·3	20·8
British Isles ...	28·2	20·4	13·2	21·9

It will be seen that the general deficiency over the British Isles at the end of September amounted to 7·8in. This was more than counterbalanced by the excessive rain of the last 3 months, which actually exceeded that of the whole of the first 9 months by 1·5in.

This compensation which Nature seems to provide, sooner or later, recalls the rainfall of 1879 and 1880, although then the contrast was not quite so striking. On that occasion the sequence was reversed, for the remarkably dry winter of 1879 to 1880 followed one of the wettest summers on record. The rainfall of the three months October to December on the average only amounts to 32 per cent. of the total for the year, but in 1929 appreciably more than this proportion was recorded everywhere in the British Isles, except in Berwickshire. The last three months gave more than half the total rainfall of the year at stations representative of the whole of England and Wales, except the northeast, and over much of the Southern Uplands and Western Highlands of Scotland. Over a large area from Hereford to the Isle of Wight two-thirds of the total for the year fell in the last 3 months. For a few widely distributed stations the actual rainfall amounts for these two periods are set out below:—

Station	Jan.-Sept.	Oct.-Dec.	Station	Jan.-Sept.	Oct.-Dec.	Station	Jan.-Sept.	Oct.-Dec.
	in.	in.		in.	in.		in.	in.
London (Camden Sq.) ...	10·2	12·4	Launceston ...	18·7	30·8	Douglas ...	21·5	23·7
			Ross ...	10·3	19·9	Glasgow ...	20·1	20·1
Tunbridge Wells	10·9	20·2	Seathwaite ..	64·6	71·9	Lerwick ...	21·3	24·7
Selborne ...	12·2	26·4	Treherbert ...	39·6	64·9	Fort William	39·4	40·3
Oxford ...	7·6	14·8	Lake Vyrnwy	24·6	38·5	Dublin ...	13·9	13·3

At Seathwaite (Cumberland) the difference in the rainfall of the two half-years is even more striking, the total for January to June being 29·9in. and for July to December 106·6in., or nearly three and a half times as much.

The remarkable variations during the year are further demonstrated by the details of the monthly general rainfall, set out below, as a percentage of the average, 1881 to 1915:—

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
England and Wales	71	49	13	57	103	78	79	79	37	120	232	190
Scotland	49	54	24	76	107	124	108	139	73	144	130	168
Ireland	57	129	24	51	109	83	119	119	38	127	151	184
British Isles	63	67	18	61	105	91	96	104	47	128	188	183

Each of the first four months was dry, with the exception of February in Ireland. It is worthy of comment that prior to January, 1929, the last 11 Januaries, with one exception, experienced a rainfall in excess of the average over the British Isles generally. In passing it may also be mentioned that in the majority of cases of a dry January the calendar year has also given less than the average rainfall. Actually, the general rainfall over the British Isles for January has been less than the average on 26 occasions in the previous 60 years and in only 9 cases was the ensuing year wet. March, 1929, was everywhere unusually dry and over the British Isles as a whole the month was the driest March since before 1870 and ranks with February, 1891 and June, 1925, as the driest months in the last 60 years. At a few stations near London there was no rain at all during the month. The rainfall of the four summer months, May to August, approximated to the average over the

British Isles as a whole. England and Wales received rather less, and Scotland and Ireland rather more than the average amounts during these months. September was unusually dry, there being in the last 60 years only four drier Septembers over the country generally; of these, 1907 and 1910 were appreciably drier, and 1894 and 1895 slightly drier. Of the last three months November and December were the most remarkable. November was easily the wettest November over the British Isles as a whole, in spite of the fact that over the greater part of the northern half of Scotland the rainfall was below the average. In parts of the southwest of England the month was the wettest of any name in the last 60 years. The rainfall of December over the country as a whole was only exceeded by that of 1876, although December, 1914, was about as wet.

At Camden Square (London) there was no rain during 37 days from August 23rd to September 28th. The previous longest "absolute drought" since the record started there in 1858 was one of 29 days, from March 18th to April 15th, 1893, and again from June 27th to July 25th, 1921. The deficiency of rainfall was so persistent that many reservoirs, especially in the Midlands, became almost completely dry and water restrictions were enforced in many localities. On the other hand during the last 3 months of the year there were only 5 rainlesss days in the mountains of Connemara. Probably the heaviest rainfall of the year occurred during November 5th to December 13th at Pont Lluest Wen Reservoir, to the north of Pontypridd in South Wales, the total rainfall during 7 days amounted to 13·7in., 15 days 21·8in., 21 days 27·2in., 28 days 33·0in., 35 days 40·4in. and 39 days 43·8in, or practically half the amount which usually falls during a whole year at that station. At Rosthwaite in Borrowdale (Cumberland) 11·8in. was recorded during the 7 days November 5th to 11th. Serious flooding resulted in a number of districts, although the extent was certainly reduced by the dry state of the ground initially. It was most disastrous between Bridgwater and Taunton and in the Rhondda Valley. In the latter district the damage was accentuted by the deposition of the rubbish from coal tips in many houses, gardens, roads, etc. The initial cause was the heavy rain of November 11th, Armistice Day, which amounted to 8·31in. at Pont Lluest Wen Reservoir. So large an amount has been recorded in a rainfall day only on June 28th, 1917 (near Bruton, Somersetshire), and August 18th, 1924 (at Cannington, near Bridgwater), and the fall of 8·31in. for November 11th ranks as the largest on record either for winter months or for the mountainous parts of the country. The rainfall lasted for 18 hours and was noteworthy for its persistence and not for its intensity at any time. Subsequent heavy rains resulted in further flooding in the Rhondda Valley. At Treherbert a measurement of 5·71in. was made for the 24 hours ending at 4 p.m. on November 19th.

While the incidence of the rainfall throughout the year was unprecedented, the annual totals everywhere approximated fairly closely to the average. Over more than half the country the annual totals were within 10 per cent. of the average. The greatest excesses occurred over the west of the land masses, associated with the unusually strong west and southwest winds experienced during the year. In most parts of Ireland the annual rainfall exceeded the average by small amounts. The largest values, rather more than 115 per cent., were recorded in the mountains of Kerry and in Connemara. In Great Britain more than the average occurred over the greater part of the southwest of Scotland, over most of Wales, and in England to the west of a line roughly from Penrith to Manchester, Rugby, Bath and Lyme Regis, as well as in the south from Southampton to Tunbridge Wells. There was more than 120 per cent. over much of the Devon-Cornwall peninsula, in South Wales, in Snowdonia, and in Islay in western Argyllshire. On the other hand rather less than 80 per cent. fell in Lincolnshire and in the neighbourhood of the Moray Firth. From information at present available the following general values for 1929 have been computed :—England and Wales 100 per cent., Scotland 103 per cent., Ireland 105 per cent. and British Isles 102 per cent. of the average 1881-1915.

At Camden Square (London) the total rainfall was 22·55in., or 1·92in. below the average for the year. A remarkable feature of the rainfall at that station was the small number of rain-days, a smaller total than 134 having been recorded in only 5 of the last 72 years.

The First Cold Spell of the Year

By S. T. A. Mirrlees, M.A.

The past year has been characterised, meteorologically, by much breaking of records. The unusually cold weather of the early part of the year helped to attract public attention to the subject of spells and periods, a peak of journalistic enthusiasm being reached in the proposal to substitute, for St. Swithin, Dr. Alexander Buchan. Apart from topical interest the choice of subject has been assisted by the fact that data lay ready to hand, these notes being based on figures prepared by Dr. Brooks and myself from the Kew Observatory records for an investigation into temperature variations.

The average temperature at Kew Observatory falls quickly in autumn, the fall becoming slower in December, and the coldest part of the average year comes in mid-January. The thick line in Fig. 1 shows the part for December to February of the smoothed curve of the annual course of temperature; it is based on mean values for the years 1871-1910, and may be said to represent the "ideal" course of temperature in the absence of day-to-day perturbations. A curve of daily temperatures shows very irregular variations, and for the investigation mentioned above it was decided to smooth the daily mean temperatures in order to differentiate warm and cold spells from single warm or cold days. The smoothing was carried out by means of over-lapping 5-day means, that is, the temperature assigned to December 3rd, say, is the mean of December 1st-5th, to December 4th, the mean of December 2nd-6th, and so on. The dotted line in Fig. 1 is the curve of the smoothed daily mean temperatures for the period 1871-1910.

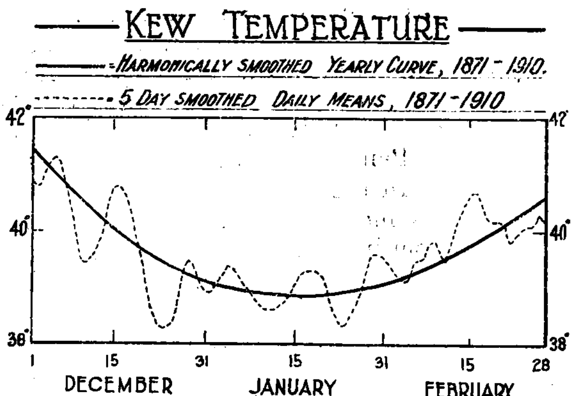


Fig. 1.

A series of curves of smoothed temperatures from January to June of 1881-1923 was also plotted so that temperature variations in individual years could be examined.

Fig. 1 gives at a glance an illustration of a remark in Dr. Buchan's original memoir*: "there are certain periods, more or less well defined, when the temperature instead of rising remains stationary or retrogrades; instead of falling, stops in its downward course, or even rises; and at other times falls or rises for a few days at a more accelerated speed than usual."

The irregularities in the dotted curve might represent tendencies for warm or cold spells to recur at the same time of year, and on this consideration one could deduce that a fall of temperature tends to set in about January 4th. It has however to be considered that a comparatively small number of outstandingly warm or cold periods which happened to fall about the same time would leave an impression on the curve of a spell for the whole period, and closer investigation is required. Taking for example January 24th, according to the dotted curve the coldest January day (actually the centre of the coldest 5-day spell, on the average, in January during the years in question) it is found that the mean temperatures for that day are, for the

* Edinburgh, J. Scot. Meteor. Soc., New Series, Vol. II., p. 4.

years 1871-1910, 38·3°F. for 1911-1927, 41·1°F. This example will show how the position of a hill or valley on the dotted curve depends on the period over which the mean is calculated; indeed it is a fair assumption that in a very long series of observations the dotted curve would coincide with the thick curve.

Everyone knows what is meant by a "cold spell," but the term has had no numerical limits assigned to it as is the case with, say, "absolute drought" in this country, or "cold wave" in the United States, where the definition includes not only the amount of drop in temperature, but also the season of the year and the district of the country. It is suggested that a spell should be classed as "cold" when the smoothed temperature falls below the normal (the thick curve) by an amount equal to or greater than 1½ times the standard deviation of the mean smoothed temperature for the date concerned, that is by an amount which varies from about 9° on January 1st to 7° on February 28th and about 5° in June. Table I gives the date of

TABLE I.—DATE OF BEGINNING AND DURATION OF FIRST COLD SPELL OF THE YEAR (1881-1923).

Year	Date	Days	Year	Date	Days	Year	Date	Days
1881	Jan. 12	19	1896	Feb. 25	5	1910	May 7	8
2	June 13	5	7	Jan. 22	5	11	Apr. 3	9
3	Mar. 7	15	8	Mar. 24	8	12	Jan. 31	9
4	Apr. 15	16	9	Feb. 26	5	13	*	
5	May 5	10	1900	Feb. 7	11	14	*	
6	Jan. 6	5	1	Feb. 13	7	15	Mar. 26	8
7	Jan. 1	7	2	Feb. 10	13	16	Feb. 24	7
8	Jan. 31	5	3	Jan. 14	6	17	Jan. 25	25
9	Jan. 4	7	4	Feb. 27	8	18	Apr. 15	11
1890	Feb. 28	8	5	Apr. 19	5	19	Feb. 1	5
1	Jan. 4	13	6	Mar. 22	9	20	June 5	5
2	Jan. 10	5	7	Jan. 24	6	21	Apr. 15	7
3	Jan. 1	10	8	Jan. 11	5	22	Mar. 21	7
4	Jan. 1	12	9	Jan. 26	7	23	May 12	10
5	Jan. 26	28						

* No cold spell Jan.-June.

occurrence of the first cold spell determined on this basis, for each year from 1881-1923 and also the number of days over which the spell continued. The duration of each spell is found from the curves for individual years, by adding 4 to the appropriate number of 5-day means which come within the prescribed limit.

Table II shows the frequency of occurrence of the first cold spell of the year in the various months from January to June, and also the percentage frequencies in the periods 1881-1894, 1895-1908 and 1909-1923 considered separately.

The tables indicate no tendency for a cold spell to set in about a particular date but point to a series of generally milder winters from 1909-1923. The inquiry has not yet been completed for the years 1924-1929 but as regards 1924-1927 the only cold spell in January was in 1926. It is interesting to note that although January 1929 was the coldest in many parts of the

TABLE II.—FREQUENCY WITH WHICH FIRST COLD SPELL OCCURS IN VARIOUS MONTHS.

	Frequency 1881-1923	Percentage Frequency		
		1881-1894	1895-1908	1909-1923
January	17	64	36	20
February	9	7	43	13
March	5	7	14	14
April	5	8	7	20
May	3	7	—	13
June	2	7	—	7
No spell January—June ...	2	—	—	13

British Isles since 1917 the Kew temperatures were not low enough to qualify for a cold spell, on the above basis; the smoothed temperature curve remained at 33°-35° during most of the month, after which a milder period was experienced until the memorable cold spell of February set in.

The definition of " cold " adopted connotes smoothed mean temperature below freezing point up about February 10th, so that Table I suggests that the need for protecting London's water supply from frost was more evident twenty or thirty years ago. Were those the old-fashioned winters?

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings will be :—

January 27th.—*Atmospheric ozone; its relation to some solar and terrestrial phenomena.* By F. E. Fowle (Smithsonian Misc. Coll., 81, No. 11, 1929). *Opener*—Mr. J. S. Dines, M.A.

February 10th.—*Some thundercloud problems.* By C. T. R. Wilson (Philadelphia, Pa. J. Franklin Inst., 208, 1929, pp. 1-12). *Opener*—Mr. E. A. Cope, B.Sc., A.R.C.S.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, December 18th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, D.Sc., President, in the Chair.

J. Edmund Clark, B.A., and I. D. Margary, M.A.—Floral Isophenes and Isakairs.

Dates of first flowering of certain widely distributed plants have been collected by the Society with the help of voluntary observers all over the British Isles since 1890. The results of these observations can often be best interpreted by presentation in map form, and this was first attempted with the Society's data in 1916. The mean date of flowering of 12 plants, ranging from hazel in January to greater bindweed in July, was given for as many observing stations as possible. Lines of equal flowering date (isophenes) were then drawn on the map through stations of equal date, thus disclosing areas in which plants flowered definitely later or earlier than in neighbouring areas. Eventually it became possible to prepare a map showing the average distribution of these dates and isophenes, and this was done for the 30 years 1891-1920 and for the 35 years 1891-1925, the two maps proving so closely similar that it was clear that the averages thus obtained were reasonably reliable and fixed. It is now possible therefore to compare the annual isophene map with the average map and to prepare from it a map showing for that year the variations from the average in all parts of the country. Lines are drawn through points of equal variation defining areas of real earliness or lateness and are called "Isakairs" (equal unseasonableness). Maps so prepared are more instructive than the original isophene maps, for these are based on the original observations which are always dependent on altitude, latitude, etc., in addition to the changing weather factors. In the isakair maps these constant influences are removed and the relation of weather to plant growth can thus be more readily followed. Isakair maps have been prepared for every year from 1891 and are being published together with the isophene maps upon which they are based. They show the general distribution and degree of earliness and lateness in the first eight months of each year, and form a unique series for such information. Local effects of abnormal weather are shown clearly in some instances (*e.g.*, marked lateness in England southwest in 1905 and 1907 due mainly to very deficient sunshine rather than to low temperature) but it must be remembered that these maps show the mean effect of 8 months during which weather conditions suffer marked changes. Much more definite relations between the isakairs and weather would be seen if shorter periods such as a month could be taken, but it has not yet been possible to undertake the somewhat lengthy preparation involved although the data are all available for anyone willing to undertake it.

Sir Gilbert T. Walker, C.S.I., F.R.S.—On the mechanism of tornadoes.

The prevailing idea that the area of a tornado is roughly vertical has been opposed by Wegener, who maintained that it is horizontal. In this paper it is urged that while Wegener's evidence against a vertical axis is conclusive he does not provide an adequate explanation of a horizontal direction, and that the rotation of the earth will, when convergence occurs, set up a spin parallel to its axis. This view is supported by the almost universal anti-clockwise rotation of tornadoes in the northern hemisphere and, in general, by the photographic evidence.

E. W. Bliss, M.A.—A study of rainfall in the West Indies.

The rainfall in the eastern islands of the West Indies is related to the circulation of the North Atlantic during the months March to May preceding, and is deficient when the circulation is more vigorous than usual; there is a close relationship with temperature in the Cape Verde Islands, and low temperatures tend to be followed by deficient rainfall. In addition the rainfall in this part of the West Indies belongs to the first group of the southern oscillation.

Correspondence

To the Editor, *The Meteorological Magazine.*

Sixteenth Century Weather

Mr. Richard Cooke's communication under the above heading in the November issue of the *Meteorological Magazine* recalls the account given by Atkyns, the historian of Gloucestershire in the XVIIIth century, of the tragic results of a visitation by ball lightning at Little Sodbury Manor. He says:—

> "In 1556 died Maurice Walsh Esq. together with seven of his children occasioned by a fiery sulphureous globe rolling in at the parlour door at dinner time which struck one dead at the table and caused the death of the rest. It made its passage through a window on the other side of the room."

CICELY M. BOTELEY.

Guildables, 17, Holmesdale Gardens, Hastings. November 21st, 1929.

The Green Flash

With reference to the letter on p. 207 of the *Meteorological Magazine* for October, 1929, the following remarks may be of interest.

Many of the people one has met in Jaffa are familiar with the "green flash," and I too have seen it on several occasions when on the beach near Jaffa. As in the letter referred to, the sun right down on the horizon retains its brilliant orange-yellow colour until just as the last portion disappears a bright green "spot" is seen, which, to me, has always appeared as a small disc of green light and lasts about a quarter of a second.

One evening when expecting to see this flash, a party of four of us, including two doctors, had discussed the possibility of this phenomenon being due to some effect in one's eyes and not to refraction*: to try this out two of us watched the sun carefully until it had set, while the other two looked eastwards and on a signal from the sun watchers turned quickly just as the sun was disappearing. The two who had watched continuously saw the green flash, while to those who did not look till the very last moment, the sun went down orange-yellow, and no green was seen.

No further opportunities have arisen to try this experiment again and with other observers.

C. VAUGHAN STARR.

R.A.F. Station, Amman, Transjordan. November 11th, 1929.

Waterspout at Holyhead

At 9h. 48m. G.M.T. on the 14th of this month, what seemed to be a waterspout was observed at a distance of about three miles across the bay to the northeast of this station.

The state of the sea was slight and the wind light from the SW. The sky was clouded with cumulo-nimbus, cumulus and cirrus, the cumulo-nimbus being mostly to the north of the station. The visibility was good; showers of rain were occurring in the immediate vicinity and a rainbow was observed to the northnortheast.

From the base of the cumulo-nimbus there hung a strip of cloud not unlike a mare's tail. The surface of the sea immediately below this strip of cloud was seen to be disturbed and what seemed to be a vaporous mist was observed to be rising to meet the hanging strip of cloud. The sea disturbance was very distant, the heavy cumulo-nimbus casting a deep shadow over the sea. The phenomenon was of only a few minutes' duration and was observed to have moved eastwards on to the land.

W. I. JONES.

Salt Island, Holyhead. November 29th, 1929.

NOTES AND QUERIES

Thunderstorm at "Warm Front" of a Depression

A thunderstorm experienced at Valentia Observatory between 14h. 15m. and 14h. 25m. on Saturday, November 9th, is note-

* *See* "The Green Flash at Sunrise." by W. L. Balls. *Nature CXX,* 1927, *p.* 728.

worthy in that it occurred at what appears to be the " warm front " of a depression.

Reproductions of the anemogram and thermogram (enlarged scale) for the afternoon and evening of November 9th are shown in the frontispiece of this number of the magazine. It will be seen that a " cold front " reached Valentia shortly before 19h. : this and the steadiness in direction and velocity of the wind from just before 15h. to 18h. 45m. as compared with the variations before and after indicate that Valentia was in the " warm sector " during that period. The thermogram showing an increase of temperature at about 15h. 5m. and a nearly constant temperature from that time until 19h. gives further evidence that Valentia was in the warm sector from about 15h. to 19h. Alto-stratus cloud was observed at 7h., 9h., 15h., 16h., and 18h. on the day in question. Another interesting feature shown in the illustration is that the wind was decidedly stronger in the " warm sector " than it was in the " cold sector."

Rainfall was also peculiar in that only a few drops of rain fell at the Observatory during the thunderstorm. The appearance of the sky, however, suggested that heavy rain was falling to the northwest where the storm seemed to be centred. Heavy rain fell at the passage of the " cold front," as much as 13mm. having been recorded in the hour and a half 18h. to 19h. 30m.

M. T. SPENCE.

Climatic Changes in Greenland

The account of the Oxford University Expedition to Greenland, published by Dr. T. G. Longstaff in the *Geographical Journal* for July, 1929, adds a few furher details to the evidence for climatic change in Greenland in the Middle Ages. The paper contains a chart of the old Norse settlements near Ilulialik north-east of Godthaab (about 64°45′N., 50°30′W.). Dr. Longstaff considers that Ilulialik represents the zone of local climatic optimum at the present time, but the main centre of the Norse population was nearer the ice-sheet. " Even in July we found it impossible to reach these settlements (where horses, sheep and possibly cattle are supposed to have been kept), owing to the masses of ice carved from the glaciers flowing into the sea from the inland ice . . . . It was perfectly obvious that no settlers could get there, much less live there, under present conditions and that some deterioration of climate must have taken place since those times."

The suggestion that the zone of climatic optimum has shifted seaward is very interesting, and fits in with a plausible reconstruction of the course of events. In other parts of the world the " climatic optimum " of Christian times seems to have occurred about the seventh to tenth centuries. If similar conditions extended to Greenland, the edge of the inland ice must have retreated considerably, and the Norse settlement must have about coincided with the time when this ice edge in west Greenland occupied its most easterly limit. Meanwhile, however, the amount of drift ice off the coast was increasing, and the coastal regions were becoming colder and less hospitable. The net result would therefore have been that in the eleventh to thirteenth centuries the climatic optimum lay further east than at present. After the fourteenth century the change of climate was reflected in the renewed growth and westward advance of the inland ice, and the climatic optimum shifted westward again, as noted by Dr. Longstaff.

C. E. P. Brooks.

The Effect of Changes in the Density of the Air on the Readings of the Pressure Tube Anemograph.

In the pressure tube anemograph, a record of the velocity of the wind is obtained by transmitting to the recording apparatus the difference between the pressure set up by the wind in an open tube facing the wind and the resultant of the pressures in a vertical tube pierced with uniformly spaced small holes. The latter is a suction effect and the difference of pressure actually available is, therefore, the arithmetical sum of the two pressures. The pressure due to a stream of fluid is proportional to its density and to the square of the velocity. Consequently, if the pressure effect is utilised to measure the velocity, account must be taken of the density of the fluid. In the pressure tube anemograph, the fluid with which we are concerned is the air, and the charts for the standard pattern anemographs employed at Meteorological Office stations are graduated on the assumption that the density of the air has the standard value 1226 g/m^3.

If the density of the air changes from the standard value ρ_0 to some other value ρ the velocity of the air V required to produce the same pressure as air having the standard density and moving at the velocity V_0 is given by the equation :—

$$V = V_0 \sqrt{\rho_0/\rho}$$

Near sea level the variations of density which occur as a result of changes of pressure and temperature are small and it is ordinarily not necessary to take account of them. Again, the mean density at various places on the earth's surface is, in general, sufficiently close to the standard value to render it unnecessary to apply corrections. If, however, an anemometer is installed at a considerable height above sea level, the mean density may be sufficiently below the standard density to produce serious errors. The following table gives the value of the ratio $\sqrt{\rho_0/\rho}$ at various heights above the earth's surface and may be used for the correction of the readings of pressure tube anemographs installed at those heights. It will be seen that the correction required is about 1½ per cent. at 1,000 feet and 3 per cent. at 2,000 feet. It should be noted that the densities used in computing these factors are the standard densiies adopted by the International Commission for Air Navigation (I.C.A.N.). To be strictly accurate, the actual mean density at the place where the instrument is installed should be used in computing the correction, but it is unlikely that the actual density would anywhere differ sufficiently from the I.C.A.N. value to make such a refinement worth while.

Feet	$\sqrt{\rho_0/\rho}$	Feet	$\sqrt{\rho_0/\rho}$
1,000	1·015	6,000	1·094
2,000	1·030	7,000	1·111
3,000	1·045	8,000	1·128
4,000	1·061	9,000	1·146
5,000	1·077	10,000	1·164

Reviews

Karten der Atmosphärischen Zirkulation auf der Nördlichen Halbkugel vom 1 *Jänner bis* 31 *März*, 1910. By Felix M. Exner. Edited by the Zentralanstalt für Meteorologie und Geodynamik. Size 14½ × 11in. Vienna, 1929.

For the purpose of studying in detail the circulation of warm and cold air masses, Professor Exner has compiled and published a series of daily charts for the northern hemisphere covering the first three months of 1910. Two charts are given at each opening; on the left is the distribution of pressure shown by 10-millimetre isobars, on the right is the temperature anomaly in steps of 5°C. The anomaly or difference from normal is employed because it is a better indication of the polar or equatorial origin of the air than is the actual temperature This fine series of charts should prove of great assistance in studies of the birth and development of barometric depressions

Elementary Applications of statistical Method. By H. Banister, Ph.D. Size 7¼ × 4¾in., pp. 56. *Illus.* London: Blackie and Son Ltd., 1929. 3s. 6d.

This little book will be useful to those who wish to make occasional use of statistical methods without requiring a knowledge of the theory or the use of highly refined methods. It deals in an elementary way with frequency distributions and the goodness of fit between observed and calculated data, measures of dispersion, the significance of the mean and simple correlation. The only type of frequency distribution referred to is the binomial, and the symmetrical binomial distribution is misleadingly called the " normal " distribution. The distribution based on the normal law of errors, to which the term "normal frequency distribution" is customarily applied, is not even mentioned. In meteorological statistics this distribution is far more important than the binomial, which rarely occurs. The criteria of goodness of fit and significance are shown graphically in four very useful diagrams.

Partial correlation is not discussed; it is admittedly a difficult subject to handle simply, but one cannot help thinking that the four pages given up to logarithmic tables, which most people possess already, could have been more usefully devoted to the elements of the subject.

News in Brief

It was announced in the list of New Year Honours that Mr. H. L. B. Tarrant, Chief Clerk of the Meteorological Office, and Mr. E. W. G. Twentyman, Harbour Master and Meteorological Observer at Suva, Fiji, have been made Members of the Order of the British Empire

A paper on "The areas covered by intense and widespread falls of rain," by Mr. J. Glasspoole, Ph.D., was read before the Institution of Civil Engineers on December 17th, 1929, and evoked an interesting discussion.

The Weather of December, 1929

Stormy unsettled weather with much rain and sun prevailed throughout the greater part of December. At Valentia it was the wettest December on record and at Ross-on-Wye the wettest since 1876. Pressure was continuously low south of Iceland from the 1st to 14th and intense secondary depressions swept quickly northeast across the country. Heavy falls of rain were monotonously frequent in many parts of the country with 24hr. totals of 1in. or more locally on many days; 2·65in. at Fofanny (Co. Down) on the 1st, 2·20in. and 2·29in. at Tynywaum (Glamorgan) on the 7th and 13th, and 1·79in. and 1·75in. at Holne (Devon) on the 6th and 7th were among the larger falls. But the outstanding feature of the month was the persistence of severe gales which were of almost daily occurrence. Between the depressions there were intervals of bright weather, the sunniest days of the first half of the month being the 3rd, 4th, 10th and 12th, when about 5hrs. bright sunshine were recorded at many places. Thunder was heard occasionally, the southern districts experiencing heavy thunderstorms during the evening of the 6th and northern England on the 8th and 9th. Temperature was high throughout this period, maxima being usually about or above 50° over the kingdom generally while 58°F. was reached at Dublin on the 13th, and at Cambridge, Kew, Margate and

Norwich on the 14th. After the 14th there was a change to fair anticyclonic conditions and temperature fell generally on the 15th and 16th to a seasonable level with minimum readings in the screen below freezing point, and severe ground frosts, 11°F. being recorded at Rhayader on the 17th, 13°F. at Burnley on the 16th. The days, however, were relatively warm with much sunshine, over 7hrs. being recorded locally in south England on the 19th. On that day pressure fell generally over the whole country and unsettled weather spread from the west. Snow or sleet fell in Scotland and northern England from the 20th to 23rd, lying locally to a depth of 1 to 2 inches, and maximum temperatures on the 20th-22nd were round 35°F. generally; 32°F. was recorded at Harrogate and 33°F. at Durham and Ross-on-Wye on the 22nd. Gales occurred at many places during these days and fog locally in north England on the 21st. On the 23rd there was a renewal of mild rainy weather with gales, severe locally, on the 25th, 28th and 29th. The heaviest rain of the month was experienced on the 28th, when 3·30in. fell at Rosthwaite (Cumberland), 3·11in. at Oughtershaw (Yorkshire), and 3·06in. at Dungeon Ghyll (Westmorland). The year closed, however, with a mainly fine quiet day. The distribution of sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs).
Stornoway	22	— 1	Valentia	34	— 7
Aberdeen	49	+13	Liverpool	70	+27
Dublin	76	+28	Falmouth	75	+20
Birr Castle	54	+11	Kew	63	+26

Pressure was below normal over the whole of northwest Europe, Iceland and Spitsbergen, the greatest deficit being 17·4mb. at Reykjavik, and above normal over Italy, the Iberian Peninsula, the Azores, Newfoundland and Bermuda, the greatest excess being 4·2mb. at Gibraltar. Temperature was above normal over the whole of western Europe, being as much as 18°F. in excess in Lapland. Rainfall was above normal in western Europe except for the extreme north of Scandinavia. In northeastern Norrland it was three times the normal.

Gales and heavy rain in France, the Netherlands and the Bay of Biscay from the 6th to 8th caused much damage to buildings, communications and shipping. Weather in Berlin about the 15th was reported to be the mildest experienced at this season of the year for over 50 years. Severe cold occurred in France and Switzerland from about the 21st, and snow fell heavily in Switzerland and eastern Europe down to sea level. This spell, however, was broken on Christmas Eve, when a gale of warm föhn wind began blowing accompanied by heavy rainfall up to 6,000ft. All the rivers rose rapidly and floods occurred in the low country. Severe gales were again experienced over Switzerland, west Germany, the Netherlands and northern France on the 28th to 30th. Part of the town of Havre was inundated by a great wave, and a landslide occurred at Boulogne. Temperature rose above 60°F. in the lower parts of Switzerland on the 29th. Considerably more than normal sunshine was experienced at Cannes during December. Owing to the severe weather conditions in Swedish Lapland, where the "reindeer moss" became covered with snow solidly frozen, herds of reindeer migrated south.

Heavy snow fell in Shanghai and throughout the Yangtze Valley on the 21st. The snow lay 18in. deep in Nanking. Nearly 200 Chinese were drowned when a local steamer foundered in a gale off Fukien Point on the 21st. A severe hurricane passed over the Fiji Islands on the 11th and 12th, during which 16 lives were lost and 7 ships wrecked. Heavy floods resulted, doing much damage to the sugar, copra and banana industries.

Gales were experienced over New Zealand on the 16th. Widespread heavy rain of great benefit to the graziers occurred over the northern pastoral areas of South Australia near the end of the month. By the 31st floods had occurred in some parts.

The central and prairie provinces of Canada experienced a spell of severe cold during the middle of the month. One of the worst December blizzards was reported from Ontario between the 18th and 22nd, while snowstorms occurred generally in the central provinces. In the U.S.A. a severe storm of glazed frost following 24 hours' rain was experienced in the northern States about the same time, 25in. of snow were measured at Marquetta, Michigan, and much damage was done to trees and wires by the weight of the ice. Snow fell as far south as New Orleans and northern Florida. Before this temperature had been considerably above the normal over the whole of the States and precipitation about normal.

Severe gales were experienced frequently on the North Atlantic causing several wrecks.

The special message from Brazil states that the rainfall was plentiful in the northern and central regions with 2·24in. and 1·10in. above normal respectively, and scarce in the southern regions with 0·59in. below normal. Five small anticyclones passed across the country. The crops were generally in good condition. At Rio de Janeiro pressure was 2·0mb. below normal and temperature 3·8°F. above normal, the last decade being exceptionally warm.

Rainfall, 1929—General Distribution

	Dec.	Year	
England and Wales ...	190	100	per cent of the average 1881-1915.
Scotland	168	103	
Ireland	184	105	
British Isles	183	102	

Rainfall: December, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	4·19	175	*Leics* .	Belvoir Castle	4·02	163
Sur .	Reigate, Alvington	7·93	249	*Rut* .	Ridlington	4·47	...
Kent .	Tenterden, Ashenden	7·70	247	*Linc* .	Boston, Skirbeck	4·00	186
,, .	Folkestone, Boro. San.	6·12	...	,, .	Lincoln	3·56	162
,, .	Margate, Cliftonville	3·80	167	,, .	Skegness, Marine Gdns	4·54	206
,, .	Sevenoaks, Speldhurst	6·20	...	,, .	Louth, Westgate	5·12	183
Sus .	Patching Farm	6·10	181	,, .	Brigg, Wrawby St.	4·26	...
,, .	Brighton, Old Steyne	5·95	292	*Notts* .	Worksop, Hodsock	4·33	183
,, .	Heathfield, Barklye	8·75	236	*Derby* .	Derby, L. M. & S. Rly.	3·80	146
Hants .	Ventnor, Roy. Nat. Hos.	5·84	177	,, .	Buxton, Devon Hos.	9·69	171
,, .	Fordingbridge, Oaklnds	7·72	195	*Ches* .	Runcorn, Weston Pt.	4·16	132
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	4·68	...
,, .	Sherborne St. John	6·43	195	*Lancs* .	Manchester, Whit. Pk.	6·03	186
Berks .	Wellington College	3·61	125	,, .	Stonyhurst College	8·66	178
,, .	Newbury, Greenham	7·88	246	,, .	Southport, Hesketh Pk	5·62	174
Herts .	Welwyn Garden City	4·57	...	,, .	Lancaster, Strathspey	7·55	...
Bucks .	High Wycombe	6·38	217	*Yorks* .	Wath-upon-Dearne	4·33	183
Oxf .	Oxford, Mag. College	4·42	191	,, .	Bradford, Lister Pk.	7·38	221
Nor .	Pitsford, Sedgebrook	4·89	202	,, .	Oughtershaw Hall	15·68	...
,, .	Oundle	2·77	...	,, .	Wetherby, Ribston H.	5·25	214
Beds .	Woburn, Crawley Mill	4·56	195	,, .	Hull, Pearson Park	3·84	159
Cam .	Cambridge, Bot. Gdns.	3·16	167	,, .	Holme-on-Spalding	4·60	...
Essex .	Chelmsford, County Lab	4·26	192	,, .	West Witton, Ivy Ho.	7·84	...
,, .	Lexden Hill House	4·07	...	,, .	Felixkirk, Mt. St. John	4·51	187
Suff .	Hawkedon Rectory	4·22	174	,, .	Pickering, Hungate	4·42	...
,, .	Haughley House	3·79	...	,, .	Scarborough	4·43	186
Norf .	Norwich, Eaton	4·93	188	,, .	Middlesbrough	2·51	129
,, .	Wells, Holkham Hall	4·71	229	,, .	Baldersdale, Hury Res.	8·39	234
,, .	Little Dunham	4·83	198	*Durh* .	Ushaw College	4·07	163
Wilts .	Devizes, Highclere	7·33	240	*Nor* .	Newcastle, Town Moor	2·94	124
,, .	Bishops Cannings	6·67	203	,, .	Bellingham, Highgreen	5·71	...
Dor .	Evershot, Melbury Ho.	11·18	216	,, .	Lilburn Tower Gdns.	4·64	...
,, .	Creech Grange	7·19	...	*Cumb* .	Geltsdale	6·64	...
,, .	Shaftesbury, Abbey Ho.	5·24	145	,, .	Carlisle, Scaleby Hall	5·28	164
Devon .	Plymouth, The Hoe	7·68	154	,, .	Borrowdale, Seathwaite	24·02	147
,, .	Polapit Tamar	10·61	207	,, .	Borrowdale, Rosthwaite	22·26	...
,, .	Ashburton, Druid Ho.	...	...	,, .	Keswick, High Hill	12·82	...
,, .	Cullompton	8·36	190	*Glam* .	Cardiff, Ely P. Stn.	8·39	164
,, .	Sidmouth, Sidmount	6·49	165	,, .	Treherbert, Tynywaun	24·05	...
,, .	Filleigh, Castle Hill	8·82	...	*Carm* .	Carmarthen Friary	12·98	226
,, .	Barnstaple. N. Dev. Ath.	6·62	149	,, .	Llanwrda	14·38	205
Corn .	Redruth, Trewirgie	10·43	167	*Pemb* .	Haverfordwest, School	12·53	...
,, .	Penzance, Morrab Gdn.	8·65	152	*Card* .	Aberystwyth	7·57	...
,, .	St. Austell, Trevarna	9·37	154	,, .	Cardigan, County Sch.	10·36	...
Soms .	Chewton Mendip	9·21	171	*Brec* .	Crickhowell, Talymaes	11·00	...
,, .	Long Ashton	8·08	...	*Rad* .	Birm W. W. Tyrmynydd	15·86	193
,, .	Street, Millfield	5·72	...	*Mont* .	Lake Vyrnwy	15·48	225
Glos. .	Cirencester, Gwynfa	7·27	217	*Denb* .	Llangynhafal	5·71	...
Here .	Ross, Birchlea	6·52	219	*Mer* .	Dolgelly, Bryntirion	10·77	157
,, .	Ledbury, Underdown	6·39	228	*Carn* .	Llandudno	5·96	192
Salop .	Church Stretton	8·07	238	,, .	Snowdon, L. Llydaw 9	...	...
,, .	Shifnal, Hatton Grange	4·39	171	*Ang* .	Holyhead, Salt Island	6·50	156
Worc .	Ombersley, Holt Lock	4·97	190	,, .	Lligwy	5·77	...
,, .	Blockley	7·08	...	*Isle of Man*			
War .	Farnborough	7·50	255		Douglas, Boro' Cem.	8·47	171
,, .	Birminghm, Edgbaston	5·34	198	*Guernsey*			
Leics .	Thornton Reservoir	4·73	195		St. Peter P't. Grange Rd.	7·58	185

Rainfall : December, 1929 : Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent of Av.
Wigt .	Stoneykirk, Ardwell Ho	..	...	*Suth* .	Loch More, Achfary...	11·20	121
,, .	Pt. William, Monreith	...	...	*Caith* .	Wick	5·60	182
Kirk .	Carsphairn, Shiel	19·34	...	*Ork* .	Pomona, Deerness	5·71	136
,, .	Dumfries, Cargen	8·96	165	*Shet* .	Lerwick	8·13	170
Dumf.	Eskdalemuir Obs.	12·90	184	*Cork* .	Caheragh Rectory	12·40	...
Roxb .	Branxholm	7·81	213	,, .	Dunmanway Rectory	14·72	183
Selk .	Ettrick Manse	...	...	,, .	Ballinacurra	7·88	154
Peeb .	West Linton	6·56	...	,, .	Glanmire, Lota Lo.	10·64	194
Berk .	Marchmont House	3·34	119	*Kerry*.	Valentia Obsy.	11·62	175
Hadd.	North Berwick Res.	2·37	110	,, .	Gearahameen	20·60	...
Midl .	Edinburgh, Roy. Obs.	3·82	178	,, .	Killarney Asylum	12·29	169
Ayr .	Kilmarnock, Agric. C.	8·41	197	,, .	Darrynane Abbey	9·45	161
,, .	Girvan, Pinmore..	11·61	194	*Wat* .	Waterford, Brook Lo...	8·53	182
Renf .	Glasgow, Queen's Pk. .	8·74	203	*Tip* .	Nenagh, Cas. Lough...	8·80	191
,, .	Greenock, Prospect H.	15·58	197	,, .	Roscrea, Timoney Park	7·15	...
Bute .	Rothesay, Ardencraig.	11·17	205	,, .	Cashel, Ballinamona...	8·21	189
,, .	Dougarie Lodge	13·08	...	*Lim* .	Foynes, Coolnanes	9·29	196
Arg .	Ardgour House	18·34	...	,, .	Castleconnel Rec.	7·95	...
,, .	Manse of Glenorchy...	19·59	...	*Clare* .	Inagh, Mount Callan...	12·56	...
,, .	Oban	12·05	...	,, .	Broadford, Hurdlest'n.	8·47	...
,, .	Poltalloch	12·28	192	*Wexf*.	Newtownbarry	10·45	...
,, .	Inveraray Castle...	...	...	,, .	Gorey, Courtown Ho...	8·79	230
,, .	Islay, Eallabus	11·93	201	*Kilk* .	Kilkenny Castle	7·48	216
,, .	Mull, Benmore	18·80	...	*Wic* .	Rathnew, Clonmannon	8·92	...
,, .	Tiree	...	...	*Carl* .	Hacketstown Rectory..	8·48	207
Kinr .	Loch Leven Sluice	4·56	116	*Leix* .	Blandsfort House	7·85	213
Perth .	Loch Dhu	19·45	180	,, .	Mountmellick	7·99	...
,, .	Balquhidder, Stronvar	...	...	*Off'ly* .	Birr Castle	6·50	197
,, .	Crieff, Strathearn Hyd.	6·85	153	*Dubl* .	Dublin, FitzWm. Sq...	6·09	245
,, .	Blair Castle Gardens...	9·03	236	,, .	Balbriggan, Ardgillan.	5·83	201
,, .	Dalnaspidal Lodge	14·01	186	*Mc'th* .	Beauparc, St. Cloud...	5·53	...
Angus.	Kettins School.	6·04	201	,, .	Kells, Headfort	6·25	164
,, .	Dundee, E. Necropolis	3·63	136	*W.M.*	Moate, Coolatore	5·43	...
,, .	Pearsie House	6·85	...	,, .	Mullingar, Belvedere..	6·51	177
,, .	Montrose, Sunnyside...	4·60	166	*Long* .	Castle Forbes Gdns	7·46	187
Aber .	Braemar, Bank	8·50	239	*Gal* .	Ballynahinch Castle...	11·52	154
,, .	Logie Coldstone Sch....	4·85	173	,, .	Galway, Grammar Sch.	7·04	...
,, .	Aberdeen, King's Coll.	6·54	203	*Mayo* .	Mallaranny	...	...
,, .	Fyvie Castle	...	...	,, .	Westport House	8·59	149
Moray.	Gordon Castle	3·91	145	,, .	Delphi Lodge	17·82	...
,, .	Grantown-on-Spey	2·65	98	*Sligo* .	Markree Obsy	7·95	168
Nairn.	Nairn, Delnies	2·03	91	*Cav'n*.	Belturbet, Cloverhill...	5·93	160
Inv .	Kingussie, The Birches	5·55	...	*Ferm* .	Enniskillen, Portora...	...	...
,, .	Loch Quoich, Loan	19·75	135	*Arm* .	Armagh Obsy	5·88	188
,, .	Glenquoich	22·78	155	*Down*.	Fofanny Reservoir	15·01	...
,, .	Inverness, Culduthel R.	2·70	...	,, .	Seaforde	8·90	216
,, .	Arisaig, Faire-na-Squir	7·92	...	,, .	Donaghadee, C. Stn...	6·99	219
,, .	Fort William	16·28	...	,, .	Banbridge, Milltown...	5·07	...
,, .	Skye, Dunvegan	9·13	...	*Antr* .	Belfast, Cavehill Rd...	7·46	...
R & C.	Alness, Ardross Cas ...	4·05	98	,, .	Glenarm Castle	10·70	...
,, .	Ullapool	5·42	...	,, .	Ballymena, Harryville	7·08	159
,, .	Torridon, Bendamph...	13·47	132	*Lon* .	Londonderry, Creggan	7·16	163
,, .	Achnashellach	13·06	...	*Tyr* .	Donaghmore	7·95	...
,, .	Stornoway	7·69	123	,, .	Omagh, Edenfel	7·71	182
Suth .	Lairg	6·74	...	*Don* .	Malin Head	6·80	...
,, .	Tongue	6·20	125	,, .	Dunfanaghy	7·97	...
,, .	Melvich	12·69	295	,, .	Killybegs, Rockmount.	10·56	145

Climatological Table for the British Empire, July, 1929.

STATIONS	PRESSURE: Mean of Day M.S.L. (mb.)	PRESSURE: Diff. from Normal (mb.)	TEMPERATURE: Absolute Max. (°F.)	Absolute Min. (°F.)	Mean Values Max. (°F.)	Mean Values Min. (°F.)	½ max. and min. (°F.)	Diff. from Normal (°F.)	Mean Wet Bulb (°F.)	Relative Humidity (%)	Mean Cloud Am'nt (0—10)	PRECIPITATION: Am'nt (in.)	Diff. from Normal (in.)	Days	BRIGHT SUNSHINE: Hours per day	Percentage of possible
London, Kew Obsy.	1017·5	+ 1·7	87	47	73·6	54·5	64·1	+ 1·4	55·5	77	5·4	2·59	+ 0·42	10	8·3	51
Gibraltar	1017·3	+ 0·5	91	63	84·1	67·9	76·0	+ 1·2	66·1	80	3·6	0·00	− 0·03	0	..	..
Malta	1017·4	+ 2·1	95	64	84·1	71·5	77·9	− 0·4	69·6	67	0·7	0·00	− 0·05	0	12·5	88
St. Helena	1016·6	+ 2·8	60	52	56·9	53·9	55·4	− 3·6	54·6	91	9·5	4·83	+ 0·80	23	..	..
Sierra Leone	1014·3	+ 1·6	86	..	81·7	72·5	77·1	− 1·5	74·8	90	6·6	45·11	+ 9·53	29	..	..
Lagos, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kaduna, Nigeria	1015·6	+ 1·6	87	63	83·1	66·5	74·8	+ 1·2	69·3	82	..	8·77	+ 0·57	19	..	..
Zomba, Nyasaland	1017·8	− 0·7	77	46	72·6	53·0	62·8	+ 0·8	..	70	4·4	0·47	+ 0·12	2	..	..
Salisbury, Rhodesia	1019·3	+ 0·1	75	36	70·3	43·7	57·0	+ 0·9	49·2	51	1·2	0·02	− 0·01	2	9·5	85
Cape Town	1022·6	+ 1·3	74	38	61·5	46·6	54·1	− 0·6	48·0	90	5·1	3·89	+ 0·27	15	..	..
Johannesburg	1023·9	− 0·4	68	29	61·2	41·8	51·5	+ 1·0	40·3	51	1·5	0·02	− 0·31	1	9·1	85
Mauritius	1020·5	+ 0·1	77	56	73·6	61·9	67·7	− 0·6	64·6	74	4·6	2·22	− 0·27	23	7·2	65
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	0·88	+ 0·50	..	..	..
Calcutta, Alipore Obsy.	996·9	− 2·3	97	76	88·2	78·8	83·5	0·0	79·1	91	9·2	11·14	− 1·37	24*	..	..
Bombay	1003·1	− 0·8	89	75	85·9	77·5	81·7	+ 0·4	77·5	.86	9·4	16·08	− 8·19	20*	..	..
Madras	1003·9	− 0·6	104	74	98·6	80·0	89·3	+ 1·9	74·6	59	7·1	1·93	− 2·01	7*	..	..
Colombo, Ceylon	1009·8	+ 0·6	86	74	84·7	77·1	80·9	− 0·2	76·8	79	8·2	2·00	− 4·43	14	6·7	54
Hongkong	1003·2	− 1·6	92	74	85·9	78·1	82·0	− 0·5	78·5	83	8·1	22·70	+ 9·32	22	5·7	43
Sandakan	..	..	91	74	88·7	74·8	81·7	− 0·1	77·5	87	..	7·89	+ 1·34	12	..	..
Sydney, N.S.W.	1018·1	− 0·4	71	37	61·3	43·4	52·3	− 0·4	44·5	70	3·7	3·17	− 1·67	5	6·9	68
Melbourne	1019·0	− 0·1	63	29	53·8	41·0	47·4	− 1·2	42·8	80	6·3	1·61	− 0·22	15	4·2	42
Adelaide	1021·3	+ 0·9	67	35	57·6	43·2	50·4	− 1·3	45·0	72	5·9	2·34	− 0·31	14	4·6	46
Perth, W. Australia	1021·8	+ 2·8	67	40	61·2	46·6	53·9	− 1·3	49·2	78	6·1	5·29	− 1·16	20	5·2	51
Coolgardie	1022·7	+ 2·8	67	30	60·4	38·8	49·6	− 1·6	44·2	70	3·9	0·40	− 0·51	7	..	..
Brisbane	1019·2	+ 0·7	76	40	68·3	45·2	56·7	− 1·8	48·9	66	2·8	0·53	− 1·81	3	8·6	82
Hobart, Tasmania	1013·8	0·0	56	29	50·9	38·7	44·8	− 0·6	39·3	76	6·9	1·66	− 0·48	22	4·1	44
Wellington, N.Z.	1009·7	− 4·2	57	35	50·6	41·7	46·1	− 1·6	44·0	86	7·3	6·91	+ 1·28	25	3·2	34
Suva, Fiji	1013·4	− 0·8	88	62	80·0	69·4	74·7	+ 1·1	70·3	79	6·2	6·91	+ 2·31	16	4·4	39
Apia, Samoa	1011·6	− 0·4	86	69	83·8	72·9	78·4	+ 1·2	75·1	73	4·1	2·95	+ 0·31	10	6·9	61
Kingston, Jamaica	1014·9	+ 0·2	93	72	89·9	73·8	81·9	+ 0·2	71·6	78	3·9	0·65	− 0·97	3	9·1	69
Grenada, W.I.	1010·4	− 2·8	89	72	86·9	73·6	80·3	+ 1·3	74·5	78	4·0	5·95	− 3·84	23	..	..
Toronto	1015·7	+ 1·6	91	46	79·8	57·6	68·7	+ 0·5	60·6	68	3·6	4·43	+ 1·39	10	10·0	66
Winnipeg	1012·6	− 0·1	96	43	80·1	56·1	68·1	+ 1·9	57·5	83	2·9	1·10	− 2·06	8	10·5	66
St. John, N.B.	1015·1	+ 1·4	79	45	69·4	52·6	61·0	+ 0·6	56·8	77	5·6	1·98	− 1·65	12	8·3	54
Victoria, B.C.	1018·2	+ 1·5	84	48	69·4	52·0	60·7	+ 0·4	54·7	72	4·4	0·25	− 0·11	4	11·2	71