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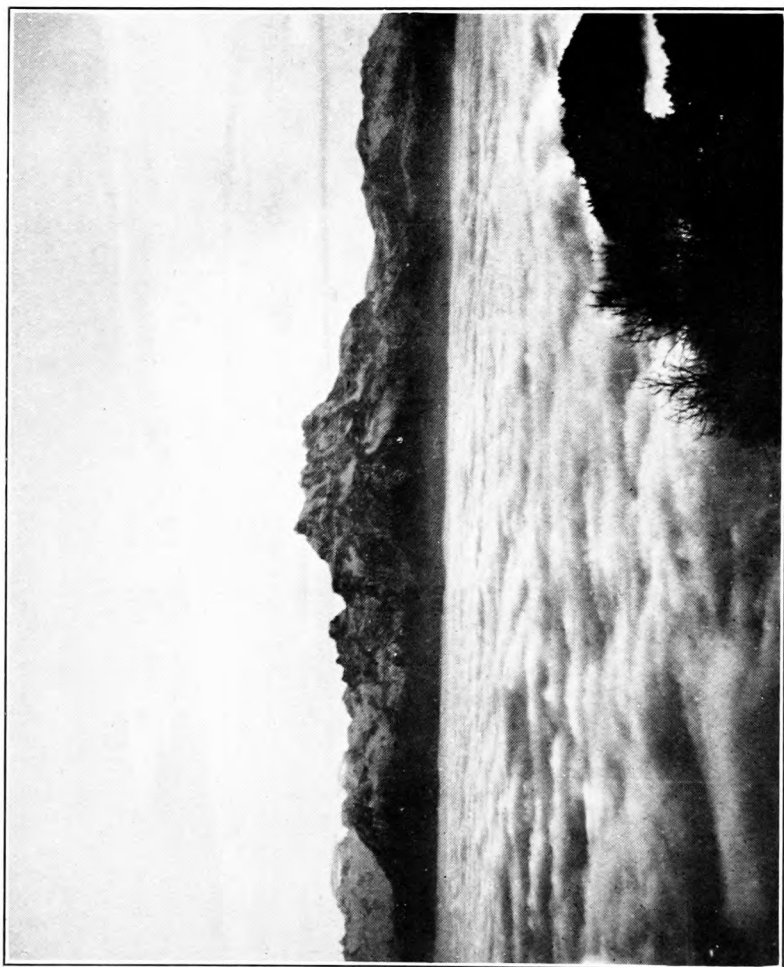




ORANWELL

1950

METEOROLOGICAL  
OFFICE



LA MER DES NUAGES AVEC LES DENTS DU MIDI. LEYSIN, DECEMBER, 1927.  
*see page 11.*

# The Meteorological Magazine



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## Two Centuries of Rain

By J. GLASSPOOLE, M.Sc., Ph.D.

The occurrence of the wet year 1927 adds interest to an attempt to define the annual rainfall over England back to 1727. Homogeneous records at individual stations rarely cover more than 60 years, and it is only by using a number of overlapping records that it has been possible to compute the general rainfall for 200 years. These values are compared with that for 1927. The systematic collection of rainfall observations was first undertaken in this country about 1860, and at this time an endeavour was made to secure earlier records. These were summarised in the *Report of the British Association* for 1866, where general percentage values were given for each of the 140 years 1726 to 1865. The investigation was undertaken primarily to see if older records gave any indication of droughts comparable with those which had occurred during the dry years 1849 to 1858. The question had a practical bearing upon the proposed schemes for supplying large towns with water from considerable distances.

Attention has been directed from time to time to inaccuracies in the computations of these early general values, *e.g.*, the late Mr. G. J. Symons, F.R.S., pointed out the following errors in his own figures: the annual total for 1737 used for Lyndon (Rutland), of 29.94 inches should have been 20.94 inches (see *British Rainfall*, 1896, p. 10), and the record at Exeter was found to have become incorrect owing to the growth of a holly bush. Since the publica-

tion\* of general values for this country for the last sixty years, an attempt has been made to re-compute the values for earlier years, adopting the standard period, 1881 to 1915, and using all the available records.

No information is available for Wales, Scotland or Ireland in these years, so that any long series of annual general values must be confined to England. The computation of such a series was undertaken in three stages, viz., 1868 to 1926, 1820 to 1867 and 1727 to 1819, commencing with the period of most numerous data, and so working to the early years of few records.

Annual values for England and Wales, Scotland, Ireland and the British Isles from 1868 to date were first published in the *Meteorological Magazine* for June, 1923, p. 102, where the method employed is described. The values for England set out in Table I. were computed at the same time, but they have not been published hitherto. Maps were also prepared to show the mean fall of each successive decade from 1870 as a percentage of the standard 35 years' average. Similar maps for earlier decades were subsequently prepared to give a series of ten maps covering the 100 years 1820 to 1919, using all the complete records for any decade. The percentage values plotted on the maps were computed either by using the average for the station for the period 1881 to 1915, or, if the record covered two or more decades, by reading off the percentage from the latest map, which would have fullest data, to give values on the earlier maps. In the case of the decade 1820 to 1829 the map is drawn from the records from 14 fairly well distributed stations, and more recent decades from 35 or more stations. The general fall for each decade estimated from the maps is set out below, together with the two earlier estimates by Mr. Symons:—

	Decadal Maps, 1928, percentage of average, 1881-1915.	British Rainfall, 1881, percentage of average, 1830-1879.	British Association, 1866, percentage of average of long but indefinite period.
1820-9 ... ..	103.5	—	103.2
1830-9 ... ..	102.5	101.4	101.4
1840-9 ... ..	102.9	100.1	102.6
1850-9 ... ..	95.5	93.0	95.2
1860-9 ... ..	101.4	100.4	101.5

The general values back to 1820 originally computed by Symons are therefore well supported by the present investigation, in which additional information has been used. The new series is 1.8 per cent. and 0.4 per cent. greater than those pre-

\* See *Meteorological Magazine*, 58 (1923), p. 102.

viously obtained using different periods as the standard. The method adopted to obtain the annual percentages for the years 1820 to 1867 referred to the period 1881 to 1915, was to take the means of the annual values corresponding with the decadal values in the third and fourth column, and to increase them (generally by 1 per cent.) to give the decadal values set out in the second column. This extends the series of annual percentage values, using the average of the period 1881 to 1915 back to 1820, *i.e.*, to include the years of the cholera epidemics of 1831, 1853 and 1865, and the wet years between 1836 and 1850 "that rained away the corn laws."

For decades before 1820 there is not sufficient information on which to construct percentage maps, so that the critical examination which was rendered possible by such a procedure could not be carried out here. For this period about twice as many records as used by Symons were employed. The average for each station for the period 1881 to 1915 was determined, either from more recent records or from overlapping records, and the rainfall of each year expressed as a percentage of the average. For each year back to 1775 at least six records were available, back to 1757 at least three, and from 1756 to 1727 at least two. The individual values for each year are in reasonably close accord, and the mean was taken in each case to give the general value for England. It may be of some interest to recall that the series goes back practically to the commencement of the Chelsea Waterworks Company, when both the site and the Thames were considered suitable for the abstraction of water for drinking purposes.

A comparison has been made between the mean of the annual percentage values for two stations and the general mean given in Table I. for the 50 years, 1870 to 1919. The two stations were chosen as near as possible to those used to obtain the earliest 30 values of Table I. The series derived from two records gave generally larger departures than the general values (the mean deviation being 14.0 compared with 11.6). The individual values were generally in close agreement, differing by more than 10 per cent. in only 5 years, the largest departure being 17 per cent. This gives some indication of the probable error in the early years of the series. The correlation coefficient between the two series is +0.92.

The present series is in substantial agreement with the earlier values back to 1770 (except in 1774), about 10 per cent. greater from 1760 to 1740, and again in reasonably close agreement in the earliest years. In 1774 Mr. Symons's value of 129 per cent. is based only on the record at Lyndon (Rutland). This is confirmed by a record in the district, but elsewhere the rainfall was much more nearly normal, and the general value given in

Table I is 105 per cent. The main feature of the table is the frequency of dry years from 1730 to 1766. Many are confirmed by early weather diaries. According to Dr. T. Short, of Sheffield, 1731 to 1734, was "mostly droughty. Springs failed in most places," and "December to the first week in June (of 1741) was almost one continued drought." It is not possible to make a quantitative comparison from these historic records, but no drought during the last 200 years appears to have equalled that

TABLE I.

GENERAL RAINFALL OVER ENGLAND AS PER CENT. OF AVERAGE,  
1881 TO 1915.

Year	1720	1730	1740	1750	1760	1770	1780	1790	1800	1810
	%	%	%	%	%	%	%	%	%	%
0	—	85	77	75	100	107	78	91	95	98
1	—	66	67	116	96	79	86	104	99	97
2	—	94	80	95	89	111	121	123	89	102
3	—	84	69	100	123	112	99	87	85	91
4	—	116	100	85	107	105	95	101	94	99
5	—	101	103	97	88	111	82	90	86	97
6	—	109	92	106	87	98	96	88	103	106
7	103	96	104	98	99	96	102	111	90	102
8	112	77	87	100	136	102	69	89	91	104
9	102	103	90	91	91	94	118	107	99	104
Total	—	931	869	963	1016	1015	946	991	931	1000

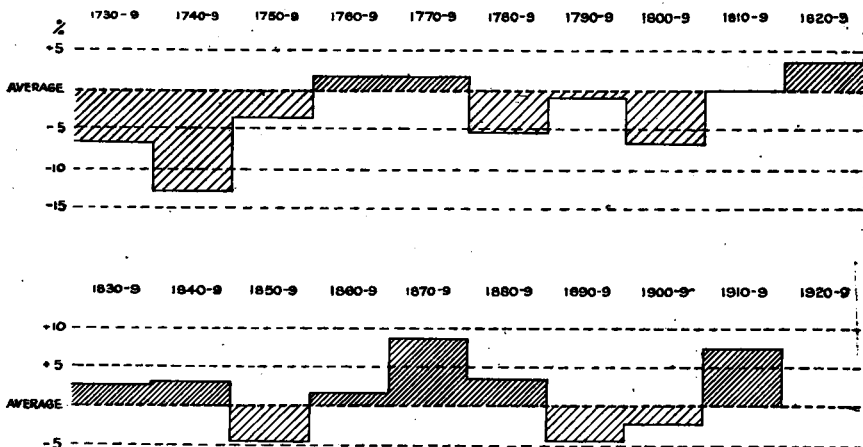
Year	1820	1830	1840	1850	1860	1870	1880	1890	1900	1910	1920
	%	%	%	%	%	%	%	%	%	%	%
0	91	111	89	92	122	81	115	90	109	113	105
1	112	114	124	88	93	97	110	111	87	93	69
2	98	98	95	137	106	144	127	95	84	126	106
3	114	105	109	100	91	89	108	83	128	96	112
4	117	90	86	77	78	93	86	108	88	108	120
5	96	99	97	87	107	116	102	96	86	112	107
6	84	114	106	94	114	118	117	94	101	115	102
7	103	88	96	97	100	125	74	100	99	99	124
8	118	91	129	81	99	111	98	86	90	106	—
9	102	115	98	102	104	110	95	94	106	105	—
Total	1035	1025	1029	955	1014	1084	1032	957	978	1073	—

during 1252 to 1255, which included "the greatest drought in England," according to Dr. T. Short, or 1716, when "thousands of persons passed across on foot, under the arches of London Bridge." The latter case is perhaps more striking as presenting the antithesis of the recent disastrous floods in London. On September 14th, 1716, following the drought, a strong west-south-west wind not only prevented the tide from coming in for twenty-four hours, but drove forward the fresh water so that there was only a narrow channel in the middle, some 10 yards wide and very shallow.

The three wettest years in the series were 1768, 1852 and 1872,

with 136, 137 and 144 per cent. respectively. There was no year as dry as 1921, with 69 per cent., since 1788. The values for the years 1731, 1741 and 1743 are equally small, but as they are based on few records the departures from the normal are likely to be larger than the proper amount, and it is therefore reasonable to conclude that no year drier than 1921 occurred in the last two centuries. It would be expected that as the departures from the average are greater in the wettest years than in the driest years, years with a rainfall below the average would be more numerous. That is the case, for out of the 200 years, 87 were in excess of the average rainfall and 106 were deficient, the percentage being 100 in the remaining 7 years.

There were 9 consecutive wet years from 1875 to 1883, but the longest run of dry years was only 6, viz., from 1800 to 1805. The recent values are remarkable in that out of the last 14 years only two, 1921 and 1917, received less than the average. There



GENERAL RAINFALL, ENGLAND, DECADAL MEANS 1730 TO 1919 AS PERCENTAGE DEPARTURES FROM AVERAGE 1881 TO 1915

is no other run of wet years in the series comparable to this, but as many as 14 out of the 16 years 1800 to 1815 were dry. It is noteworthy that the deficiency of 1921 was more than made up in the following three years.

For the 100 years 1827 to 1926, the computed fall is rather more than that of the standard period 1881 to 1915, while that of the 100 years 1727 to 1826 is rather less than the average, the mean percentage values being 101.9 and 96.6 respectively. The diagram illustrates that there have been two runs of three consecutive dry decades, and one of two decades. Similarly, there were two runs of three consecutive wet decades and one of two decades. The decade 1810 to 1819 received the normal fall with 5 wet and 5 dry years.

*Conclusion.* A series of 200 annual values for the rainfall

of England is set out in Table I. The values back to 1820, *i.e.*, for over 100 years, are well supported, those for the preceding 50 years, although less reliable, are based on at least six records, and the earlier values, while necessarily even less reliable, are based on at least two records which support each other. The fall over England during 1927 of 124 per cent. has been exceeded in eight years out of the last 200. The three years 1768, 1852 and 1872 were markedly wetter than 1927.

## Observations of Temperature and Humidity in certain Occluded Cyclones

In the February and March numbers of *Ciel et Terre* for 1927, Jaumotte discusses some observations of the temperature, pressure and humidity in the upper air made near Brussels with the aid of aeroplanes, in order to see whether these confirm the views advanced a few years ago by V. and J. Bjerknes, H. Solberg, and other Norwegian meteorologists, with regard to the structure and evolution of the cyclones of temperate latitudes.

By far the most interesting of these soundings was one made on July 2nd, 1924. At that time an area of rain, associated with a deep depression northwest of Ireland, was approaching Belgium. This depression was in the "occluded" stage: at

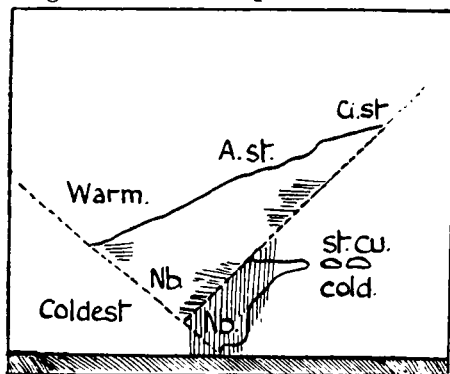


FIG. 1.

The general air movement is supposed to be from left to right, and the dotted lines showing the boundaries of the occluded warm air are shown some hundred-fold more steeply inclined to the horizontal than would normally be the case. The sounding under discussion was made in that part of the diagram where stratocumulus clouds are indicated, and should reveal at a certain height a surface of discontinuity where the occluded warm air is first encountered. Examination of Fig. 2, where temperature is plotted against pressure, and the relative humidity is written alongside, does in fact show such a transition at a height of about

6 p.m. on June 30th, when centred north of the Azores, it had shown a warm sector on its southern side, characterised by damp warm southwest winds, obviously of equatorial origin, which soon disappeared from the level of the sea to be replaced by cool westerly winds of polar origin. In Fig. 1 a section through such an occluded cyclone is shown.



12,000 feet, at the base of a thick sheet of alto-stratus or alto-cumulus cloud. There was in addition, at about 5,000 feet, a sheet of strato-cumulus and above it a slight inversion of temperature with very low humidity. A similar inversion to this last was found to be persistent in the southeast of England on the previous morning under anticyclonic conditions, and was not completely broken down by the rise of temperature in the

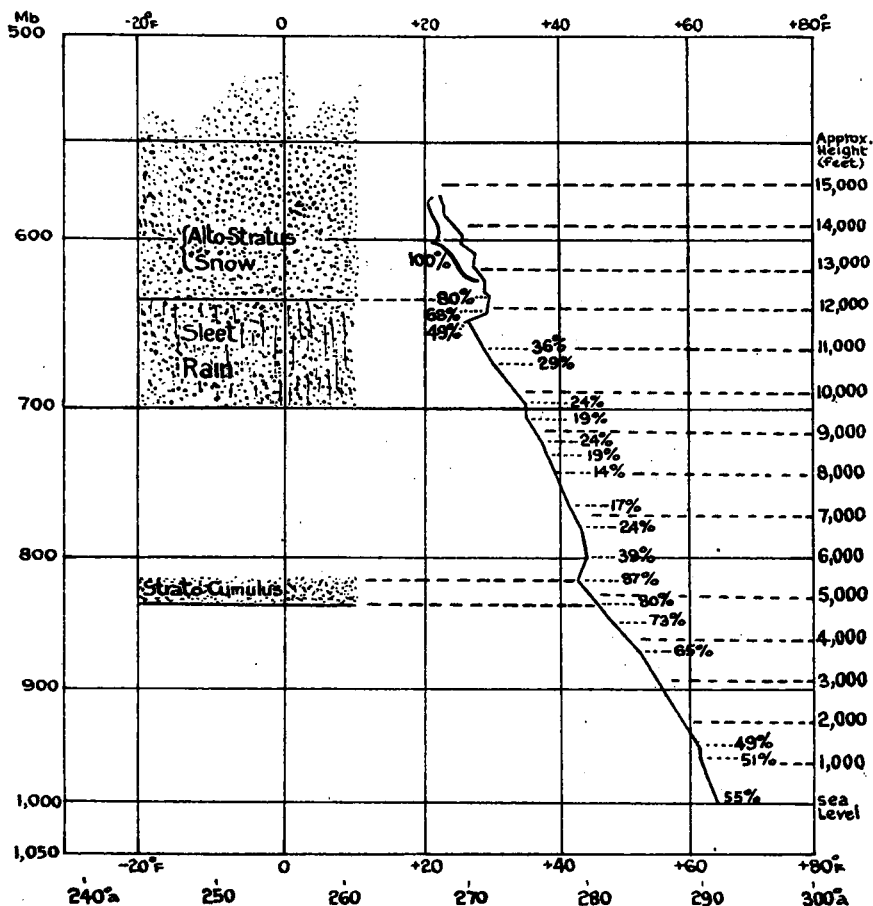


FIG. 2 BRUSSELS, 8h. G.M.T. JULY 2, 1924.

middle of the day. Its presence at the time of our ascent may be regarded as of little importance in regard to the evolution of the depression.

The most interesting point in connexion with this sounding is the strong evidence that the air above 12,000 feet had actually been resting upon the surface of the sea north of the Azores, about a day and a half earlier. An average speed northeastwards of 32 m.p.h. would have brought the air to Belgium at the correct time, a speed which is in good agreement with the average

upper winds deduced from the pressure gradient out on the Atlantic, and from such French pilot balloon ascents as were available at about the time when the air passed over northwest France. Moreover when the temperature was calculated, to which air on the sea in the warm sector should fall after reduction of its pressure to the value of 643 millibars found at the bottom surface of the warm damp air above 12,000 feet over Belgium, the result agreed to within about a degree with the temperature of 29° F. actually observed at that surface.

In another interesting ascent through an occlusion, made on July 10th, 1925, the base of the warm moist air was encountered at about 11,500 feet, and in a second ascent about five hours later, when the main mass of occluded air should have been nearly overhead, it was encountered at about 9,000 feet. In this case, and also in two further examples of occlusions, the Norwegian conception of occluded cyclones receives definite observational support.

E. V. NEWNHAM.

### Discussions at the Meteorological Office

The subjects for discussion for the next meetings will be :—  
February 27th. *Über den Einfluss des Golfstromes auf die Winter temperatur in Europa.* By J. W. Sandström (Met. Zs. 43, 1926, pp. 401-11). *Opener*—Mr. A. Walters.

March 12th. *Ratio of heat losses by conduction and by evaporation from any water surface.* By I. S. Bowen (Physic Rev., Minneapolis, Minn., 27, 1926, pp. 779-87). *Evaporation from lakes.* By N. W. Cummings and B. Richardson (*idem.*, 30, 1927, pp. 527-34) and other papers. *Opener*—Mr. R. Corless, M.A.

### Royal Meteorological Society

The Annual General Meeting of this Society was held on Wednesday, January 18th, at 49 Cromwell Road, South Kensington, Sir Gilbert Walker, C.S.I., F.R.S., President, being in the chair.

The Report of the Council for 1927 was read and adopted, and the Council for 1928 duly elected, the new President being Sir Richard Gregory, D.Sc., LL.D.

The Symons Gold Medal, which is awarded biennially for distinguished work done in connexion with meteorological science, was presented to Professor Dr. Hugo Hergesell, Hon. Mem., Director of the Aeronautical Observatory, Lindenberg. After receiving the medal, and thanking the Fellows of the Society for the award, Prof. Dr. Hergesell delivered a short address on "The Observation of Clouds with special reference to the safety of Aviation." The address described the methods in use at

Lindenberg Observatory, where soundings of the air up to 3,000 metres or more are made regularly twice a day, by means of kites, kite-balloons or captive balloons, according to the wind velocity. From the records of temperature and especially humidity obtained in this way, the heights and thicknesses of the different cloud layers can be deduced, and this information is then included in the reports broadcast from the Observatory. At Tempelhof, meteorological aeroplane flights are made whenever possible, the aeroplane being equipped with a horizontal gyroscope for flying through cloud. Other information about cloud heights and movements is obtained by the use of an inverting range finder.

Sir Gilbert Walker also delivered an address on "World Weather," of which the following is an abstract :—

Comparisons by graphical methods of variations of pressure, temperature and rainfall have during the past half century brought to light a number of relationships between conditions at places separated by considerable distances ; and then these have in recent years been studied systematically by taking 30 centres widely distributed over the earth and calculating by statistical methods the relationships between their seasonal values. It appears that there are three main oscillations or swayings :—(1) the North Atlantic, (2) the North Pacific, and (3) the Southern, affecting the Pacific and the Indian Oceans. These relationships have obvious applications for seasonal forecasting.

---

## Correspondence

To the Editor, *The Meteorological Magazine*

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### Weather and Antiquaries

In your article on the above subject, you mention that a shingle bar grew across the mouth of the Little Hundred River in Suffolk in the thirteenth or fourteenth century.

In this connexion it is well to recall that "a great convulsion of the elements" is noticed by all the chroniclers in 1287. One effect of that storm was to submerge Winchelsea and Boomehill, to break up the sandbanks on which they stood, and to change the course of the River Rother from its former artificial channel to that which it now follows on its passage to the sea by Rye.\* The choking up of the Priory Brook at Hastings and the successive loss of two harbours by that town may be difficult to date exactly. Corresponding changes at Seaford, Pevensey, Hythe, Folkestone and other places on the south-east coast have attracted much attention, and have invariably been attributed to the "Law of Eastward Drift," of which Prof. Burrows had

---

\* Cinque Ports. By Montagu Burrows, ed. 1903, p. 16.

so much to say. The Royal Commission on coastal erosion generally accepted this explanation of the records.

Nevertheless, the accumulation of evidence pointing to substantial variations in rainfall seems to call for a reconsideration of this matter. Has this eastward drift of shingle been constant, and if not what are the causes of its variation? Have fluctuations in the discharge of these streams affected the growth of shoals at their mouths? If so, have such fluctuations been due to changes in rainfall or to more recondite alterations in underground drainage? All these questions seem to demand fresh consideration, especially in view of the curious evidence of climatic changes from Greenland.

In the first instance, the solution of such problems must be dependent upon the adequate collection of facts by archæologists, geologists and meteorologists. At present data are lacking, and further search for records is of prime importance. As soon as the history of these changes can be written clearly and with certainty, there can be no doubt that it will deserve the most careful attention of those practical men in whose hands rests the future policy of the country in the matter of the choice of sites for new ports, and in the development of those which already exist.

Your reference to the drought in Sussex in the time of St. Wilfrid (A.D. 681), recalls a notable achievement by a Kentish saint which must have been nearly contemporaneous. Unfortunately I am unable to give the original reference to Capgrave's *Nova Legenda Angliæ*, but this source is quoted in Lambard's *Perambulation of Kent*, ed. 1826, p. 152, when we are told of St. Eanswide "that she haled and drewe water over the hils and rockes against nature from Swecton a mile off to her Oratorie at the sea-side." This seems to be an account of the first (post-Roman) artificial water-supply in the country. St. Eanswide was the daughter of Eadbald, King of Kent (616—640), and was the first Prioress of St. Peter's Priory near Folkestone. Her portrait is to be seen on the seal of the Mayor of that town reproduced on p. 812 of Boy's *Collections for a History of Sandwich*.

GEORGE M. MEYER.

1, Victoria Terrace South, Low Fell, Gateshead. November 24th, 1927.

### The Cold Weather of December at Guernsey

The bitterly cold weather of the last half of December in England, extended its ramifications to Guernsey, where the month's mean temperature, 41·8° F., made it the coldest December at this station for at least 34 years. The previous coldest December was that of 1917, mean 41·9° F. The coldest day last month,

the 18th, gave a minimum temperature of  $23.4^{\circ}$  F., and a mean of  $26.4^{\circ}$  F. The lowest maximum,  $29.1^{\circ}$  F. occurred the next day. To find a colder day than December 18th, which was as much as  $19.5^{\circ}$  F. colder than the normal, we have to go back to the still memorable February of 1895.

Last month's intense cold was of short duration (5 days), and the snap that followed in the ending week of the year was much less severe as regards cold, but the strength of the easterly gale isolated the island from the mainland for the 3 days, 26th to 28th—an unprecedented occurrence.

One remarkable feature of both cold snaps was that not a flake of snow fell—a fortunate immunity in which I believe all the islands of this favoured group participated.

BASIL T. ROWSWELL.

*Les Blanchés, St. Martin's, Guernsey. January 23rd, 1928.*

### Cloud at Leysin

I read in the Press that half Europe is under fog, and it occurred to me, you may be interested to learn how it appears from my mountain perch (4,500 ft.). For about ten days, perhaps less, we have not seen the Rhone basin (the 20 miles of its length previous to its entering Lake Geneva) at all, on account of a dense layer of cloud lying below us. This layer has remained nearly stationary night and day throughout that time. Its upper face is as clean cut as it could be, like the most perfectly defined cumulus you ever saw. This face has varied from perfectly even, through small billowy tufts, to sometimes long undulating waves of the ocean roller type. With the sun glinting their tops they are a magnificent picture. The top of this layer has been for the most part at about 2,500 ft. (the Rhone at this point is 1,500 ft.), but the layer seems to be suspended in very critical equilibrium, because it slowly rises and falls. It will rise perhaps 500 ft. in an hour and as slowly recede. Yesterday and to-day it has been gradually rising, and has attained about 4,000 ft. to-day.

Local disturbances are quite common—a small area will appear to boil slowly, so that a hemisphere will rise above the mean level, like a man's bald head; sometimes these disturbances take the form of a small local horizontal whirl. I ought perhaps to explain this sea of cloud in our view is 7 miles wide and upwards of 25 miles long. The sky above varies from fully overcast (only rarely), half overcast with cirrus to pure blue sky. These higher clouds have not descended lower than 8,000 ft. and have been generally over 15,000. I quote these figures fairly confidently, because I know the heights of the various peaks around, and it is remarkable that if the clouds are

at 8,000 on one side of the plain they will be the same height almost invariably on the other side 7 miles away.

I was noticing a peculiar thing to-day. The upper clouds were at perhaps 12,000 ft., the fog layer top-face about 4,000 ft. Both appeared to be perfectly motionless and yet a good breeze was blowing at my level, 4,500 ft., showing that a strata of air can move swiftly along without, by friction, disturbing the upper and lower faces. Another pretty sight is to see waves of this layer roll along to the mountain side and swish up it like a wave upon a beach. The only difference is that the wave rises up the mountain concave upwards, *i.e.*, they do not roll in as billows do on a sea-shore but as a wave strikes the face of a cliff and curls upwards. It takes a quarter of an hour to complete the phenomena and often much longer instead of the usual few seconds.

The photograph in the frontispiece shows the view of Les Dents du Midi from Leysin in December, 1927. The distance across the clouds is 7 miles and to Les Dents du Midi in the centre of the view is 13 miles. The top of the clouds is about 4,000 feet and the valley is 2,500 feet below the cloud surface. It appears that the cloud sometimes reaches the ground below, but not always.

J. J. SHAW.

*Mon Repos, Leysin, Switzerland, December 1st, 1927.*

### The Significance of Correlation Coefficients

In 1921 there was published in the *Meteorological Magazine* a note in which the following rule, due to Mr. W. H. Dines, was stated.\*

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

Mr. Dines did not give a general demonstration, and my proof, which was printed in the note, was not quite satisfactory. Consideration of the criticisms which have been made has convinced me that the difficulty lies in the wording of the rule: there is no difficulty in demonstrating a certain mathematical equation. It is a matter of opinion whether the rule as enunciated by Mr. Dines is equivalent to this equation.

Let  $X$  and  $Y$  be corresponding values of two variables. No assumption need be made as to which is cause and which is effect. Let the means of  $n$  values of each of the variables be taken, and let  $x$  and  $y$  be the departures of  $X$  and  $Y$  from these means. Let  $\sigma_x$  and  $\sigma_y$  be the standard deviations. Further,

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\* Vol. 56 (1921) p. 20. The letters  $X$  and  $Y$  have been written for Mr. Dines's A and M.

let  $r$  be the correlation coefficient determined by the  $n$  values of  $x$  and  $y$ . By definition

$$n\sigma_x^2 = \sum x^2, \quad n\sigma_y^2 = \sum y^2$$

and

$$nr\sigma_x\sigma_y = \sum xy$$

Now consider the approximation to  $y$ , which can be obtained by the use of a relation such as

$$y^1 = \alpha x$$

in which  $\alpha$  is a constant and  $y^1$  is the required approximation.

We know that, if the approximation satisfies the condition that  $\sum (y^1 - y)^2$  is as small as possible, then the coefficient  $\alpha$  must be given by the equation

$$\alpha = r \frac{\sigma_y}{\sigma_x}$$

The equation for determining  $y^1$  is therefore the "regression equation"

$$\frac{y^1}{\sigma_y} = r \frac{x}{\sigma_x}$$

On the other hand,  $x$  is related to  $y$  by the equation

$$\frac{x}{\sigma_x} = r \frac{y}{\sigma_y} + \xi$$

in which  $\xi$  is written for a quantity not correlated with  $y$ , the sum  $\sum y\xi$  being zero.

It follows that  $y^1 = r^2 y + r\sigma_y \xi$

This equation may be written

$$y^1 = r^2 y + \eta \quad \dots\dots\dots (A)$$

Here  $\eta$ , being identical with  $r\sigma_y \xi$ , is not correlated with  $y$ .

With the equation (A) we may associate the relation

$$\sigma_{y^1} = r\sigma_y \quad \dots\dots\dots (B)$$

which is an immediate deduction from the regression equation.

The significance of (A) is that the computed variations of  $y^1$  are equivalent to  $r^2$  of the true variations of  $y$ , combined algebraically with random, irrelevant variations. This statement embodies my interpretation of Dines's rule.

The significance of (B) is that the variations of  $y^1$  are on a scale smaller than those of  $y$  in the ratio  $r$  to 1. This equation of itself gives no information as to whether the variations of  $y^1$  and  $y$  are in sympathy with each other.

The point which I want to emphasize is that the equation (A) justifies us in regarding  $r^2$  as the figure of merit of a correlation coefficient  $r$ . It is  $r^2$  which measures the advantage which will be derived from the use of a correlation coefficient in forecasting weather, or in any similar application of statistics.

Owing, I presume, to the reluctance of the Editor to inflict mathematics on the readers of the *Meteorological Magazine*, the foregoing note has been awaiting publication for some months. Meanwhile two notes on the subject by Sir Gilbert Walker and

Dr. Woolard have appeared in the *Monthly Weather Review*.\* Sir Gilbert is unable to find any use for Dines's rule. Dr. Woolard cuts down its utility by saying "if, as frequently happens," a certain term "is practically zero," then the rule holds.

Under these circumstances it seems best to admit that the original wording of the rule is so misleading that it must be discarded entirely. The new rule which I want to substitute is not a statement about cause and effect, but a statement about the application of regression equations. It runs as follows:

*If the correlation coefficient for two variables  $X$  and  $Y$  is  $r$ , and if the appropriate regression equation is used for estimating  $X$  from known values of  $Y$ , then  $x^1$ , the estimated departure of  $X$  from the mean, is related to  $x$ , the true departure of  $X$  from the mean, by an equation of the type*

$$x^1 = r^2x + \xi$$

*in which  $\xi$  is a variable quantity not correlated with  $x$ .*

The rule involves no assumptions as to the distribution of the values of  $x$  and  $y$  and no assumption as to the existence of other correlated variables.†

As an example of the new rule, consider the following example. Suppose that the correlation coefficient for annual rainfall at two places is  $\frac{1}{2}$ . The average rainfall at A is 20 inches. I know that the rainfall at A in a particular year is 28 inches; you know the rainfall at B for that year, and estimate the rainfall at A by using the regression equation. "On the average" your estimate will be 22 inches. There is no reason to suppose you will estimate more than 22 inches rather than less. The helpfulness of the correlation in estimating the rainfall at A is evidently measured by the value of  $r^2$ , which is  $\frac{1}{4}$ .

F. J. W. WHIPPLE.

### Remarkable Hailstorm

Mr. C. S. Durst has drawn my attention to an interesting paper by Becquerel communicated to the Académie des Sciences on November 13th, 1865, entitled "Mémoire sur les zones d'Orages à Grêle." In this paper is given a description of a remarkable hailstorm observed at Clermont-Ferrand on July 3rd, 1863. The day in question was exceedingly hot, and by 3 p.m. the sky was covered by an enormous nimbus cloud, with flashes of lightning in quick succession. About 6 p.m. there rapidly approached from west a cloud whose height was estimated to be

\* *M.W.Rev.*, Washington, 55 (1927), pp. 459, 460.

† In the notation which I have introduced elsewhere

$$\xi = r(1-r^2)^{\frac{1}{2}} \sigma_x Ca$$

Ca being written for a casual number which has the standard deviation unity and is not correlated with  $x$ .



about 1,500 metres, whose form resembled a huge net. The portions of the network showed violent agitation, and soon after the arrival of the cloud there was a violent hailstorm lasting for about five minutes, the hailstones having the size of nuts. During the fall of the hail there was no wind. The most remarkable feature of this particular storm was the distribution of hail over the ground. The fall of hail was so violent that it caused considerable damage wherever it fell. M. Lecoq, who observed the storm, and described it in the *Comptes Rendus*, Vol. XXXVII, p. 75, stated that the damage produced by the hail was limited to small patches, which were surrounded by undamaged zones, forming a network whose meshes were irregular, but roughly 60 to 100 metres apart.

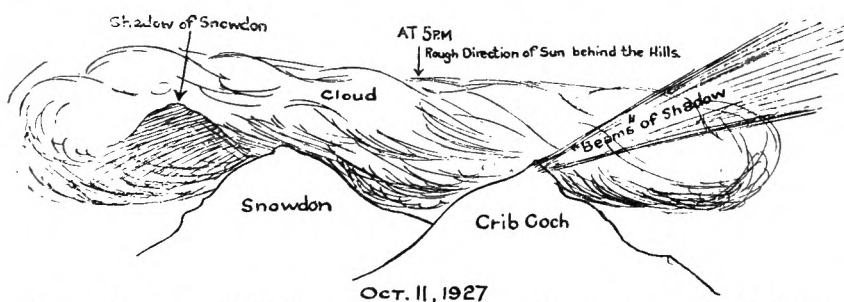
The distribution of hail corresponds to the form of the lower cloud which form recalls Bénard's cellular divisions in unstable liquids, a note on which appeared in the *Meteorological Magazine* for February 1925, p. 1. I should be very much interested to know whether any further observations of similar distribution of hail or rain have ever been noted, since they have a very definite bearing on the physics and dynamics of the atmosphere.

D. BRUNT.

[A brief scrutiny of the literature failed to show any similar case.—Ed. *M.M.*]

### A Sideways Mirage

Perhaps the following phenomena of the sky which I observed during a walk from Capel Curig to Pen-y-Gwryd may be of interest to you, while if you can suggest an explanation it will satisfy a natural academic curiosity of the writer.



At 17h. 5m. G.M.T. on October 11th, the sun had fallen behind the Snowdon range, and the range was backed by a large golden, fleecy cloud, on which was outlined a dark, well-defined shadow of Snowdon, persisting for some five or ten minutes. I find it difficult to understand how the shadow was cast in the direction of the sun, as the cloud was manifestly on the far side of the hills, the atmosphere was clear, and the eastern sky was almost cloudless.

At 17h. 20m. the cloud had disappeared, and the western horizon was clear except for some distant striations, when suddenly there appeared over Crib Goch a streaky golden outline of its summit, which faded out after perhaps 15 seconds or half a minute.

W. G. EMMETT.

*Elm Avenue, Beeston, Nottingham. October 12th, 1927.*

[Cases are on record in which sideways mirages have been observed. A mirage is the appearance assumed by a single object which can be seen in two different directions simultaneously: in one direction the rays of light may proceed in straight lines from the object to the eye; in the other they may be bent slightly, owing to the refraction effects in air of varying density. The second image of Snowdon would in that case be reversed (*i.e.*, right to left and left to right).

Sideways mirages are much rarer than vertically displaced mirages, and the appearance of Crib Goch seen later might perhaps be explained as an ordinary mirage as often seen in air arranged in layers of varying density.

It would be difficult to say how the varying densities were produced, but it may perhaps be tentatively suggested that as the air was apparently clear, the temperature of the air in the shadow of the mountains might fall rapidly as the shadow increased in extent, so that appreciable temperature differences would form near the boundary of the shadow.—R. CORLESS.]

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### Road Mirages

In connexion with the letter on the above subject by Mr. T. W. Vernon Jones in the December number of the *Meteorological Magazine*, Mr. H. E. Wimperis, M.A., calls our attention to a letter which appeared in *Nature* dated August 20th, 1903, and which was quoted in the *Daily Telegraph* of the following day. In this letter Mr. Wimperis described a road mirage which he had observed in Putney on August 17th, 1903.

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### Mirage at Sea

In an interesting note on "Road Mirages," in the December issue of the *Meteorological Magazine*, the writer points out that one would expect the temperature distribution of the air, which is supposed to be responsible for the phenomenon, would be disturbed by the constant passing of vehicles.

Although not dealing with land surface, it may be interesting to hear of the formation of mirages of ships as seen from the Meteorological Office, Holyhead. From Salt Island the only unrestricted view of the sea is towards north-northeast, and the ships passing Carmel Head are some ten miles away. The shapes of these ships are distorted when the temperature of the

sea is higher than the temperature of the air, and the visibility is such that the ships can be seen clearly, but it would seem that wind force makes no difference to their formation.

It is suggested that in this case the mirage is not formed by the temperature distribution of the air near the sea, but by the differences of temperature of the sea itself and the temperature of the air above it.

It would be interesting to compare the reflecting powers of the two surfaces (road and sea).

H. L. PACE.

*Salt Island, Holyhead. December 23rd, 1927.*

## NOTES AND QUERIES

### The Thames Floods of January 7th

Shortly after midnight on January 7th, an abnormal rise of the Thames occurred, the tidal reaches of the river attaining their highest level for at least fifty years. Serious flooding resulted in the City, Southwark, Westminster and as far west as Putney and Hammersmith. In the low-lying areas fourteen people lost their lives, through being trapped in basements, and a very large amount of material damage was done by the water.

After the Christmas snowstorm, a thaw set in gradually on December 31st and January 1st, and was general by January 2nd. Flooding became widespread in the Thames valley above London, but the areas affected were chiefly those in which floods occur almost every year. During the first week of 1928, the rainfall in London and Surrey generally averaged about one inch, which is nearly twice the normal for the week. The river continued to rise, the flow at Teddington weir, as reported in *The Times*, increasing from 5,200 million gallons on January 1st to 9,500 million gallons on January 7th, by which date, however, a gradual fall had set in along the upper reaches of the river. The river was thus already in a swollen condition, but the severity of the flood in London appears to have been due more to the circumstance that a spring tide coincided with high winds from the north-west in the North Sea than to the water of the river itself.

On January 6th, at 1 a.m. a depression was approaching the Hebrides and the centre of this depression moved east-south-east at a rate of about 60 m.p.h. towards Denmark. In its rear there was a steep pressure gradient, and the winds rose rapidly, probably reaching gale force during the evening over most of the North Sea between the English coast and Holland. Over east and south-east England and the eastern Channel, the winds blew strongly from between south-west and west during the morning, and veered towards north-west in the afternoon. Winds up to gale force prevailed until 6 p.m., but later in the

evening there was a general decrease of wind force, and by 1 a.m. on the 7th, the winds over south-east England had fallen light, but it seems that by that time they had sufficed to drive large quantities of sea water into the estuary, to be carried towards London by the tide.

The predicted height of the tide in the early morning of January 7th was approximately 21 feet at London Bridge. On two occasions in recent years, September 26th, 1926, and November 1st, 1921, tides have occurred in the Thames sufficiently high to arouse Press comment. On each of these occasions the predicted height was approximately 23 feet; it may be remarked that an even higher figure, 25 feet, was predicted for September 24th, 1926, associated with a combination of full moon and moon's perigee on September 21st. On this occasion, however (September, 1926), the winds were mainly light, and only minor flooding occurred, while in November, 1921, although the predicted height was about the same, the tram-lines on the Embankment were under water, and wharves in the City were flooded\*; on this occasion, the weather conditions resembled those of January, 1928. On October 31st and November 1st, 1921, a depression moved rapidly east-north-east from between Iceland and the Faroes to central Norway. By 7 a.m. on November 1st, north to north-west gales were blowing over most of the North Sea, and these continued in the eastern part of the region for 24 hours, but by 1 p.m. the winds over east and south-east England had become mainly moderate. The flood occurred in the afternoon.

Some reference may be made to earlier floods in the Thames. In 1894, the flow at Teddington was recorded as 20,000 million gallons on November 18th, and enormous areas of country were under water.† *The Times* mentions that in 1882 occurred a high tide which swept away Charing Cross pier. In *Symons's Meteorological Magazine* for February 1869, p. 11, appears the statement under the heading "High Tides and Heavy Gales": "Last year, the Thames rose to an unusual height, flooding the densely inhabited district of Westminster, which lies near the river, and overflowing the lowlands of Battersea and Chelsea, as far as Kew." On January 11th, 1877‡ "a high flood which had been accumulating from about Christmas, reached its maximum on this day . . . as it synchronised with a very high tide, there was great destruction in Southwark and all the low-lying places along the river." In 479, the Thames was much flooded, both above and below London, and great damage was caused, but the earliest recorded

\* *Meteorological Magazine*, 56 (1921), p. 295.

† *Symons's Meteorological Magazine*, 30 (1895), p. 71.

‡ The November floods of 1894 in the Thames Valley. By G. J. Symons and G. Chatterton. *London, Q.J.R. Meteor. Soc.*, 21 (1895), p. 189.

Thames flood was in A.D. 9, when many inhabitants are said to have been destroyed.

The two following references of high tides in the Thames, contributed by Mr. Richard Cooke, of Detling, Maidstone, Kent, may also be mentioned.

From the *Journal of the British Archæological Association*. Vol. XXXII., Pt. II., Dec., 1926.

Page 171. "The Monastery of Bermondsey."

Bermondsey suffered severely from floods. In 1294 on October 18 there was a tremendous inundation when the Thames waters rushed through a great breach in the embankment at Rotherhithe and much damage was done. *Flores Historiarum*, Vol. III., page 93 Rolls Series.

Page 179.

In 1338 another inundation of the Thames did great damage and a respite of payment was granted. *Cal. of Close Rolls* 1333-7, p. 182.

S. T. A. MIRRLEES.

### Memoirs of the Royal Meteorological Society

In the *Meteorological Magazine* for July 1926, there appeared a description of the circumstances which led to the initiation of the series of *Memoirs*, with brief summaries of the first three of the series. The completion of the first volume of ten numbers affords us an opportunity of congratulating the Society on the success of this valuable new departure.

The titles and authors of the later numbers of the first volume are as follows :—

- No. 4. "The variance of upper wind and the accumulation of mass," by L. F. Richardson, D. Proctor, and R. C. Smith.
- No. 5. "The Nile flood and world weather," by E. W. Bliss.
- No. 6. "British winters and world weather," by E. W. Bliss.
- No. 7. "On the relation between temperature changes and wind structure in the upper atmosphere," by C. K. M. Douglas.
- No. 8. "Geopotential and height in a sounding with a registering balloon," by Sir Napier Shaw.
- No. 9. "On periodicity and its existence in European weather," by Sir Gilbert T. Walker.
- No. 10. "The mean cloudiness over the earth," by C. E. P. Brooks.

The first volume of the *Memoirs* has thus already ranged over a large part of the field of meteorology, though as would be expected, the theoretical aspect predominates. The grant of £150 from the Government Publication Grant has again been renewed, and the Society has already made a start with volume 2 of the *Memoirs*.

### Approximate Equations for the Determination at Cranwell of Screen Minimum Temperatures during Radiation Nights in Winter from Data of the preceding 15h.

Defining "winter" as the months October to March (inclusive) and a "radiation night" as one in which the mean cloud amount at 18h., 1h., and 7h. was four-tenths or less, this note embodies an attempt to determine for such radiation nights during winter the relation between the dew point at 15h. and the succeeding night screen minimum temperature measured at 7h. the following morning. The period brought under review stretched from October 1st, 1920, to March 31st, 1927. The thermometers employed have standard and very good exposures, on flat and open ground approximately 240 feet above sea level.

In determining the equations representing the relationships by the usual graphical method, a three-fold differentiation with regard to wind force during the night as measured by a Dines anemometer whose head is 43 feet above ground was made, taking the average of the readings at 18h., 1h. and 7h. as the deciding factor. The three wind groups were (A) a mean of 8 miles an hour or less, (B) a mean of between 8 and 15 miles an hour, and (C) a mean greater than 15 miles an hour. Each of these three 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 = or > 85	T = D - 6	32
	H < 85	T = D - 8	33
8 m.p.h. to 15 m.p.h.	H = or > 85	T = D - 1	31
	H < 85	T = D - 4	49
15 m.p.h. or more	H = or > 85	T = D	25
	H < 85	T = D - 2	23

D and H being observed at 15h. and a mean value of the wind speed for the night forecasted, T may be obtained using the appropriate equation. The results so gained approximate with great fidelity to the readings actually registered. As would be expected, low relative humidity and a stagnant atmosphere both lead to low night minimum temperatures. It is possible that though the equations were derived from a consideration of

Cranwell data they may have an application considerably beyond Cranwell confines.

In all the cases heretofore treated D was greater than 32° F. There were, however, a few cases available in which D was less than 32° F., and although the number of these cases was insufficient to justify sound generalization, it was clearly to be noted that the values of T actually registered were considerably lower than those that would have been computed from the equations. It therefore needs to be emphasised that the equations only hold for values of D greater than 32° F.

W. H. PICK.  
J. PATON.

Radiation from the Sky

RADIATION MEASURED AT BENSON, OXON, 1927.

Unit: one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays)				
Averages for Readings				
		Oct.	Nov.	Dec.
Cloudless days:—				
Number of readings ... ..	$n$	4	3	0
Radiation from sky in zenith ...	$\pi I$	473	409	..
Total radiation from sky ... ..	$J$	501	435	..
Total radiation from horizontal black surface on earth ...	$X$	706	670	..
Net radiation from earth ... ..	$X-J$	205	235	..
DIFFUSE SOLAR RADIATION (luminous rays).				
Averages for Readings between 9 h. and 15 h. G.M.T.				
Cloudless days:—				
Number of readings ... ..	$n_0$	3	2	0
Radiation from sky in zenith ...	$\pi I_0$	40	11	..
Total radiation from sky ... ..	$J_0$	55	16	..
Cloudy days:—				
Number of readings ... ..	$n_1$	3	3	1
Radiation from sky in zenith ...	$\pi I_1$	78	43	15
Total radiation from sky ... ..	$J_1$	74	39	14

Unit for I = gramme calorie per day per steradian per square centimetre.  
Unit for J and X = gramme calorie per day per square centimetre.  
For description of instrument and methods of observation, see *The Meteorological Magazine*, October, 1920, and May, 1921.

### Meteorological Observations at St. Kilda

During the months of May to August, 1927, meteorological observations were made at St. Kilda by Mr. J. Mathieson, F.R.S.E., who was at that time engaged on a survey of the island. The period is short, but as regular observations have not previously been available it seems desirable to put on record the results for the four months, together with a comparative statement indicating the nature and extent of the differences between the St. Kilda figures and the corresponding ones for Stornoway and Tiree.

#### Comparison of St. Kilda with Tiree and Stornoway

1927	Temperature					Rainfall			Sun-shine	Mean Cloud
	Mean			Absolute						
	7h.	Max.	Min.	Max.	Min.	Total	Most in day	Date	Mean	7h.
May.	° F.	° F.	° F.	° F.	° F.	in.	in.		h.	0—10
St. Kilda ...	46·5	50·6	44·1	60	39	2·58	0·89	13	5·31 (27 days)	8·3 (30 days)
Tiree ...	48·2	53·7	44·1	72	32	2·11	0·63	13	8·69	6·2
Stornoway ...	45·4	51·5	40·0	63	28	1·81	0·35	13	5·54	7·8
June.										
St. Kilda ...	48·5	53·4	46·2	61	42	3·55	0·69	15	6·64	7·4
Tiree ...	50·2	55·1	46·3	64	40	3·33	0·71	15	7·78	6·9
Stornoway ...	49·5	54·6	43·2	63	35	3·76	0·43	27	6·47	7·7
July.										
St. Kilda ...	55·1	59·9 (30 days)	53·1 (30 days)	67	49	1·87	0·48	3	5·01	7·6
Tiree ...	56·2	61·5	52·7	68	45	3·28	0·79	29	6·40	7·2
Stornoway ...	56·1	62·3	50·7	67	43	3·92	0·71	29	5·63	7·7
August.										
St. Kilda ...	55·5	59·9	53·6	65	49	3·58	0·62	18	4·16	7·2
Tiree ...	56·1	62·3	52·2	67	44	2·35	0·39	7	5·04	6·9
Stornoway ...	54·6	62·5	49·6	71	37	2·72	0·47	25	5·44	7·7
4 months May-August.										
St. Kilda.....	—	55·9	49·3	67	39	11·58	0·89	May 13	5·28	7·6
Tiree ...	—	58·3	48·8	72	32	11·07	0·79	July 29	6·98	6·8
Stornoway ...	—	57·7	45·9	71	28	12·21	0·71	July 29	5·77	7·7

It will be noted from the table above that the St. Kilda climate is slightly more "maritime," *i.e.*, the mean and the extreme maximum temperatures are a little lower and the mean and extreme minimum temperatures a little higher than at the two



other stations. In the matter of rainfall St. Kilda has a little more than Tiree and a little less than Stornoway, but the differences are small and the length of the period of observation is also rather too small to justify any generalization on this point. In the matter of sunshine St. Kilda is very decidedly less favoured than Tiree, the difference being supported by the relative cloud amounts at 7h., and it is rather less favoured than Stornoway, though the cloud amounts at 7h. come out in this case approximately equal.

A closer resemblance might exist possibly between St. Kilda and Barra Island, but it happens that only three of the months under discussion (May to July) are covered by simultaneous observations. Over that period mean maximum and mean minimum temperatures were each approximately a degree lower at St. Kilda. The total falls of rain are 8.00 and 8.23 inches respectively, and the mean daily amounts of sunshine are 5.65 and 6.89 hours, so that St. Kilda again comes out rather unfavourably in the matter of sunshine. The smaller amount of sunshine recorded arises, in Mr. Mathieson's opinion, from the number of occasions on which there was sufficient mist or haze around St. Kilda to prevent the sun marking the card in the recorder. This is borne out by the visibility observations, there having been at St. Kilda 36 cases, at Tiree only 6 and at Stornoway only 15 cases, where the most distant of the fixed "visibility objects" was the  $1\frac{1}{4}$ -mile or some nearer object.

The highest point on St. Kilda, Conochair, according to the recent survey, is nearly 1,400 ft. above mean sea level.

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### News in Brief

The Seventh Annual Dinner of the Staff of the Meteorological Office, Shoeburyness, was held at the Queen's Hotel, Westcliff, on Saturday, February 4th. Mr. D. Brunt, Superintendent for Army Services, was the guest, and Mr. C. Britton was in the chair. After the dinner an excellent entertainment was provided by members of the staff, consisting chiefly, in accordance with custom, of original items specially prepared for the occasion.

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### The Weather of January, 1928

In striking contrast to the cold, exceptionally snowy weather experienced at the end of December, 1927, January was almost throughout mild and unsettled. The winds were mainly southwesterly, strong on most days and frequently of gale force, while rainfall was much above the average, though sunshine was often abundant for the time of year. Some sharp frost occurred in the early morning of the 1st, Eskdalemuir registering a

minimum in the screen of  $11^{\circ}$  F., but the passage of a deep depression off Ireland caused a general rise in temperature with heavy rain in the southwest. In consequence the thick snow of the last weeks of December melted rapidly and floods occurred in many parts of the country. Further frost, though seldom severe, occurred sometimes at night in the fair periods between the depressions, but the latter passed in such rapid succession (generally to the northwestward of the British Isles) that there was no spell of quiet frosty weather. Day temperatures were generally high for the time of year, the highest maximum being  $59^{\circ}$  F. at Wisley on the 6th and  $58^{\circ}$  F. at Llandudno on the 21st. On the 6th a depression deepened near the Hebrides and moved southeastwards across the North Sea to Denmark, causing very high wind velocities, gusts of over 80 m.p.h. being recorded at Fleetwood, Southport and Spurn Head. The highest gust of the month, 87 m.p.h., however, occurred at Lerwick on the 24th, and gusts of about 75 m.p.h. occurred at one or more of the anemograph stations on the 8th, 10th and 23rd to 26th. Beaufort force 9 (49 m.p.h.) was reported at Edinburgh at 13h. on the 10th and at St. Ann's Head four times between 18h. on the 24th and 7h. on the 26th. On the 7th unusually high tides occurred on the Thames with flooding in London.\* "Snow-lying" was reported frequently from Scotland and north England, and the rainfall showed a large excess in most parts of the country. At Stornoway (Hebrides) 10.5 in. constituted the largest January total there since records began in 1873, and at Bolton 11.33 in. was the largest January total for 97 years. Over 25 in. was recorded during the month in the English Lake District and in Snowdonia. At a few stations, *e.g.*, Keswick, Rhayader, Dean Park (Devon) and Mallarany, it rained every day of the month. Among the largest falls in 24 hours were 4.01 in. at Cwm Dyli (Snowdon) and 3.24 in. at Rosthwaite (Borrowdale) on the 12th, 3.14 in. at Didworthy (Devon) on the 1st and 2.73 in. at Treherbert (Glamorgan) on the 23rd. Thunder storms occurred locally in Scotland and Ireland. The total sunshine for the month was above the average in many parts. At Dublin the sun shone for 86 hrs., which is 29 hrs. above the average, and at London for 58 hrs., which is 15 hrs. above the average. At Ross-on-Wye it was the sunniest January since records began 14 years ago. The greatest amount enjoyed on one day was 8.1 hrs. on the 27th at Torquay.

Pressure was below normal over northwest Europe, Spitsbergen and the northern part of the North Atlantic to Newfoundland, the greatest deficit being 14.8 mb. at Thorshavn, and above normal over southwest Europe, the Azores and Bermuda, the greatest excess being 8.4 mb. at Horta. South-

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\* See page 17.

westerly winds prevailed generally over northwest Europe. Temperature and rainfall were above normal in most parts, there being an excess of 45 per cent. in the rainfall of Svealand and southern Norrland in Sweden. At Zürich the temperature was 7° F. above normal and at Spitsbergen as much as 10° F.

After about '10 days' fine dry mild weather, sufficient snow fell in Switzerland on the 6th to make the ski-ing again good in most places above 3,500 ft. On the 9th, however, the weather became mild owing to the prevalence of the Föhn wind and continued so until the 17th when snow fell again and normal conditions were renewed until the end of the month. Owing to the high winds and alternate freezing and thawing many avalanches fell, landslips were reported near Geneva, and accidents were numerous. Severe gales occurred in various parts of Germany on the 8th, and telegraphic communications were disturbed in Silesia owing to the heavy snowfalls. The floods in western Flanders extended considerably about the 10th with the heavy rain and thawing of the snow. The ice on the lower Danube was melting on the 25th, causing slight local floods. Many storms occurred over the North Sea.

Renewed floods in Algeria on the 3rd caused the roads in the Perregaux regions to become impassable again and several bridges collapsed. Heavy rain again fell on the 12th, and at the end of the month a heavy fall of snow destroyed most of the repairs done during the month.

Very cold weather with gales was reported from New York early in the year and severe gales were experienced along the Atlantic seaboard from eastern Canada to Florida on the 25th. On the 29th a heavy snowstorm occurred in the Eastern States, a fall of 10½ in. being reported from Washington.

Many severe gales occurred on the North Atlantic between the 16th and 31st.

The special message from Brazil states that the rainfall in the northern and central districts was scarce, being 1·2 in. and 1·8 in. below normal respectively, while that in the southern districts was irregular in distribution with a total 1·0 in. above normal. Two anticyclones passed across the country and the unusual occurrence of depressions in the high latitudes caused several storms. Temperature was high. The crops (except the sugar cane) were generally in good condition. At Rio de Janeiro pressure was 0·1 mb. below normal and temperature 1·1° F. below normal.

### Rainfall, January, 1928—General Distribution

England and Wales ..	210	} per cent. of the average 1881-1915.
Scotland .. .. .	214	
Ireland .. .. .	166	
British Isles .. .. .	202	

202 is the largest January percentage since 1870.

## Rainfall: January, 1928: England and Wales

CO.	STATION.	In.	Per- cent. of Av.	CO.	STATION.	In.	Per- cent. of Av.
<i>Lond.</i>	Camden Square . . . . .	3.60	194	<i>Leics</i>	Thornton Reservoir . .	4.44	224
<i>Sur.</i>	Reigate, The Knowle . .	4.42	197	"	Belvoir Castle . . . . .	3.77	213
<i>Kent.</i>	Tenterden, Ashenden . .	3.50	163	<i>Rut.</i>	Ridlington . . . . .	4.70	...
"	Folkestone, Boro. San. .	3.80	...	<i>Linc.</i>	Boston, Skirbeck . . . .	3.48	215
"	Margate, Cliftonville . .	2.58	161	"	Lincoln, Sessions House	3.35	199
"	Sevenoaks, Speldhurst . .	4.22	...	"	Skegness, Marine Gdns.	3.85	222
<i>Sus.</i>	Patching Farm . . . . .	5.67	218	"	Louth, Westgate . . . .	4.24	196
"	Brighton, Old Steyne . .	5.10	211	"	Brigg . . . . .	...	...
"	Tottingworth Park . . . .	6.87	254	<i>Noths.</i>	Workop, Hodsock . . . .	3.42	193
<i>Hants</i>	Ventnor, Roy. Nat. Hos. .	5.30	199	<i>Derby</i>	Derby . . . . .	5.16	258
"	Fordingbridge, Oaklands .	5.85	212	"	Buxton, Devon. Hos. . .	10.76	241
"	Ovington Rectory . . . .	6.88	255	<i>Ches.</i>	Runcorn, Weston Pt. . .	5.65	238
"	Sherborne St. John . . . .	4.72	202	"	Lancaster, Dorfold Hall	5.07	...
<i>Berks</i>	Wellington College . . . .	3.06	155	<i>Lancs</i>	Manchester, Whit. Pk. . .	7.68	306
"	Newbury, Greenham . . . .	4.95	214	"	Stonyhurst College . . . .	12.27	287
<i>Herts.</i>	Benington House . . . . .	3.30	181	"	Southport, Hesketh Pk . .	7.15	280
<i>Bucks</i>	High Wycombe . . . . .	5.29	253	"	Lancaster, Strathspey . .	9.86	...
<i>Oxf.</i>	Oxford, Mag. College . . .	3.46	201	<i>Yorks</i>	Wath-upon-Deane . . . .	3.19	166
<i>Nor.</i>	Pitsford, Sedgebrook . . .	3.79	204	"	Bradford, Lister Pk. . . .	8.12	282
"	Oundle . . . . .	2.72	...	"	Oughtershaw Hall . . . .	17.84	...
<i>Beds.</i>	Woburn, Crawley Mill . . .	3.69	216	"	Wetherby, Ribston H. . . .	4.93	239
<i>Cam.</i>	Cambridge, Bot. Gdns. . . .	2.97	198	"	Hull, Pearson Park . . . .	4.26	236
<i>Essex</i>	Chelmsford, County Lab . .	3.26	213	"	Holme-on-Spalding . . . .	4.87	...
"	Lexden, Hill House . . . .	3.06	...	"	West Witton, Ivy Ho. . . .	6.55	...
<i>Suff.</i>	Hawkedon Rectory . . . . .	3.52	202	"	Felixkirk, Mt. St. John . .	4.04	202
"	Haughley House . . . . .	2.60	...	"	Pickering, Hungate . . . .	4.23	...
<i>Norfol.</i>	Beccles, Geldeston . . . . .	2.83	170	"	Scarborough . . . . .	3.90	195
"	Norwich, Eaton . . . . .	3.77	192	"	Middlesbrough . . . . .	2.73	171
"	Blakeney . . . . .	2.73	159	"	Baldersdale, Hury Res. . .	6.65	...
"	Little Dunham . . . . .	4.71	242	<i>Durh.</i>	Ushaw College . . . . .	3.28	160
<i>Wilts.</i>	Devizes, Highclere . . . . .	4.42	203	<i>Nor.</i>	Newcastle, Town Moor . .	2.25	110
"	Bishops Cannings . . . . .	4.00	172	"	Bellingham, Highgreen . .	5.92	...
<i>Dor.</i>	Evershot, Melbury Ho. . . .	7.09	204	"	Lilburn Tower Gdns. . . .	4.51	...
"	Creech Grange . . . . .	7.06	...	<i>Cumb</i>	Geltsdale . . . . .	6.18	...
"	Shaftesbury, Abbey Ho. . . .	3.67	141	"	Carlisle, Scaleby Hall . . .	6.90	278
<i>Devon</i>	Plymouth, The Hoe . . . . .	7.27	218	"	Borrowdale, Rothwaite . .	24.83	...
"	Polapit Tamar . . . . .	7.29	196	"	Keswick, High Hill . . . .	12.16	...
"	Ashburton, Druid Ho. . . . .	10.13	199	<i>Glam.</i>	Cardiff, Ely P. Stn. . . . .	9.51	252
"	Cullompton . . . . .	6.38	197	"	Treherbert, Tynywaun . .	22.16	...
"	Sidmouth, Sidmount . . . .	4.67	163	<i>Carm</i>	Carmarthen Friary . . . .	10.77	246
"	Filleigh, Castle Hill . . . .	7.30	...	"	Llanwrda, Dolaucothy . .	12.63	238
"	Barnstaple, N. Dev. Ath. . .	6.46	197	<i>Pemb</i>	Haverfordwest, School . .	7.89	171
<i>Corn.</i>	Redruth, Trewirgie . . . . .	8.88	210	<i>Card.</i>	Gogerddan . . . . .	9.17	224
"	Penzance, Morrab Gdn. . . .	8.25	218	"	Cardigan, County Sch. . . .	7.31	...
"	St. Austell, Trevarna . . . .	8.14	190	<i>Brec.</i>	Crickhowell, Talymaes . .	6.60	...
<i>Soms.</i>	Chewton Mendip . . . . .	9.91	258	<i>Rad.</i>	Birm. W. W. Tyrmynydd . .	12.26	195
"	Street, Hind Hayes . . . . .	4.07	...	<i>Mont.</i>	Lake Vyrnwy . . . . .	16.24	288
<i>Glos.</i>	Clifton College . . . . .	...	...	<i>Denb.</i>	Llangynhafal . . . . .	4.45	...
"	Cirencester, Gwynfa . . . .	5.21	208	<i>Mer.</i>	Dolgelly, Bryntirion . . .	10.80	190
<i>Here.</i>	Ross, Birchlea . . . . .	4.63	191	<i>Carn.</i>	Llangudno . . . . .	4.25	159
"	Ledbury, Underdown . . . .	4.21	191	"	Snowdon, L. Llydaw 9 . . .	29.43	...
<i>Salop</i>	Church Stretton . . . . .	6.04	239	<i>Ang.</i>	Holyhead, Salt Island . . .	6.03	207
"	Shifnal, Hatton Grange . . .	3.92	202	"	Lligwy . . . . .	7.59	...
<i>Worc.</i>	Ombersley, Holt Lock . . . .	3.91	204	<i>Isle of Man</i>	Douglas, Boro' Cem. . . .	7.81	233
"	Blockley, Upton Wold . . . .	4.76	202	<i>Guernsey</i>	St. Peter P't. Grange Rd . .	6.48	221
<i>War.</i>	Farnborough . . . . .	4.58	213				
"	Birmingham, Edgbaston . .	4.81	238				

## Rainfall: January, 1928: Scotland and Ireland

CO	STATION.	In.	Per- cent. of Av.	CO.	STATION.	In.	Per- cent. of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	7.05	239	<i>Suth.</i>	Loch More, Achfary...	13.77	189
"	Pt. William, Monreith.	7.75	...	<i>Caith</i>	Wick .....	4.70	191
<i>Kirk.</i>	Caraphairn, Shiel. ....	18.14	...	<i>Ork.</i>	Pomona, Deerness ....	5.18	150.
"	Dumfries, Cargen.....	11.83	296	<i>Shet.</i>	Lerwick .....	7.65	180.
<i>Dumf.</i>	Eskdalemuir Obs.....	15.37	285	<i>Cork.</i>	Caheragh Rectory ....	9.78	...
<i>Roxb.</i>	Branxholm .....	7.52	274	"	Dunmanway Rectory.	10.21	163.
<i>Selk.</i>	Ettrick Manse .....	14.96	...	"	Ballinacurra .....	4.14	104
<i>Peeb.</i>	Castlecraig .....	...	...	"	Glanmire, Lota Lo. ...	5.80	135
<i>Berk.</i>	Marchmont House ....	4.64	206	<i>Kerry</i>	Valentia Obsy. ....	8.14	148
<i>Hadd.</i>	North Berwick Res....	2.78	162	"	Gearahameen .....	18.50	...
<i>Midl.</i>	Edinburgh, Roy. Obs..	4.91	282	"	Killarney Asylum.....	...	...
<i>Ayr.</i>	Kilmarnock, Agric. C..	9.67	283	"	Darrynane Abbey ....	7.82	156
"	Girvan, Pinmore .....	9.15	194	<i>Wat.</i>	Waterford, Brook Lo..	4.08	111.
<i>Renf.</i>	Glasgow, Queen's Pk..	8.68	260	<i>Tip.</i>	Nenagh, Cas. Lough...	6.38	161.
"	Greenock, Prospect H..	15.52	227	"	Roscrea, Timoney Park	4.71	...
<i>Bute.</i>	Rothesay, Ardencraig..	10.44	232	"	Cashel, Ballinamona ..	4.52	119.
"	Dougarie Lodge .....	10.56	...	<i>Lim.</i>	Foynes, Coolnanes ....	5.98	158.
<i>Arg.</i>	Ardgour House .....	20.10	...	"	Castleconnell Rec. ....	6.55	...
"	Manse of Glenorchy..	18.88	...	<i>Clare</i>	Inagh, Mount Callan ..	9.46	...
"	Oban .....	10.78	...	"	Broadford, Hurdlest'n.	6.22	...
"	Poltalloch .....	11.33	224	<i>Wexf.</i>	Newtownbarry .....	6.86	...
"	Inveraray Castle .....	21.28	259	"	Gerey, Courtown Ho. ..	5.02	161.
"	Islay, Eallabus .....	10.42	223	<i>Kilh.</i>	Kilkenny Castle .....	4.19	131.
"	Mull, Benmore .....	15.20	...	<i>Wic.</i>	Rathnew, Clonmannon ..	4.25	...
"	Tiree .....	...	...	<i>Carl.</i>	Hacketstown Rectory ..	4.22	119.
<i>Kinn.</i>	Loch Leven Sluice ....	7.15	227	<i>QCo.</i>	Blandsfort House.....	4.32	132
<i>Perth.</i>	Loch Dhu .....	22.35	246	"	Mountmellick .....	6.56	...
"	Balquhider, Stronvar..	17.07	...	<i>KCo.</i>	Birr Castle .....	3.89	138.
"	Crieff, Strathearn Hyd.	10.16	252	<i>Dubl.</i>	Dublin, FitzWm. Sq. ...	2.23	97.
"	Blair Castle Gardens ..	8.44	254	"	Balbriggan, Ardgillan ..	3.52	154.
<i>Forf.</i>	Kettins School.....	6.61	279	<i>Me'th</i>	Beauparc, St. Cloud ..	3.31	...
"	Dundee, E. Necropolis..	4.43	227	"	Kells, Headfort.....	4.66	148.
"	Pearcie House .....	6.73	...	<i>W.M.</i>	Moate, Coolatore .....	3.84	...
"	Montrose, Sunnyside..	4.32	217	"	Mullingar, Belvedere ..	4.98	155.
<i>Aber.</i>	Braemar, Bank .....	6.63	208	<i>Long</i>	Castle Forbes Gdns....	6.00	180.
"	Logie Coldstone Sch. ..	3.73	169	<i>Gal.</i>	Ballynahinch Castle ..	10.47	169.
"	Aberdeen, King's Coll..	3.80	174	"	Galway, Grammar Sch..	5.71	...
"	Fyvie Castle .....	3.02	...	<i>Mayo</i>	Mallaranny.....	12.67	...
<i>Mor.</i>	Gordon Castle .....	2.96	147	"	Westport House.....	7.60	163.
"	Grantown-on-Spey....	3.71	153	"	Delphi Lodge .....	15.98	...
<i>Na.</i>	Nairn, Delnies .....	3.43	172	<i>Sligo</i>	Markree Obsy. ....	7.48	190
<i>Inver.</i>	Ben Alder Lodge .....	11.35	...	<i>Cav'n</i>	Belturbet, Cloverhill..	4.94	165.
"	Kingussie, The Birches	7.31	...	<i>Ferm</i>	Enniskillen, Portora ..	7.35	...
"	Loch Quoich, Loan ....	24.00	...	<i>Arm.</i>	Armagh Obsy. ....	4.84	192
"	Glenquoich .....	21.11	154	<i>Down</i>	Fofanny Reservoir ....	12.93	...
"	Inverness, Culduthel R.	5.21	...	"	Seaforde .....	6.37	202
"	Arisaig, Faire-na-Squir	8.78	...	"	Donaghadee, C. Stn....	5.47	215
"	Fort William .....	16.75	174	"	Banbridge, Milltown ..	3.77	168
"	Skye, Dunvegan .....	12.06	...	<i>Antr.</i>	Belfast, Cavehill Rd..	7.07	...
<i>R&amp;C</i>	Alness, Ardross Cas. ..	6.71	177	"	Glenarm Castle .....	8.66	...
"	Ullapool.....	8.81	...	"	Ballymena, Harryville	7.41	200
"	Torridon, Bendamph..	17.55	187	<i>Lon.</i>	Londonderry, Creggan ..	7.72	214
"	Achnashellach .....	13.94	...	<i>Tyr.</i>	Donaghmore .....	7.51	...
"	Stornoway .....	...	...	"	Omagh, Edenfel .....	7.66	216
<i>Suth.</i>	Lairg .....	6.98	...	<i>Don.</i>	Malin Head .....	7.36	282
"	Tongue .....	7.61	193	"	Dunfanaghy .....	8.64	213
"	Melvich .....	5.03	152	"	Killybegs, Rockmount..	13.12	234

## Climatological Table for the British Empire, August, 1927

STATIONS	PRESSURE		TEMPERATURE						Relative Humidity	Mean Cloud Am't	PRECIPITATION		BRIGHT SUNSHINE	
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values			Am't			Diff. from Normal	Days	Hours per day	Per-cent- age of possi- ble
			Max.	Min.	Max.	Min.	1 and 5 min.							
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	%	0-10	in.	in.		
London, Kew Obsy. . . . .	1012.1	- 3.2	76	47	68.7	55.2	61.9	+ 0.3	89	6.9	4.07	+ 1.83	17	5.6
Gibraltar . . . . .	1015.9	- 0.8	94	63	83.6	68.7	76.1	+ 0.1	78	4.2	0.07	- 0.06	1	...
Malta . . . . .	1015.2	- 0.1	98	68	85.6	74.8	80.2	+ 1.1	79	1.6	0.00	- 0.14	0	12.1
St. Helena . . . . .	1016.4	+ 2.8	66	52	60.6	54.2	57.4	- 0.5	91	3.5	3.04	- 0.68	21	...
Sierra Leone . . . . .	1013.6	+ 0.9	87	69	82.5	71.8	77.1	- 0.8	85	8.5	22.02	- 14.55	24	...
Lagos, Nigeria . . . . .	1013.0	- 0.6	82	71	80.2	73.5	76.9	- 0.8	83	3.1	0.25	- 2.55	5	...
Kaduna, Nigeria . . . . .	1015.8	+ 2.0	86	...	81.1	...	...	...	89	...	12.83	+ 3.15	28	...
Zomba, Nyasaland . . . . .	1017.4	+ 0.6	83	44	75.8	50.6	63.2	- 1.7	75	2.5	0.04	- 0.33	2	...
Salisbury, Rhodesia . . . . .	1016.3	- 1.0	84	38	73.5	46.5	60.0	- 0.2	53	1.5	0.04	- 0.04	1	9.6
Cape Town . . . . .	1019.6	- 0.6	87	41	66.0	49.0	57.5	+ 1.9	88	5.0	5.08	+ 1.69	9	...
Johannesburg . . . . .	1021.6	- 0.1	70	27	63.4	41.2	52.3	- 2.0	46	1.4	0.07	- 0.44	1	9.5
Mauritius . . . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bloemfontein . . . . .	...	...	73	25	64.0	37.2	50.6	- 1.6	67	3.1	0.72	+ 0.25	2	...
Calcutta, Alipore Obsy. . . . .	1001.1	+ 0.1	93	77	88.8	79.0	83.9	+ 0.9	89	8.2	7.02	- 5.67	15*	...
Bombay . . . . .	1005.7	- 0.2	85	76	84.0	77.2	80.6	- 0.1	86	8.3	6.74	- 7.71	25*	...
Madras . . . . .	1005.8	+ 0.3	100	74	95.4	78.9	87.1	+ 1.2	71	7.2	3.71	- 0.93	8*	...
Colombo, Ceylon . . . . .	1009.9	+ 0.2	89	73	86.9	77.2	82.1	+ 1.0	76	7.5	0.52	- 2.61	9	7.2
Hongkong . . . . .	1003.5	- 1.6	93	74	87.5	78.0	82.7	+ 0.6	86	7.5	20.91	+ 6.86	19	6.8
Sandakan . . . . .	...	...	91	73	89.2	75.2	82.2	+ 0.4	85	...	8.07	+ 0.01	13	...
Sydney . . . . .	1015.8	- 2.4	78	39	65.3	45.6	55.5	+ 0.5	59	1.3	0.30	- 2.71	5	8.6
Melbourne . . . . .	1014.9	- 3.2	70	37	57.8	44.0	50.9	- 0.2	73	7.0	1.93	+ 0.12	21	4.4
Adelaide . . . . .	1016.9	- 2.4	74	40	61.6	46.4	54.0	- 0.0	71	6.0	3.79	+ 1.28	20	5.3
Perth, W. Australia . . . . .	1017.1	- 1.7	70	38	63.8	49.6	56.7	+ 0.8	75	6.7	6.49	+ 0.87	24	5.5
Coolgardie . . . . .	1017.4	- 1.9	77	36	64.8	43.2	54.0	+ 0.4	62	3.9	0.49	- 0.53	7	...
Brisbane . . . . .	1017.8	- 1.4	81	40	72.9	46.2	59.5	- 0.9	56	1.5	0.27	- 1.86	1	9.7
Hobart, Tasmania . . . . .	1008.5	- 5.1	66	34	54.3	41.2	47.7	- 0.3	69	6.0	1.19	- 0.65	22	5.1
Wellington, N.Z. . . . .	1008.4	- 6.7	63	31	54.0	42.6	48.3	- 0.3	81	7.3	7.38	+ 2.89	23	4.1
Suva, Fiji . . . . .	1013.3	- 1.0	88	66	80.3	71.1	75.7	+ 2.0	77	4.8	9.14	+ 0.90	23	36
Apia, Samoa . . . . .	1012.5	+ 0.3	86	71	85.0	75.2	80.1	+ 2.3	74	3.4	1.36	- 1.79	16	7.2
Kingston, Jamaica . . . . .	1013.3	- 0.2	93	70	89.7	73.2	81.5	- 0.0	84	3.4	2.83	- 0.72	6	9.2
Grenada, W.I. . . . .	1008.8	- 3.8	92	71	87.7	75.9	81.8	+ 2.3	75	3.6	3.46	- 6.12	18	...
Toronto . . . . .	1015.9	+ 0.5	85	48	74.7	55.0	64.9	- 1.7	73	3.6	1.47	- 1.30	4	7.2
Winnipeg . . . . .	1016.1	+ 2.2	88	36	74.7	51.9	63.3	+ 0.3	85	4.3	2.85	+ 0.41	9	7.8
St. John, N.B. . . . .	1014.9	- 0.5	76	47	67.1	53.5	60.3	- 0.3	85	6.4	8.96	+ 5.10	12	...
Victoria, B.C. . . . .	1015.9	- 1.3	85	49	67.8	52.5	60.1	- 0.0	75	3.8	0.48	- 0.17	5	9.9

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

M.O. 303.

CRANWELL  
METEOROLOGICAL  
OFFICE

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## Growth of Trees in the Forest of Dean in relation to Rainfall.

Mr. E. G. Burt has kindly supplied several series of measurements of the annual rings of growth of trees in the Forest of Dean. The best and longest series was given by a yew, which grew on a south-west slope overlooking Lower Sondley. The tree was cut in the winter of 1922-23, and proved to be 200 years old. The individual measurements are given in Table I., and smoothed values constructed by taking overlapping five-yearly totals are shown in the uppermost curve of Fig. 1. It will be seen that the tree grew very slowly at the beginning and end of its existence and more rapidly in middle age. There are four periods of most rapid growth; the first and most important occurred from about 1780 to 1800, with a maximum from 1786 to 1792, and the second reached its maximum in 1829 to 1830. The third maximum extended from about 1861 to 1878, but is not very striking; on the other hand, the fourth maximum, which comes at 1899 to 1900, is remarkably sharp and definite. It will be noticed that the lengths of the intervals between these maxima, about 40, 40 and 30 years respectively, give an average of 36·37 years, which is very near that assigned to the Brückner cycle.

Measurements of two oak trees are given, both of which grew on Staple Edge Hill and were cut about 1921. The individual

measurements are not reproduced here, but the figures smoothed by forming five-yearly totals are shown in Fig. 1. Curves 9A and 9B are from measurements taken at right angles on the same tree—an exceptionally well formed root—9A being along a line due west from the centre and 9B along a line due north. An attempt had been made at some time to burn the stump, and the outer 40 mm., representing about 42 years' growth, were charred. It will be noticed that from 1830 to 1864 the tree grew somewhat more rapidly on the west than on the north side, but that from 1864 to 1883 this condition was reversed, growth being more rapid on the north side of the trunk. The curve labelled 10 represents the second oak tree, which showed no signs of burning. The two curves 9A and 9B are obviously closely related; No. 10 is fairly similar, but the pronounced maximum just before 1840

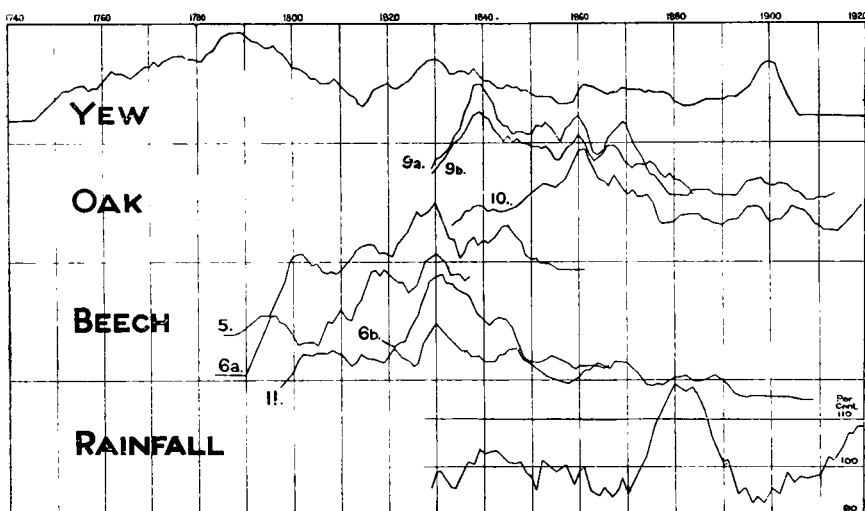


FIG. 1.

is barely represented, and the period of most rapid growth occurred instead about 1860. The most curious point is that these records of oak trees show very little similarity with that of the yew which grew only a short distance away. This is partly due to the much lesser age of the oaks, not one of which was 100 years old, so that the period of slow growth at the beginning of their existence coincides with the full maturity of the yew, and in fact with one of its periods of maximum. It is only when we examine the curves in detail that we can see points of resemblance, in particular the rapid increase of growth-rate about 1860 and the general slow growth from 1880 to 1893. There is a distinct suggestion that the oaks responded more rapidly to changes of weather than the yew, for the curves 9 and 10 are far more irregular than the uppermost curve. The pronounced maximum at 1900 on the latter shows itself as a



double maximum on both oak trees, and similarly the small minimum of 1865 on the curve for the yew becomes much more important in the oaks.

Of the beech trees numbers 5 and 6 grew on the Blaize Bailey ridge and No. 11 grew near the yew tree; the dates of felling are not known, but were probably between 1900 and 1910. The two records 6A and 6B are from measurements along two lines at right angles on the same tree, but the actual directions are not specified. Since the dates of felling were not known exactly, it was necessary to fit the curves together from intrinsic evidence only. This was not difficult so long as only the three beech trees were considered; the correlation actually adopted seems to be the only possible one. When it came to fixing the age of the trees absolutely, by reference to the yew and oaks of which

TABLE I.—GROWTH OF YEW TREE IN MILLIMETRES.

Years.	0	1	2	3	4	5	6	7	8	9
1740				1.0	1.0	1.0	1.0	1.0	2.0	2.0
1750	2.0	2.0	2.0	3.0	2.0	2.5	2.5	2.0	2.0	2.5
1760	2.5	3.5	3.5	3.0	2.0	2.5	3.0	3.0	4.0	3.0
1770	3.0	3.0	4.0	3.0	4.0	3.5	3.5	4.0	3.0	3.5
1780	3.5	3.0	4.0	4.5	4.0	4.5	5.0	4.5	5.0	4.0
1790	4.5	4.5	3.5	4.5	3.5	4.0	4.5	4.0	3.0	3.0
1800	3.0	3.0	3.5	2.5	2.5	2.0	3.0	2.5	2.5	2.5
1810	3.0	2.0	1.5	1.0	2.0	1.5	1.5	3.0	3.0	2.5
1820	2.0	2.0	2.0	3.0	3.0	2.5	3.0	3.5	4.0	4.0
1830	3.0	3.0	3.0	3.0	2.5	3.0	3.5	3.0	2.5	3.5
1840	2.0	2.0	3.0	2.0	2.5	2.0	2.5	2.5	2.0	2.0
1850	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.5	2.0	2.0
1860	2.5	3.0	3.0	1.5	2.0	2.0	2.5	2.5	2.0	2.0
1870	3.0	2.0	2.5	2.0	2.0	2.5	2.5	2.0	2.0	2.0
1880	2.0	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0
1890	2.0	2.0	2.5	2.0	2.0	2.5	3.0	3.5	4.0	4.0
1900	3.5	3.0	3.0							

Total growth 1723—32, 8 mm., 1733—42, 9 mm.

„ „ 1903—12, 14 mm., 1913—22, 14 mm.

the dates of felling are known, it was a different matter, and the dating adopted in drawing Fig. 1 is to be regarded as something of a guess. Like the oaks and the yew, the beech trees grew slowly at the beginning and end of their existence, while the response to changes of climate seems to have been more rapid than that of the yew, but perhaps not quite so rapid as that of the oaks.

For comparison between the rate of tree-growth and the amount of rainfall, Dr. J. Glasspoole has been good enough to calculate a series of rainfall values for the Forest of Dean extending from 1820 to 1920, expressed as a percentage of the normal for the 35 years 1881 to 1915. A comparison of these figures with the annual growths of the yew in Table I. shows that there

is little if any relation between the growth in any one year and the rainfall in that year. When we smooth the data over a number of years, there are some indications that heavy rainfall is inimical to the growth of the yew, but with the oak and the beech the relation is still indefinite. The rainfall data, smoothed by forming overlapping ten-year means, are shown in the lowest curve of Fig. 1; following the model of the well-known American investigations into the relation between tree-growth and rainfall the curve has been shifted to the left, in order to compare the tree-growth in any year with the rainfall during the previous ten years. Thus the point where the rainfall curve crosses the vertical line for 1830 shows the rainfall of the years 1821 to 1830, which was 98 per cent. of normal.

The period of rather rapid growth of the yew about 1830 comes at a time when the rainfall curve is low, but the minimum from 1851 to 1859 follows the maximum of the rainfall curve by about ten years. The poorly developed period of maximum growth from 1861 to 1870 fits in fairly well with the minimum of the same years on the rainfall curve, but the outstanding maximum shown by the latter about 1880 to 1883 is only represented by a slight minimum on the curve of tree-growth. On the other hand the pronounced maximum growth about 1900 agrees very well with the minimum on the rainfall curve. The opposition is also shown in Table II., where the total growth of

TABLE II.—COMPARISON OF GROWTH OF YEW TREE WITH RAINFALL

Tree growth mm. ...	1826-35	1836-45	1846-55	1856-65	1866-75	1876-85	1886-95	1896-1905	1906-15
	32	26	21	20.5	23	19	21	28	(14)
Rainfall per cent. ...	1820-29	1830-39	1840-49	1850-59	1860-69	1870-79	1880-89	1890-99	1900-09
	95	104	98	96	98	114	102.5	92.5	98

the yew in successive periods of ten years is compared with the rainfall six years earlier. The most notable feature of this table is that, excluding the years 1906 to 1915, when the slow growth of the tree may be attributed to old age, the slowest growth, 19 mm. in 1876 to 1885, corresponds with the decade 1870-79, which was by far the rainiest, while the two periods of most rapid growth, 1826 to 1835 and 1896 to 1905, correspond with the two decades of least rainfall. There are no available records for the Forest of Dean previous to 1820, and a comparison of the growth of the yew from 1750 to 1820 with Dr. Glasspoole's figures for the whole of England, published in the *Meteorological Magazine* for February, failed to show any definite relationship. If the hypothesis that the yew grew best in dry weather is correct, we should infer that in the Forest of Dean the years 1803 to 1813 were rainy and the years 1780 to 1790 dry; it

would be interesting to know if local non-instrumental records confirm or disprove this. The general results of the comparison are not very convincing, however, and do not make it probable that we shall ever be able to write the history of our rainfall from the annual rings of our trees, as has been done so successfully in the west of America, even if we can find any trees of sufficient age.

## Winds in the Forth Valley

The south of Scotland is bisected by a valley which joins the Forth and Clyde Estuaries at a level little above that of the sea. Both to the south and north considerable mountain areas exist. The valley runs in a general east to west direction and at its western end bifurcates near Renfrew, one branch running

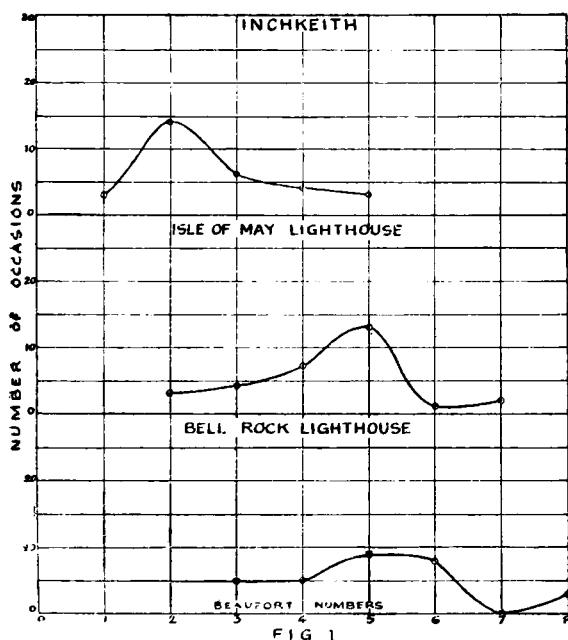


FIG 1  
Frequency curves showing the number of occasions on which each Beaufort Number occurred at Inchkeith, Isle of May and Bell Rock respectively during the six months. November, 1926—April, 1927, when the gradient at Inchkeith was from a southerly point and equal to 30 m.p.h. or more.

northwest to Greenock and the other southwest to Ardrrossan. Those who work with daily weather maps have long noticed peculiarities in the surface winds reported from Renfrew and from Inchkeith which lie near the western and the eastern ends of the valley respectively, and it has been difficult to ascribe these effects to any cause other than the local topography. At Renfrew the effect most commonly shown is a deflection of winds in the direction of the valley so that ENE or WSW winds are frequently

found when the pressure gradient suggests quite other conditions. At Inchkeith the effect is more pronounced on the velocity of the winds than on their direction. The station is at the top of a rocky islet in the middle of the Forth Estuary, some three to four miles from Leith in the south and from the Fifeshire coast in the north,

An inquiry has lately been carried out into the local winds at Inchkeith and the results obtained seemed of sufficient general interest to be put on record. During the winter of 1926-7 the gradient wind in that neighbourhood was noted on all occasions where it equalled or exceeded 30 m.p.h. from the southward. The observations of wind reported from Inchkeith at these times were also noted together with those from the lighthouses at Isle of May and Bell Rock, which were kindly supplied by the Commissioners of Northern Lights. The Isle of May is situated in the entrance to the Firth of Forth, 25 miles eastnortheast of

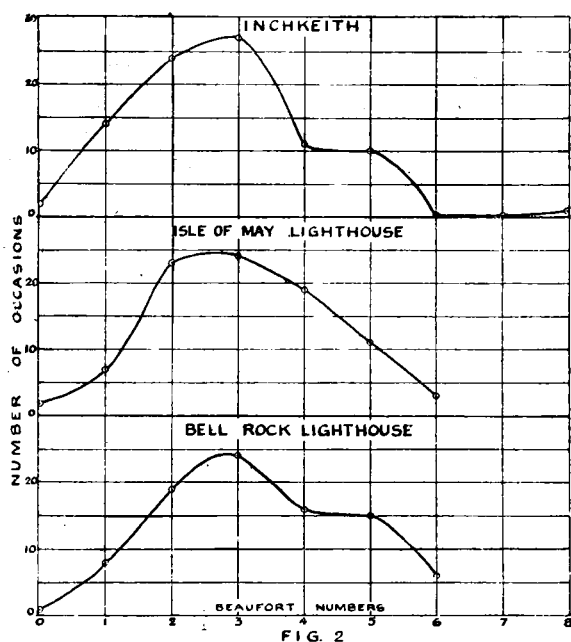


FIG. 2  
Frequency curves showing the number of occasions on which each Beaufort Number occurred at the three stations for all wind directions at 3 p.m. during the three months, February, March and April, 1927.

Inchkeith, while Bell Rock is a further 20 miles to the northeast and lies well out in the North Sea.

The frequency with which different surface wind forces were reported at the three stations under these conditions of strong southerly gradient (30 m.p.h. or over) is shown in Fig. 1. A gradient of 30 m.p.h. corresponds at a normal fairly well exposed station with a surface wind of about force 4 and stronger gradients would naturally be associated with higher surface

winds. It will be seen that at Bell Rock winds of forces 5 and 6 were most frequent, while at the Isle of May there was a marked preponderance of force 5. At Inchkeith, on the other hand, winds were almost always light, force 2 being reported 14 times against 6 reports of force 3 and even less frequent records of forces 4 and 5. It has been stated that the station at Inchkeith is on the top of a rocky islet and the exposure is certainly not ideal for wind observations, but there are reasons for thinking that this peculiarity of light winds with southerly gradients is a feature of stations in the Firth valley and is not confined to Inchkeith.

It seemed desirable to compare the winds reported from

Inchkeith, Isle of May and Bell Rock for all wind directions in order to test whether the effect found for southerly winds was peculiar to that direction or persisted more generally. Frequency curves similar to those given in Fig. 1 were therefore drawn for all winds reported during the three months February to April, 1927, observations at 3 p.m. daily being used. These curves are plotted in Fig. 2 and show good agreement between the three stations.

J. S. DINES.

### Royal Meteorological Society

The monthly meeting of the Society was held on Wednesday, February 15th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, D.Sc., LL.D. President, in the Chair.

Dr. L. F. Richardson described two of the Society's *Memoirs* by himself and other authors :

No. 2. "The single-layer problem in the atmosphere and the height-integral of pressure."

No. 4. "The variance of upper wind and the accumulation of mass."

Both *Memoirs* were published in 1926 ; an account of No. 2 will be found in the *Meteorological Magazine* for September, 1926, p. 191. No. 4 is a study of simultaneous pilot balloon ascents at two stations a short distance apart, or at one station at short intervals. The mathematical study of smooth functions suggests that the closer two ascents approach in space or time, the more nearly similar should be their results, but the observations do not always support this, perhaps because the wind does not possess the required kind of smoothness.

Dr. J. Glasspoole then read a paper on "The distribution over the British Isles of the average number of days with rain during each month of the year." He pointed out that one naturally associates a large frequency of rain-days with a large average rainfall, but the frequency of rain-days was also affected by geographical factors. While rainfall decreases from west to east, the decrease in the number of rain-days is rather from north-west to south-east—from 270 in the Outer Hebrides to 150 along the Thames Valley. In the present paper maps are given showing the distribution of the average number of days with rain in each month as well as for the year as a whole. There are only 10 days with rain on the average along the Thames Estuary in June, July and September, and 26 in December in the north-west of Scotland and in the mountains of Kerry, Connemara and Donegal. June is the month of fewest days with rain over the British Isles generally, averaging 14, while December has most with 20. May also has less days with rain than either July or August, so

that the popular call for early holidays is well supported by rainfall statistics. It is also shown that the amount of rain per rain-day is greater during the last six months of the year than the first six months, another factor which makes May and June more favourable for holiday makers than July and August.

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### The Storm of February 10th

Probably you will receive many reports of the storm of the 10th instant. This appears to have been in the nature of a line squall of exceptional kind, remarkable for its severity, for the great length of country affected, for its accompanying winter thunderstorm almost everywhere, and for the striking variations of wind force and temperature in many places.

Here the morning was overcast with gusty southerly wind, rain setting in at noon. Switching on my wireless set at 1.30 p.m., I was surprised to hear atmospheric of a frequency and vigour usually associated with heavy summer thunderstorms. At 1.50 p.m. the sky rapidly darkened and thunder was heard. Sleet began to fall followed immediately by blinding snow, accompanied by vivid lightning and heavy thunder, the wind veering west at no great strength. The snow was wet, temperature being about 35°, and it continued thickly for half an hour, lying to a depth of half an inch. Clear sky spread in from westnorthwest at 3 p.m. behind a very fine cirrified edge, extending in an almost unbroken straight line from north to south, the sky shading to a deep black on the eastern horizon and forming a magnificent spectacle. The wind was not notably strong at any time, but later in the evening furious squalls of wet snow preceded the hurricane which rose to 104 m.p.h. at Liverpool.

E. C. RUTHERFORD.

*Red Holm, Macclesfield Road, Buxton. February 13th, 1928.*

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### Return of Balloons in Ceylon

In connexion with the upper air work here, it is the practice to pay a reward of one rupee for the return of balloons, and a notice to that effect in English, Sinhalese and Tamil is attached to the tail of the balloon and produces a fair response, though of course many are lost in the jungle or at sea.

It is not unusual for letters returning the slip, and claiming the rupee, to contain irrelevant information regarding the finder's circumstances and character, leading up to a request for a further cash payment or a post in the Observatory, but I think a letter in Sinhalese received to-day may possibly be of amuse-

ment to your readers. I may add that tail No. 720 had already been returned and the reward duly paid.

Translation of letter received.

A piece of black paper bearing No. 720 to which is pasted a printed notice in English, Sinhalese and Tamil, another paper attached by a wire and a rubber balloon have been found by us.

A reward of one rupee is not sufficient. If the Superintendent of the Observatory will advertise in the *Dinamina* newspaper in rather large letters an offer of a hundred pounds, we will inform him where and when these were found.

A. J. BAMFORD.

*Colombo Observatory, Ceylon, November 11th, 1927.*

## NOTES AND QUERIES

### Commission for Synoptic Weather Information

Arrangements have been made for a meeting of the Commission for Synoptic Weather Information to be held in London during the period May 29th to June 2nd next. The last meeting of the Commission was at Zürich in September, 1926.

British members of the Commission are Lt.-Col. E. Gold, D.S.O., F.R.S., and Air Commodore L. F. Blandy, C.B., D.S.O.

Under the Rules of the International Meteorological Organisation any question which is to form the subject of discussion at a meeting of the Commission must be communicated by a member of the Commission to the President and a report on it distributed at least two months before the meeting.

### Meteorological Service of Madagascar

On June 15th, 1927, a Meteorological Service was established for the Colony of Madagascar and its Dependencies. The new Service is under the control of the Director of the Observatory of Antananarivo, and its duties will be forecasting, climatology and aerology. The forecasting service is concerned with the issue of cyclone warnings by wireless; for this purpose a network of 25 telegraphic reporting stations is established, and it is hoped that weather reports will be received from ships. The climatological service includes 40 stations reporting monthly, and the data will be published monthly in the *Journal Officiel*, and quarterly in greater detail in the *Bulletin Economique*.

### A New Observatory for Yugoslavia

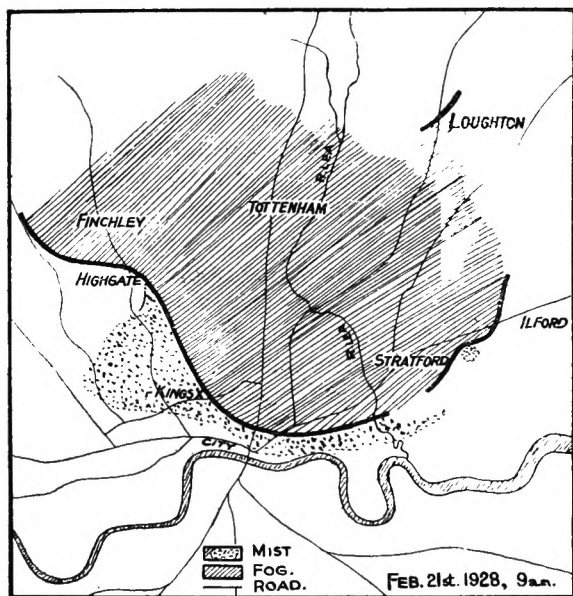
The new City Meteorological Observatory which has been established by the City of Split, Yugoslavia, with the help of a subsidy from the Government, was formally opened on December 1st, 1927. The Observatory has been built at a height of 128 metres above sea level on Mount Marjan, which is just outside the city in 40° 21' N., 16° 26' E.

Besides all the usual instruments for observations at fixed

intervals it is equipped with numerous self-recording instruments. There is also a wireless receiving station in the building and a seismic station will shortly be established. Work at the Observatory has been going on during the whole of 1927, and it is hoped that in the near future the Observatory will become the Headquarters of the meteorological service which is to be organised along the Adriatic coast of Yugoslavia.

### London Fog, February 21st, 1928

In the March number for 1927 there appeared a map showing the movements of fog over London on the previous January 29th. The occurrence of fog in the third week of February, 1928, gave an opportunity to investigate its distribution on another occasion. Unfortunately fog occurred on several successive days and to avoid the possibility of mistakes it was not considered safe to accept statements with regard to observations later than the day after that on which the fog distribution was investigated.



The accompanying map is thus not so detailed as that drawn last year. Information was however obtained from districts considerably farther east, and this, together with its curious similarity to its predecessor, which may or may not be significant, makes it worth while to put it on record. The map speaks for itself, the noticeable fact being that it is

again the Lea valley which appears to be the fog reservoir, the Roding valley being also affected, but Epping forest apparently stood out above the fog. Whether fog extended to the river in the Silvertown area is doubtful, but the evidence is against it. A misty belt of varying width surrounded the fog, but elsewhere London was bathed in sunshine.

It may perhaps be noted that (1) there had been fog over somewhat the same area the previous morning; (2) shortly after 9 a.m. the fog moved slightly westward, but that was all the movement that took place; (3) over most of the area the fog



had disappeared by 12.30 p.m., but in the central portion of the valley it remained to some extent all day ; (4) the fog appeared over very much the same area at night ; (5) next morning, fog lay over many parts of London, east, west and south, but whether these were continuous with the northern area is not known.

J. FAIRGRIEVE.

### Mock Moons

Mr. F. Sargent of Durham University Observatory reports that he observed " mock moons " on the evening of Sunday, January 8th, from the Observatory. At a few minutes before 9 o'clock a small patch of the prevailing thin cirrus cloud situated some distance to the right of the nearly full moon was seen to be illuminated as though by a bright light behind it. A little later a similar patch of light, a second mock-moon, developed at a similar distance to the left. With the increased altitude of the moon one hour later a similar mock moon was visible vertically below and a fourth appeared faintly above. Occasionally, the familiar lunar halo would develop, when it could be seen that the mock moons were situated on the outer edge of it, the appearance then being of the usual halo with four small circular illuminated patches dividing it equally in the vertical and horizontal places. The phenomenon was observed for two hours.

The only other local record of this phenomenon known to Mr. Sargent is one from the Newcastle district, where it was seen on January 18th, 1902.

### Wind at the Level of a Rain Gauge

Owing to difficulties arising from the effects of blown sand upon the rainfall record at Spurn Head, arrangements were made in 1925 for a rain gauge to be erected in the enclosed yard of the lighthouse station. This yard is circular and measures 36 yards in diameter. It is surrounded by low buildings, the approximate height of these being 16 feet. As the yard was paved it was considered necessary that the rain gauge should be at a height greater than 1 foot, so that the effects of insplashing should be avoided. It was actually installed at a height of 4 feet. It is well known that the rainfall collected by a gauge with the rim at a height of 4 feet exposed in an ordinary situation would be less than the rainfall collected with a gauge with the rim at a height of 1 foot. This difference arises from the eddies caused by the wind and is naturally dependent upon the strength of the wind, though not solely upon the strength.

With a view to getting some idea as to whether the exposure of the new rain gauge at Spurn Head could be considered normal so far as the strength of the wind at the height of the rim of the gauge is concerned, it was decided to make some measurements

with an anemometer in the yard with the cups placed at the same level as the rim of the rain gauge. From these measurements it was found that the wind at the level of the rim of the rain gauge was about 25 per cent. of the wind recorded by the pressure tube anemometer at a height of 42 feet above ground. The highest value recorded at the level of the rain gauge was 11 miles per hour at a time when the pressure tube anemometer recorded a wind of 39 miles per hour : in each case the value refers to the mean velocity over a period of 60 minutes. When the results came to be examined it was found that there were no records available of the strength of the wind at a height of 1 foot above the ground in a situation which would be considered normally satisfactory for a rain gauge exposure. It was therefore arranged that some measurements of the strength of the wind should be made at a height of 1 foot above the ground in the neighbourhood of the rain gauge at Kew Observatory. From these measurements it was found that the strength of the wind at rain gauge level at Kew Observatory was between 25 per cent. and 40 per cent. of the strength of the wind recorded by the pressure tube anemometer on the top of the Observatory, the value depending naturally upon the direction of the wind. The highest value recorded at a height of 1 foot was 10 miles per hour at a time when the pressure tube anemometer recorded a wind of 28 miles per hour.

It appears from this that the exposure of the rain gauge at Spurn Head is sufficiently near the normal so far as strength of the wind at the level of the rim of the gauge is concerned for no artificial screening of the gauge to be necessary, and it appears from the further observations at Kew Observatory that the exposure of a rain gauge may be considered as sufficiently near the normal to require no artificial screening if the wind at the level of the rim of the gauge does not exceed 10 to 15 miles per hour. This must not be taken to imply that a wind of 10-15 m.p.h. has no effect upon the catch of a rain gauge—all that it means is that the effect is not great enough to render the records useless for comparison with the records from other gauges.

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E. GOLD.

### **Rainfall and Farming in the Transvaal**

In this bulletin of the Transvaal University College, Pretoria,\* there are two parts. The first, by F. E. Plummer, Professor of Geography, is a preliminary investigation into the variability of the rainfall, and the second, by H. D. Leppan, Professor of Agronomy, is entitled " Rainfall in relation to agriculture in the Transvaal."

The outstanding feature of the rainfall in the Transvaal is the

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\* *Transvaal University Bulletin* No. 12, pp. 63+17 maps, Pretoria, 1927.

fact that from 80 to 90 per cent. of it falls in the summer months, October to March. As the processes of farming depend directly upon the summer rains, Professor Plummer takes for the "hyetal year" the twelve months commencing July, instead of the twelve months of the calendar year. With the scanty material at his disposal he deduces that the mean annual rainfall varies from rather less than 15 in. in the extreme west to over 30 in. over the mountains in the east, where, in general conformity with the contours, the average rainfall shows various small areas of maxima exceeding 50 in., with an extreme average of 72 in. at Woodbush Forest. The "dispersion" (computed by the ordinary formula for probable error of a set of observations) of the deviations of the serial annual values at a station is worked out in as many cases as possible, in order to obtain a measure of the "reliability" of the rainfall from year to year. The dispersions for all the stations, when expressed as percentages of the respective annual average values of rainfall and plotted on a map, show values of less than 7.5 per cent. towards the south-east of the province, west of the mountains, increasing to over 25 per cent. in the east, over 20 per cent. in the extreme west, and over 25 per cent. in the north-west. Pretoria, at a height of 4,350 feet, has an average rainfall of about 29 in. and a percentage dispersion of 16 per cent., *i.e.*, the actual dispersion is about  $4\frac{1}{2}$  in. By the theory of probability, and under a certain (false) assumption which will presently be referred to, it can, therefore, be concluded that the chances are even that the rainfall at Pretoria in any year will lie between  $33\frac{1}{2}$  and  $24\frac{1}{2}$  in. The chances are also even that it will be outside these limits. The author also works out by the theory of probability, and shows cartographically (1) the minimum amount of rainfall which may reasonably be expected to occur in seventy-five years out of one hundred; (2) the number of years per century in each of which a minimum of (A) 20 in. and (B) 24 in. may be expected to occur; (3) the duration of the rainy period with an average of (A) 1 in., (B) 3 in., and (C) 4 in. per month; (4) the month of maximum rainfall irrespective of amount; and (5) the percentage of the mean annual rainfall which is recorded in each of the two three-monthly periods comprising the six months of summer. He also classifies the Transvaal into hyetal regions, and sets out diagrammatically various types of average monthly distribution.

The paper is a valuable addition to our knowledge of the rainfall of the Transvaal, and as such is very welcome.

Exception must, however, be taken to the author's use of the theory of probability in his treatment of the rainfall data, by means of which he obtains certain results which are manifestly improbable. For example, he shows a diagram of serial annual values of rainfall at Johannesburg on which the annual average

value 33.39 in. is marked. The diagram extends from 1889 to 1925, 37 years. It shows one year (1908-9) of markedly excessive rainfall (50 in.), and another (1917-8) of even greater excess (63.92 in.). Yet the author goes on to state: "According to the law of probability this amount" (*i.e.*, 50 in. in 1908-9) "cannot reasonably be expected to occur more often than 23 times in 10,000 years" (*i.e.*, twice in 1,000 years approximately)! He also concludes that the value of 63.92 registered in 1917-8 cannot be expected to occur more than five times in 100,000 years. The key to the error is found on p. 10, where it is stated that "there appears to be no reason why the law of probability of error should not be applicable to the analysis of rainfall data, as equal positive and negative deviations from the mean are equally probable, if the series of observations is sufficiently extensive." The author thus regards annual rainfall totals in the same way statistically as he would regard successive annual attempts of some Jupiter Pluvius to deal out the exact average rainfall by means of a huge graduated watering can. It is, however, known that the deviations of annual rainfall do not follow the normal frequency curve of error, but are distributed in a skew manner about the average annual value. Accordingly, the assumed law of error, and the criterion of rejection of outstandingly high annual values which is used, are invalid, and the computations based on them are subject to consequential errors. Judging from data printed in the tables, these errors should not, however, affect seriously the main conclusions of the paper.

Professor Leppan gives a very clear and interesting account of the manner in which farm crops are affected by the seasonal distribution of the rainfall, by the variations in annual rainfall, and by effects of percolation and evaporation. He discusses the question of the most suitable crops for cultivation in the different rainfall zones, and warns new settlers in the Transvaal against certain pitfalls into which they may not improbably fall, such as the temptation to acquire land in regions where the rainfall is very uncertain, in view of the low price at which it is offered for sale.

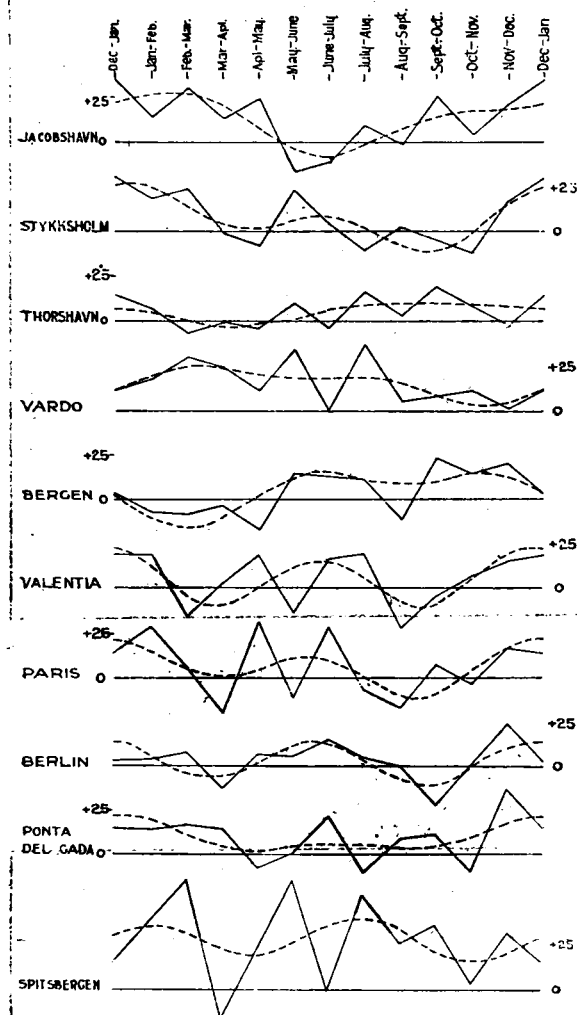
R. CORLESS.

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### Persistence of Pressure Deviations in Western Europe

One of the features which distinguishes the temperate regions from almost all other parts of the world is the extreme smallness of the tendency for deviations of pressure from normal to persist with the same sign over more than one month. This characteristic feature is brought out by the results in Table 1, obtained by correlating the pressures of every month at each of a number of stations in the eastern North Atlantic and north-western Europe,

with the pressures at the same station in the following month. The results are shown graphically in Fig. 1. The upper line for each station in the table, and the full curves in Fig. 1, represent the coefficients actually obtained; the lower lines in the table, and the broken lines in the figure, represent the results after smoothing by means of the first two terms of a Fourier series. The figures in brackets in the last column represent the



largest of the twelve monthly coefficients which would be expected if there were no real connexion between the pressure in succeeding months.

Considering first the mean values, and omitting for the moment consideration of Spitsbergen, we find that although all are positive, only the two northern stations, Jacobshavn and Vardö, exceed  $+10$ . The mean values are smallest at the intermediate stations, Thorshavn, Bergen, Valentia and Berlin, and increase slightly southwards as well as northwards. At these four stations not one of the monthly values exceeds the highest value which would be expected if there

were no real connexion, so that there is no real evidence of an appreciable connexion between the pressure in successive months at any season of the year.

At Vardö all twelve coefficients are positive, though that for June to July is very small, and it is here that the evidence for persistence is strongest. Coefficients were accordingly calculated

for Spitsbergen, and although, owing to the short record (only 15 years), the monthly values are very irregular, the annual average of  $+0.27$  evidently indicates a real tendency for persistence from one month to the next, which appears to be strongest

TABLE 1.

CORRELATION COEFFICIENTS BETWEEN PRESSURES IN SUCCESSIVE MONTHS.

	Dec. Jan.	Jan. Feb.	Feb. Mar.	Mar. Apr.	Apr. May	May June	June July	July Aug.	Aug. Sept.	Sept. Oct.	Oct. Nov.	Nov. Dec.	Mean
Jacobshavn ... 1873-1923	$+0.35$ $+0.22$	$+0.14$ $+0.26$	$+0.30$ $+0.27$	$+0.13$ $+0.20$	$+0.24$ $+0.07$	$-0.16$ $-0.04$	$-0.11$ $-0.08$	$+0.08$ $-0.02$	$-0.01$ $+0.07$	$+0.25$ $+0.14$	$+0.04$ $+0.17$	$+0.20$ $+0.18$	$+0.12$ ( $-0.27$ )
Stykkisholm... 1846-1926	$+0.31$ $+0.26$	$+0.18$ $+0.25$	$+0.24$ $+0.14$	$-0.01$ $+0.04$	$-0.07$ $+0.02$	$+0.23$ $+0.06$	$+0.04$ $+0.08$	$-0.10$ $+0.02$	$+0.02$ $-0.07$	$-0.04$ $-0.10$	$-0.11$ $-0.01$	$+0.17$ $+0.15$	$+0.07$ ( $-0.21$ )
Thorshavn ... 1872-1922	$+0.15$ $+0.07$	$+0.07$ $+0.04$	$-0.07$ $-0.00$	$-0.01$ $-0.03$	$-0.04$ $-0.02$	$+0.10$ $+0.01$	$-0.04$ $+0.06$	$+0.16$ $+0.09$	$+0.03$ $+0.10$	$+0.19$ $+0.10$	$+0.08$ $+0.09$	$-0.02$ $+0.08$	$+0.05$ ( $-0.27$ )
Vardo ... 1874-1924	$+0.12$ $+0.12$	$+0.18$ $+0.20$	$+0.30$ $+0.25$	$+0.25$ $+0.24$	$+0.12$ $+0.21$	$+0.34$ $+0.19$	$+0.01$ $+0.19$	$+0.37$ $+0.19$	$+0.06$ $+0.16$	$+0.08$ $+0.09$	$+0.11$ $+0.04$	$+0.02$ $+0.05$	$+0.16$ ( $-0.27$ )
Bergen ... 1868-1924	$+0.04$ $+0.03$	$-0.07$ $-0.10$	$-0.08$ $-0.16$	$-0.03$ $-0.10$	$-0.17$ $+0.02$	$+0.15$ $+0.13$	$+0.13$ $+0.16$	$+0.12$ $+0.12$	$-0.11$ $+0.09$	$+0.24$ $+0.11$	$+0.15$ $+0.15$	$+0.21$ $+0.13$	$+0.05$ ( $-0.25$ )
Valentia ... 1866-1926	$+0.18$ $+0.22$	$+0.18$ $+0.12$	$-0.15$ $-0.04$	$+0.02$ $-0.09$	$+0.18$ $-0.01$	$-0.13$ $+0.11$	$+0.16$ $+0.14$	$+0.18$ $+0.05$	$-0.22$ $-0.07$	$-0.04$ $-0.08$	$+0.06$ $+0.04$	$+0.15$ $+0.19$	$+0.05$ ( $-0.24$ )
Paris ... 1874-1920	$+0.14$ $+0.22$	$+0.29$ $+0.15$	$+0.06$ $+0.05$	$-0.19$ $+0.01$	$+0.32$ $+0.04$	$-0.11$ $+0.11$	$+0.28$ $+0.10$	$-0.06$ $+0.01$	$-0.17$ $-0.09$	$+0.07$ $-0.09$	$-0.03$ $+0.03$	$+0.17$ $+0.17$	$+0.06$ ( $-0.28$ )
Berlin ... 1848-1923	$+0.03$ $+0.14$	$+0.04$ $+0.07$	$+0.08$ $-0.03$	$-0.13$ $-0.06$	$+0.07$ $+0.02$	$+0.06$ $+0.12$	$+0.15$ $+0.13$	$+0.05$ $+0.04$	$-0.00$ $-0.07$	$-0.22$ $-0.10$	$+0.01$ $-0.01$	$+0.24$ $+0.10$	$+0.03$ ( $-0.22$ )
Ponta Delgada 1865-1926	$+0.15$ $+0.22$	$+0.14$ $+0.20$	$+0.17$ $+0.12$	$+0.14$ $+0.05$	$-0.07$ $+0.02$	$+0.01$ $+0.04$	$+0.21$ $+0.05$	$-0.09$ $+0.05$	$+0.08$ $+0.03$	$+0.11$ $+0.04$	$-0.08$ $+0.09$	$+0.37$ $+0.17$	$+0.09$ ( $-0.24$ )
Spitsbergen ... 1911-1925	$+0.15$ $+0.29$	$+0.37$ $+0.35$	$+0.61$ $+0.31$	$-0.17$ $+0.23$	$+0.24$ $+0.19$	$+0.60$ $+0.25$	$-0.01$ $+0.35$	$+0.52$ $+0.39$	$+0.26$ $+0.33$	$+0.35$ $+0.22$	$+0.03$ $+0.16$	$+0.31$ $+0.20$	$+0.27$ ( $-0.49$ )

in late winter and at midsummer. At Jacobshavn and Stykkisholm, and again at Ponta Delgada, the coefficients appear to indicate a real, though small, persistence in winter, but almost complete independence in summer.

TABLE 2.

PERSISTENCE OF PRESSURE DEVIATIONS FROM ONE QUARTER TO THE NEXT.

	Jan.-Mar. to Apr.-June.	Apr.-June to July-Sept.	July-Sept. to Oct.-Dec.	Oct.-Dec. to Jan.-Mar.	Mean.
Jacobshavn ...	$+0.18$	$+0.01$	$+0.04$	$+0.27$	$+0.13$
Stykkisholm...	$+0.13$	$+0.02$	$+0.03$	$+0.17$	$+0.09$
Thorshavn ...	$+0.25$	$-0.19$	$-0.06$	$-0.07$	$-0.02$
Vardö ...	$+0.06$	$-0.03$	$-0.19$	$+0.04$	$-0.03$
Bergen ...	$+0.06$	$-0.13$	$-0.06$	$-0.17$	$-0.07$
Valentia ...	$-0.02$	$+0.16$	$-0.19$	$+0.11$	$+0.01$
Paris ...	$+0.02$	$+0.15$	$-0.02$	$+0.13$	$+0.07$
Berlin ...	$+0.01$	$+0.18$	$+0.06$	$+0.16$	$+0.10$
Ponta Delgada	$+0.14$	$+0.19$	$+0.16$	$+0.05$	$+0.13$

Table 2 shows the correlation between the means of pressure

during successive quarters. The greatest persistence is shown at Jacobshavn and Stykkisholm in winter and by Ponta Delgada in summer ; at the remaining stations the figures are all small and irregular.

C. E. P. BROOKS.

WINIFRED A. QUENNEL.

### An Unusual Cyclone Track \*

In a recent publication of the Royal Alfred Observatory, Mauritius, appears a short note by Mr. M. Koenig on a cyclone which is said to be unique in being "the first case on record, in this region of the Indian Ocean, of a cyclone actually moving towards the equator." From examination of observations made at Rodriguez, Mauritius and Madagascar, as well as on several ships, it is deduced that this cyclone, which passed north of Mauritius on February 27th, 1927, moved over a track of the usual "parabolic" shape to a position about 100 miles north of Réunion on March 2nd, but then, instead of continuing south or south-east after recurving, took a WNW course towards Madagascar. At the same time the intensity and rate of travel of the cyclone increased considerably. The centre passed over Tamatave (Madagascar) on March 3rd, pressure falling to 940 mb. in the central calm area and winds reaching an estimated speed of 125 miles per hour, and was traced inland across Madagascar for some distance, but up to the time of the writing of the note, the subsequent history of the cyclone was unknown.

S. T. A. MIRRELES.

### High Temperatures in Iraq

Maximum temperatures ranging from 110° to 121° F. in the shade were registered in Iraq during July in the years 1922-24. The stations considered were Mosul in the north, Baghdad and Ramadi in central Iraq and Shaibah near the head of the Persian Gulf. There is a great preponderance of north-westerly winds in Iraq in July and practically no southerly winds, so that nearly

HINAIDI (NEAR BAGHDAD).

Percentage frequencies of winds in July at 3,000 ft.

Period	Hour	No. of Obs.	N	NE	E	SE	S	SW	W	NW	Velocity 3 mph or less
1922-26	0h 30m to 5h	141	28	1	1	1	0	2	7	59	1

all these high temperatures occurred on days when the wind was northerly. These hot northerly winds were often quite strong

\*The cyclone of February 24th to March 3rd, 1927. By M. Koenig, A.Inst.P. (Misc. Pub. Royal Alfred Observatory, No. 6, pp. 5.) Port Lewis, Mauritius, 1927.

and attained their maximum velocity at about 1,500 feet above ground level where the velocity in a few cases exceeded 50 miles per hour. On July 11th, 1923, for example, the temperature at Hinaidi rose to  $114^{\circ}$  F. in the shade, while the surface wind at 10h. G.M.T. (*i.e.*, about 13h. local time) was reported as 35 miles per hour from north; on July 12th, 1924, also at Hinaidi, the maximum temperature was  $115^{\circ}$  F. and the surface wind at 10h. G.M.T. 28 miles per hour from north-west. An extreme temperature of  $121^{\circ}$  F. was recorded at Hinaidi on July 21st, 1922. On this date the wind was blowing from north-west with a velocity of 16 miles per hour at 5h. G.M.T., but had fallen to calm at 10h. G.M.T.; while on July 13th, 1924, when  $121^{\circ}$  F. was again recorded at Hinaidi the wind was moderate or fresh from north-west. A general survey of the observations therefore shows that high temperatures in Iraq are usually associated with northerly winds which may be quite strong.

The mean maximum temperature for July at Hinaidi during the five years 1922-26 was  $110^{\circ}$  F. During the three-year period 1922-24 there were six days on which the wind at 3,000 feet at Hinaidi was southerly and on four of these days the maximum temperatures were all above normal, the highest being  $119^{\circ}$  F. On the remaining two days the maxima were  $108^{\circ}$  and  $110^{\circ}$  F. Hence the temperature in Iraq is also likely to be high when the wind is southerly.

The occurrence of high temperatures in Iraq when the wind is northerly suggests the existence of a föhn effect because this region is flanked on the north and east by ranges of mountains. If the existing air over Iraq is withdrawn at any time and replaced by air from the mountains the dynamical warming which occurs will give a föhn effect provided that the initial distribution of temperature in the vertical in the descending air is suitable, and it is not difficult to imagine that suitable initial temperatures will at times occur in summer.

The pressures observed in Iraq on the three hottest days in each of the years 1922-24 were all below normal for the time of year and indicate an extension or intensification of the low pressure centre which normally exists at this season over north-west India. Since the wind at Hinaidi at 3,000 feet was southerly on only one of these nine days the observations in Iraq suggest an association between föhn effects and pressure changes similar to that observed in Switzerland and elsewhere. The preponderance of northerly winds is lost at a height of 6,000 feet at Mosul, so that the vertical thickness of the air flowing in from the mountains on the north may be taken to lie between 3,000 and 6,000 feet.

The observations in Iraq therefore indicate that the heat of this region in summer is supplemented at times by a föhn effect.



## A Thermometric Chart

A new Thermometric Conversion Chart designed by P. L. Markes, L.R.I., B.A., has been published by Crosby Lockwood and Son. With this chart the conversion, to the nearest whole degree, from one thermometer scale to another can be seen at a glance, and constants are given at the foot of the chart for use when greater accuracy is desired. Five thermometric scales are charted, including the De l'Isle scale, which is now only of historical interest, and in the introduction a brief account of the history of the invention of each of the scales is given. The book is well got up, and should prove an acceptable addition to the literature of thermometry.

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## Reviews

*Physical Factors of the Historical Process.* By A. Tchijevsky.

Size  $9\frac{1}{4} \times 7\frac{1}{2}$ , pp. 72. Russian with English summary.

*Illus.* Kaluga, 1924.

There is a well-known theory, due to W. S. Jevons, that commercial crises have an eleven-year cycle corresponding with that of sunspots, but the relation is generally considered to be an indirect one, resulting from the effect of a sunspot periodicity in rainfall on the yield of crops. Equally well known is the relation between weather conditions and crime, including suicide, and here again there is the possibility of an indirect relation with sunspots. The author of the present paper postulates a close relation between sunspots and the collective activity of the mob, as expressed in rebellions, revolutions, riots, religious movements and other "mass-historical" events. As the result of "a minute scrutiny of the history of all the peoples and states known to science, beginning with the V. century B.C.," he finds that "as soon as the sunspot activity approaches its maximum, the number of the important mass-historical events, taken as a whole, increases," and he calculates that 60 per cent. of these events occur in the three years of spot maximum, compared with only five per cent. in the three years of spot minimum. During the latter period there is, instead, a time of peaceful creative work. A curious individual instance is a curve showing the parallelism between outbursts of revolutionary activity in Russia and outbursts of sunspots day by day from October, 1905, to April, 1906. This seems to indicate that the supposed relation does not take effect through the ordinary weather channels such as rainfall, but acts far more quickly. The author does not venture an explanation, but one immediately thinks of the nervous effects of variations of atmospheric potential gradient.

The author's results are certainly striking, and we may yet

hear an anarchist accused of bomb-throwing plead in defence the influence of sunspots, but there must be difficulty in avoiding bias in the selection of the "mass-historical" events, and for the present it would be as well to keep an open mind.

C. E. P. BROOKS.

*Sur la Distribution de la Pluie en Belgique.* By Emile Vanderlinden. Inst. Roy. Météor. de Belgique, Mémoires Vol. II. Size  $12\frac{1}{2} \times 9\frac{1}{2}$ , pp. 50. *Illus.* Brussels, 1927.

It is not surprising that with the difficult war and post-war conditions in Belgium, the number of rainfall stations should have decreased considerably. In fact, it is very satisfactory to note that as many as 100, out of the 311 stations recording in 1913, still survived in 1918. Subsequently the number of new records has kept pace with those which have ceased. A detailed study had to be limited to the 17 years commencing 1910 when standard gauges were introduced.

Mean monthly and annual amounts are set out for each station, those from incomplete records being computed in the usual way by reference to the nearest stations with complete records. Except in the case of the record at Uccle, the means have been increased by 3.2 per cent. This factor has been determined experimentally as the difference between the catch of the standard gauge and that of a "normal rain gauge" set up on the bottom of a cylindrical tub 28 in. in diameter with its rim and that of the gauge level with the ground. Finally the corrected annual means have been reduced in the ratio 108.5 : 100, since this is the ratio of the annual catch at Uccle for the years 1910 to 1926 and that for 1887 to 1926. The final values are taken as the normals for the 40 years' period. The defects of the gauges in use prior to 1910 were the large surface of the collecting funnel, leading to losses by evaporation, the lack of adequate precautions for the measurement of snow and the exposure with the rim 5 feet above the ground. The gauges caught from 10 to 20 per cent. less than a gauge exposed with the rim level with the ground. The standard gauge is of the Howard pattern, *i.e.*, a shallow funnel and bottle. The gauge rests on the ground with the mouth 30 cm. (11.8 in.) above the level of the ground, and is prevented from being blown over by a cylinder projecting just above the ground and soldered to a horizontal sheet buried about 5 cm. Each gauge is supplied with a spare funnel about 9 in. deep, for use in time of frost and snow. Like the other funnel, it is of zinc and 10 cm. (3.9 in.) in diameter. The method employed of increasing the recorded values by 3.2 per cent. seems open to serious objections, and more direct observations are desirable. In the first place there is probably some insplashing from the ground only 1 foot away and level with the mouth of the normal rain gauge. Furthermore, any correction is likely

to vary with the seasons and with the different exposures of the gauge, *i.e.*, any loss is likely to be greater in the winter months and with gauges in more open sites, owing to the increased amount of wind-eddy set up round the gauge in both cases with the stronger winds. The decrease in the ratio of 108.5 to 100 is probably reasonable, since recent years were generally wet and since Uccle is in the central portion of Belgium. If reliable data were, however, available, most probably the factor would have varied appreciably in the outlying districts.

The publication includes a map showing the distribution of the average annual rainfall as computed for the period 1887 to 1926. The fall varies from about 25 in. along part of the coast to about 50 in. on the higher ground to the south-east. This is a much smaller range than in the British Isles, where the average annual rainfall varies from about 20 in. in the neighbourhood of the Thames Estuary to over 150 in. in the English Lake District, Snowdonia and the Western Highlands of Scotland. Details are given of the maximum recorded intensity of rainfall. For durations less than 10 minutes, the greatest rates are generally smaller than those for the British Isles, probably owing to our larger number of highly sensitive recording gauges. The greatest rates on record for rains of from 10 to 45 minutes' duration are similar for the two countries, varying from about 7 in. to 3.5 in. per hour. A fall of 7.9 in. in 3 hours 15 minutes at Louvain on May 14th, 1906, is comparable with that at Cannington, near Bridgwater, Somersetshire, on August 18th, 1924, when, during an intense and remarkable local thunderstorm, a conservative estimate is that 8 in. of rain and hail fell in 5 hours.

There is a detailed discussion of the abnormally dry weather from August, 1920, to October, 1921, a drought apparently without precedent in Belgium in historic times. The drought was most intense during the six months May to October, 1921, when deficiencies occurred of from 60 to 75 per cent. at a number of stations. The drought seems to have been even more severe than in the British Isles, since in the corresponding driest six months period, February to July, 1921, deficiencies in this country only just exceeded 65 per cent. of the average. It is interesting to note that the Lac de la Gileppe, which usually contains 13 million cubic metres, was reduced to little over one million cubic metres by December 8th, 1921, and striking photos are given of a nearly empty lake. In this connexion references are given to earlier droughts, from the author's work on *Chronique des événements météorologique en Belgique jusqu'en 1834*, together with details of more recent droughts in Belgium.

J. GLASSPOOLE.

*Weather Observations and Aids to Forecasting.* By Donald W. Horner. Size  $7\frac{1}{4} \times 5$ , pp. 64. *Illus.* London, G. Allen & Unwin, 1927. 2s. 6d. *net.*

This little volume has been written, according to the Preface, with the intention of being used as an elementary text book for schools and colleges, and on this account "great care has been taken to verify every fact, and the information given will be found completely up to date and quite reliable throughout."

The book, however, contains only a few instructions on how weather observations are made, and some of these are rather misleading. For example, on page 36, in describing the setting of the grass minimum thermometer, the following occurs:—

"The 'grass thermometer' is 'set' in a similar way to the ordinary minimum thermometer, *i.e.*, by tipping it up gently so that the index . . . impinges upon the indicating medium, which, however, in this case is mercury." The grass minimum thermometer is, of course, a spirit thermometer. Again, regarding rainfall measurement, page 44: "rainfall measurements are taken in inches or millimetres. We can use which we prefer, but once having adopted a particular system we must adhere to it, and no conversion from inches to millimetres or *vice versa* should be attempted. Exact conversion is impossible, . . ." On page 43 it states: "The actual cause of rain—apart from rain brought about by electric influence—is dust-motes collecting water vapour until, becoming sufficiently heavy, they fall by gravitation to the earth as rain."

Distributed throughout the book are instructions on how to forecast coming weather. Such instructions often involve the making of assertions which cannot be readily proved. On page 28 there is a typical case, here the author assumes that rain is falling in south-east England with a north-east wind and a rising barometer: "The probabilities are ten to one that the persistent rain with a north-easterly wind and steadily rising barometer will be followed by a spell of from seven to ten days' fine weather."

On page 41 a peculiar explanation is given of the formation of fog: "The origin of the dense fogs prevalent in London, Liverpool and other large towns or cities situated on the banks of rivers in winter is similar. The cold, damp air rises from the surface of the rivers and mixes with the warmer and drier air of the town." Later, on the same page: "It does not seem generally understood that the same 'visible moisture' which causes the 'objectionable fog' is also responsible for those magnificent cumulus (thunder) clouds which we all admire."

Perhaps rigid accuracy has after all been occasionally sacrificed to simplicity, for the book is written in simple language and makes easy and interesting reading.

J. CRICHTON.

### Books Received

*Memorias y Revista de la Sociedad Cientifica "Antonio Alzate."*

Tomo 45 and 46, Num. 3-6 and 7-12. Mexico, 1926.

The article in Tomo 46, pp. 237-77, on "Geological phenomena in the Valley of Mexico and their influence on the production of Dust Devils," is of special interest to meteorologists. *Bollettino Meteorologico della Cirenaica*, 1925 (*Riassunto annuale, della osservazioni*). R. Ufficio Meteorologico, No. 5. Tripoli, 1927.

*Bollettino*, 1925 (*Riassunto annuale della osservazioni*). R. Ufficio Meteorologico della Tripolitania, No. 7. Tripoli, 1927.

*Nautisk-Meteorologisk Aarbog*, 1926. The Danish Meteorological Institute. Copenhagen, 1927.

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### Obituary

*Prof. Willis L. Moore.*—We regret to learn of the death of Prof. Willis L. Moore, on December 18th, 1927, aged seventy-one years. Prof. Moore was Chief of the Weather Bureau from 1895 to 1913 and was succeeded by the present Chief, Prof. C. F. Marvin. After his retirement from the Official Service he became professor of applied meteorology at George Washington University. He was elected an Honorary Member of the Royal Meteorological Society in 1902 and is chiefly known to English meteorologists for his textbook *Descriptive Meteorology*.

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*M. Spas Watzof.*—We regret to learn of the death, on February 2nd, of the Bulgarian meteorologist, M. Spas Watzof, in his 72nd year. Although he published little himself, M. Watzof was keenly interested in science, and in 1894 he organised the formation of the Meteorological and Seismological Service of Bulgaria, of which he became the first Director, a post which he held until his death.

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### News in Brief

Sir John Moore reports that on Saturday afternoon, February 25th, he observed two beautiful parhelia followed by a sun pillar in the neighbourhood of Bletchley, Buckinghamshire.

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The degree of Doctor of Science has been awarded by the University of Cambridge to Mr. F. J. W. Whipple, Superintendent of Kew Observatory and Assistant Director of the Meteorological Office.

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The Ninth Annual Soirée of the Meteorological Office Staff was held on Thursday, February 23rd, at Anderton's Hotel, Fleet Street. An excellent Cabaret Concert and a Dance, each held in separate rooms throughout the evening were enjoyed by a record number of past and present members of the Staff and their friends.

## The Weather of February, 1928

During the first half of the month the weather continued mild and unsettled as in January with strong westerly winds or gales and heavy rain at times, but towards the end fine warm dry conditions prevailed with an unusually large number of hours of bright sunshine. Hail and sleet showers were general in the north during the first days and "snow lying" was reported from a few places, especially in Scotland where measurements of 6 to  $7\frac{1}{2}$  in. were recorded at West Linton on the 2nd, 3rd and 4th. The lowest screen minimum temperature for the month was  $19^{\circ}$  F. at West Linton on the 4th and at Balmoral on the 23rd and the lowest grass minimum,  $12^{\circ}$  F. at Balmoral on the 4th. Strong winds and gales were often reported from most parts of the country between the 1st and 17th, the strongest winds occurring on the 10th and 11th. During the afternoon of the 10th a line squall passed over England, a sudden drop of about  $10^{\circ}$  F. in temperature being recorded in London and elsewhere while thunderstorms with hail, sleet or snow occurred in many places. In the evening a secondary depression developed off northwest Ireland and moved eastward causing strong gales over England. Mean velocities between 55 and 60 m.p.h. were measured at Fleetwood, Southport, Holyhead and Scilly with gusts of over 80 m.p.h. at Valentia, Holyhead and Southport. A gust of 104 m.p.h. was recorded by the Osler swinging plate anemometer at Bidston Observatory. During this period minimum temperatures were unusually high for the time of year; minima of  $52^{\circ}$  F. were registered at Valentia, Gorleston and Kew on the 16th. Among the heaviest amounts of rain recorded were 4.65 in. at Cwm Dyli, Snowdon, on the 4th, 3.02 in. at Treherbert (Glamorgan) on the 15th, 2.83 in. at Mourne Mountains (Co. Down) on the 29th. After the 17th an anticyclone began to spread over the British Isles causing a change to quiet, almost rainless, sunny conditions. A good deal of fog developed locally and some frost occurred at night, but day temperatures continued generally above the average for the time of year, though there were some low readings mainly due to the presence of fog. In many parts, however, the weather was remarkably fine, sunshine records of over nine hours a day occurring repeatedly. The highest values were recorded on the 27th, when 9.9 hrs. occurred at Eastbourne and 9.8 hrs. at Bath, Cheltenham and Jersey. The total sunshine for the month was above the normal in most parts, being 26 hrs. above normal at Kew Observatory, 19 hrs. at Dublin, 13 hrs. at Aberdeen and 10 hrs. at Falmouth. In southwest Ireland however there was a deficiency of 4 hrs. at Valentia. At Kew Observatory, the total of 86 hrs. has only twice been exceeded in February during the past 48 years.

Pressure was below normal in Spitsbergen, Iceland, Newfoundland, Scotland, northeast England, Norway and Sweden, the greatest deficit being 10.6 mb. at Reykjavik, and above normal over an area extending from Denmark, Germany and Italy across the North Atlantic to Bermuda, the greatest excess being 7.5 mb. at Madrid. Temperature was above normal generally and rainfall was above normal except in northern Norway, eastern Gothaland and Svealand (Sweden) and eastern British Isles.

Several heavy snowfalls between the 1st and 6th made the conditions for ski-ing excellent in Switzerland during those days, but the heavy rainfall which fell in France at the same time caused the Seine to rise dangerously. Storms and floods occurred in southwest and west Norway on the 8th to 10th and caused loss of life and much material damage, nine bridges on the Bergen railway being destroyed. Flooding also occurred in Leningrad owing to the storms in the eastern Baltic on the 8th and 9th. On the 11th severe gales and thunderstorms were reported from western Germany while the continued bad weather in France caused flooding on all the main rivers until about the 17th when there was a general improvement in the weather in Europe. The ice broke up on the Vistula at Warsaw on the 13th but floods were prevented by bombing any ice dams that formed. Many avalanches fell and floods occurred in Switzerland and in the Austrian Alps round about the 15th owing to the rapid melting of the snow under the influence of the föhn wind. Owing to strong northwest winds in Transjordan swarms of locusts which attacked Wady Musa near Petra on the 2nd were driven back to the desert.

Welcome rains fell in most of New South Wales and southwestern Queensland during the first half of the month but by the 16th the rainfall was excessive and resulted in severe floods. On the 17th the drought in South Australia was broken and here, too, the rains were so heavy that extensive flooding occurred. Unusually dry weather prevailed in New Zealand early in the month.

The special message from Brazil states that the rainfall in the northern and central regions was scarce, being 2.6 in. and 3.1 in. below normal respectively, while in the southern regions it was plentiful with 1.8 in. above normal. Eight anticyclones passed across the country and gales were frequent in the south and along the coasts of the central regions. The sugar cane was in good condition. At Rio de Janeiro pressure was 0.2 mb. below normal and temperature 1.1° F. above normal.

### Rainfall, February, 1928—General Distribution

England and Wales	..	119	} per cent. of the average 1881-1915.
Scotland	.. .. .	115	
Ireland	.. .. .	128	
British Isles	.. .. .	120	

## Rainfall: February, 1928: England and Wales

CO.	STATION.	In.	Per- cent. of Av.	CO.	STATION.	In.	Per- cent. of Av.
<i>Lond.</i>	Camden Square . . . . .	1.66	99	<i>Leics</i>	Thornton Reservoir ..	2.24	134
<i>Sur</i>	Reigate, The Knowle ..	1.77	86	"	Belvoir Castle . . . . .	1.58	95
<i>Kent.</i>	Tenterden, Ashenden ..	1.33	68	<i>Rut</i>	Ridlington . . . . .	1.74	...
"	Folkestone, Boro. San.	1.19	...	<i>Linc.</i>	Boston, Skirbeck . . . .	1.34	92
"	Margate, Cliftonville ..	.88	64	"	Lincoln, Sessions House	1.03	71
"	Sevenoaks, Speldhurst ..	1.63	...	"	Skegness, Marine Gdns.	1.57	103
<i>Sus</i>	Patching Farm . . . . .	1.66	75	"	Louth, Westgate . . . .	1.78	93
"	Brighton, Old Steyne ..	1.76	87	"	Brigg . . . . .	...	...
"	Tottingworth Park . . . .	2.01	86	<i>Notts.</i>	Worksop, Hodsock . . . .	2.11	137
<i>Hants</i>	Ventnor, Roy. Nat. Hos.	2.03	97	<i>Derby</i>	Derby . . . . .	2.52	156
"	Fordingbridge, Oaklands	2.85	114	"	Buxton, Devon. Hos. . .	5.10	136
"	Ovington Rectory . . . .	2.46	95	<i>Ches.</i>	Runcorn, Weston Pt. . . .	2.48	133
"	Sherborne St. John . . . .	2.25	103	"	Nantwich, Dorfold Hall	2.48	...
<i>Berks</i>	Wellington College . . . .	1.42	76	<i>Lancs</i>	Manchester, Whit. Pk. . .	3.43	179
"	Newbury, Greenham . . . .	2.11	96	"	Stonyhurst College . . . .	6.26	187
<i>Herts.</i>	Benington House . . . .	1.54	97	"	Southport, Hesketh Pk . .	3.31	158
<i>Bucks</i>	High Wycombe . . . . .	2.35	127	"	Lancaster, Strathspey . .	5.22	...
<i>Oxf.</i>	Oxford, Mag. College . . .	1.68	106	<i>Yorks</i>	Wath-upon-Dearne . . . .	2.30	140
<i>Nor</i>	Pitsford, Sedgebrook . . .	1.91	114	"	Bradford, Lister Pk. . . .	4.43	189
"	Oundle . . . . .	1.16	...	"	Oughtershaw Hall . . . .	10.18	...
<i>Beds.</i>	Woburn, Crawley Mill . . .	1.45	98	"	Wetherby, Ribston H. . . .	2.38	138
<i>Cam.</i>	Cambridge, Bot. Gdns. . . .	...	...	"	Hull, Pearson Park . . . .	1.53	92
<i>Essex</i>	Chelmsford, County Lab . .	1.25	84	"	Holme-on-Spalding . . . .	1.70	...
"	Lexden, Hill House . . . .	1.08	...	"	West Witton, Ivy Ho. . . .	3.86	...
<i>Suff.</i>	Hawkedon Rectory . . . .	1.32	87	"	Felixkirk, Mt. St. John . .	1.31	78
"	Haughley House . . . . .	.92	...	"	Pickering, Hungate . . . .	1.60	...
<i>Norw.</i>	Beccles, Geldeston . . . .	.98	72	"	Scarborough . . . . .	1.78	106
"	Norwich, Eaton . . . . .	1.49	91	"	Middlesbrough . . . . .	.99	76
"	Blakeney . . . . .	1.53	103	"	Baldersdale, Hury Res. . .	4.18	...
"	Little Dunham . . . . .	1.43	88	<i>Durh.</i>	Ushaw College . . . . .	1.41	89
<i>Wills.</i>	Devizes, Highclere . . . .	2.22	112	<i>Nor</i>	Newcastle, Town Moor . .	1.26	79
"	Bishops Cannings . . . .	...	...	"	Bellingham, Highgreen . .	2.48	...
<i>Dor</i>	Evershot, Melbury Ho. . . .	3.07	98	"	Lilburn Tower Gdns. . . .	1.84	...
"	Creech Grange . . . . .	3.20	...	<i>Cumb</i>	Geltsdale . . . . .	3.36	...
"	Shaftesbury, Abbey Ho. . . .	1.98	86	"	Carlisle, Scaleby Hall . . .	3.61	162
<i>Devon</i>	Plymouth, The Hoe . . . .	3.31	111	"	Borrowdale, Rosthwaite . .	12.26	...
"	Polapit Tamar . . . . .	3.80	118	"	Keswick, High Hill . . . .	5.95	...
"	Ashburton, Druid Ho. . . .	4.97	105	<i>Glam.</i>	Cardiff, Ely P. Stn. . . .	5.27	176
"	Cullompton . . . . .	3.50	125	"	Treherbert, Tynywaun . .	14.33	...
"	Sidmouth, Sidmount . . . .	2.81	112	<i>Carm</i>	Carmarthen Friary . . . .	5.23	141
"	Filleigh, Castle Hill . . . .	4.39	...	"	Llanwrda, Dolaucothy . .	5.62	129
"	Barnstaple, N. Dev. Ath. . .	3.36	124	<i>Pemb</i>	Haverfordwest, School . .	4.69	135
<i>Corn.</i>	Redruth, Trewirgie . . . .	4.04	107	<i>Card.</i>	Gogerddan . . . . .	6.67	210
"	Penzance, Morrab Gdn. . . .	4.33	130	"	Cardigan, County Sch. . . .	3.50	...
"	St. Austell, Trevarna . . . .	4.83	126	<i>Brec.</i>	Crickhowell, Talymaes . . .	4.00	...
<i>Soms</i>	Chewton Mendip . . . . .	4.67	139	<i>Rad.</i>	Birm. W.W. Tyrmynydd . .	6.42	122
"	Street, Hind Hayes . . . .	2.30	...	<i>Mont.</i>	Lake Vyrnwy . . . . .	10.68	235
<i>Glos.</i>	Clifton College . . . . .	4.13	175	<i>Denb.</i>	Llangynhafal . . . . .	2.61	...
"	Cirencester, Gwynfa . . . .	3.02	134	<i>Mer.</i>	Dolgelly, Bryntirion . . .	7.43	167
<i>Here.</i>	Ross, Birchlea . . . . .	2.14	106	<i>Carn.</i>	Llandudno . . . . .	3.33	160
"	Ledbury, Underdown . . . .	2.11	116	"	Snowdon, L. Llydaw 9 . . .	17.56	...
<i>Salop</i>	Church Stretton . . . . .	3.43	156	<i>Ang.</i>	Holyhead, Salt Island . . .	3.58	147
"	Shifnal, Hatton Grange . . .	1.94	120	"	Lligwy . . . . .	4.31	...
<i>Worc.</i>	Ombersley, Holt Lock . . . .	1.87	114	<i>Isle of Man</i>	Douglas, Doro' Cem. . . .	3.70	116
"	Blockley, Upton Wold . . . .	1.99	88	<i>Guernsey</i>	St. Peter P't. Grange Rd . .	3.90	159
<i>War.</i>	Farnborough . . . . .	2.51	122				
"	Birmingham, Edgbaston . .	2.26	134				



## Rainfall: February, 1928: Scotland and Ireland

CO	STATION.	In.	Per- cent. of Av.	CO.	STATION.	In.	Per- cent. of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	3.34	128	<i>Suth.</i>	Loch More, Acharty...	9.38	142
<i>"</i>	Pt. William, Monreith.	3.33	...	<i>Caith</i>	Wick .....	1.69	74
<i>Kirk.</i>	Caraphairn, Shiel. ....	6.99	...	<i>Ork.</i>	Pomona, Deerness ....	3.40	113
<i>"</i>	Dumfries, Cargen .....	5.17	133	<i>Shet.</i>	Lerwick .....	5.37	170
<i>Dumf.</i>	Eskdalemuir Obs. ....	...	...	<i>Cork.</i>	Caheragh Rectory ....	6.62	...
<i>Roxb.</i>	Braxholm .....	4.19	159	<i>"</i>	Dunmanway Rectory.	6.81	116
<i>Selk.</i>	Ettrick Manse .....	7.40	...	<i>"</i>	Ballinacurra .....	2.92	78
<i>Peeb.</i>	Castlecraig .....	...	...	<i>"</i>	Glanmire, Lota Lo. ...	3.54	90
<i>Berk.</i>	Marchmont House ....	2.56	123	<i>Kerry</i>	Valentia Obsy. ....	4.69	90
<i>Haid.</i>	North Berwick Res. ...	1.31	84	<i>"</i>	Gearahameen .....	11.90	...
<i>Edin.</i>	Edinburgh, Roy. Obs. ...	2.57	162	<i>"</i>	Killarney Asylum....	4.85	113
<i>Ayr.</i>	Kilmarnock, Agric. C. ...	3.38	118	<i>"</i>	Darrynane Abbey ....	5.60	121
<i>"</i>	Girvan, Pinmore .....	4.08	96	<i>Wat.</i>	Waterford, Brook Lo. ...	2.52	77
<i>Renf.</i>	Glasgow, Queen's Pk. ...	3.98	135	<i>Tip.</i>	Nenagh, Cas. Lough ...	5.61	180
<i>"</i>	Greenock, Prospect H. ...	6.41	114	<i>"</i>	Roscrea, Timoney Park	4.34	...
<i>Bute.</i>	Rothsay, Ardencraig. ...	5.46	137	<i>"</i>	Cashel, Ballinamona ..	3.69	115
<i>"</i>	Dougarie Lodge .....	4.72	...	<i>Lim.</i>	Foynes, Coolnanes ....	4.83	151
<i>Arg.</i>	Ardgour House .....	11.49	...	<i>"</i>	Castleconnell Rec. ....	5.42	...
<i>"</i>	Manse of Glenorchy. ...	10.45	...	<i>Clare</i>	Inagh, Mount Callan ...	7.65	...
<i>"</i>	Oban .....	5.20	...	<i>"</i>	Broadford, Hurdlest'n.	4.64	...
<i>"</i>	Poltalloch .....	4.51	105	<i>Wexf.</i>	Newtownbarry .....	3.90	...
<i>"</i>	Inveraray Castle .....	10.32	152	<i>"</i>	Gorey, Courtown Ho. ...	2.95	105
<i>"</i>	Islay, Ballabus .....	5.20	124	<i>Kilk.</i>	Kilkenny Castle .....	3.11	122
<i>"</i>	Mull, Benmore .....	12.80	...	<i>Wic.</i>	Rathnew, Clonmannon	3.20	...
<i>"</i>	Tiree .....	...	...	<i>Carl.</i>	Hacketstown Rectory .	3.40	113
<i>Kinr.</i>	Loch Leven Sluice ....	3.24	115	<i>QCo.</i>	Blandsfort House .....	3.57	133
<i>Perth</i>	Loch Dhu .....	10.05	135	<i>"</i>	Mountmellick .....	4.81	...
<i>"</i>	Balquhidder, Stronvar. ...	8.33	...	<i>KCo.</i>	Birr Castle .....	3.89	170
<i>"</i>	Crieff, Strathearn Hyd. ...	3.54	101	<i>Dubl.</i>	Dublin, FitzWm. Sq. ...	2.46	130
<i>"</i>	Blair Castle Gardens ...	3.55	127	<i>"</i>	Balbriggan, Ardgillan .	2.90	148
<i>Forf.</i>	Kettins School .....	2.10	99	<i>Me'th</i>	Beauparc, St. Cloud ..	3.18	...
<i>"</i>	Dundee, E. Necropolis. ...	1.83	97	<i>"</i>	Kells, Headfort .....	4.13	153
<i>"</i>	Pearsie House .....	2.48	...	<i>W.M.</i>	Moate, Coolatore .....	3.18	...
<i>"</i>	Montrose, Sunnyside ..	1.24	67	<i>"</i>	Mullingar, Belvedere .	3.75	135
<i>Aber.</i>	Braemar, Bank .....	1.42	50	<i>Long</i>	Castle Forbes Gdns. ...	3.23	114
<i>"</i>	Logie Coldstone Sch. ...	1.16	56	<i>Gal.</i>	Ballynahinch Castle ..	4.67	91
<i>"</i>	Aberdeen, King's Coll. ...	.64	31	<i>"</i>	Galway, Grammar Sch. ...	4.08	...
<i>"</i>	Fyvie Castle .....	.77	...	<i>Mayo</i>	Mallaranny .....	6.21	...
<i>Aior.</i>	Gordon Castle .....	.91	47	<i>"</i>	Westport House .....	3.03	77
<i>"</i>	Grantown-on-Spey .....	...	...	<i>"</i>	Delphi Lodge .....	6.54	...
<i>Na.</i>	Nairn, Delnies .....	2.26	126	<i>Sligo</i>	Markree Obsy. ....	3.93	112
<i>Inv.</i>	Ben Alder Lodge .....	...	...	<i>Cav'n</i>	Belturbet, Cloverhill..	3.13	120
<i>"</i>	Kingussie, The Birches ...	4.96	...	<i>Ferm</i>	Enniskillen, Portora ..	4.51	...
<i>"</i>	Loch Quoich, Loan ....	17.30	...	<i>Arm.</i>	Armagh Obsy. ....	3.57	161
<i>"</i>	Glenquoich .....	17.46	169	<i>Down</i>	Fofanny Reservoir ...	8.67	...
<i>"</i>	Inverness, Culduthel R. ...	2.60	...	<i>"</i>	Seaforde .....	4.98	163
<i>"</i>	Arisaig, Faire-na-Squir ...	3.83	...	<i>"</i>	Donaghadee, C. Stn. ...	3.11	135
<i>"</i>	Fort William .....	10.40	138	<i>"</i>	Banbridge, Milltown ..	3.23	155
<i>"</i>	Skye, Dunvegan .....	5.59	...	<i>Antr.</i>	Belfast, Cavehill Rd. .	4.63	...
<i>R&amp;C</i>	Alness, Ardross Cas. ...	4.53	137	<i>"</i>	Glenarm Castle .....	5.29	...
<i>"</i>	Ullapool .....	6.20	...	<i>"</i>	Ballymena, Harryville ...	3.99	123
<i>"</i>	Torridon, Bendamph. ...	9.60	122	<i>Lon.</i>	Londonderry, Creggan ...	4.72	148
<i>"</i>	Achnashellach .....	9.20	...	<i>Tyr.</i>	Donaghmore .....	5.65	...
<i>"</i>	Stornoway .....	5.48	123	<i>"</i>	Omagh, Edenfel .....	5.56	187
<i>Suth.</i>	Lairg .....	5.16	...	<i>Don.</i>	Malin Head .....	4.61	191
<i>"</i>	Tongue .....	4.39	126	<i>"</i>	Dunfanaghy .....	4.35	123
<i>"</i>	Melvich .....	3.43	115	<i>"</i>	Killybegs, Rookmount. .	6.93	139

Climatological Table for the British Empire, September, 1927

PRESSURE			TEMPERATURE						PRECIPITATION			BRIGHT SUNSHINE	
Mean Diff. from M.S.L. (Normal)		mb.	Absolute		Mean Values				Mean Cloud Amt	Diff. from Normal	Days	Hours per day	Percentage of possible
Max.	Min.		Max.	Min.	1/2 max. and min.	Diff. from Normal	Wet Bulb						
° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	in.	in.			
71	35	61.9	49.8	55.9	- 1.2	51.4	92	7.5	4.49	2.62	15	3.4	27
85	56	79.2	65.4	72.3	- 0.2	63.4	80	4.4	0.29	1.10	2	...	...
90	66	81.4	72.1	76.7	+ 0.7	72.2	84	3.5	0.37	- 0.90	4	8.9	72
65	52	59.7	54.2	56.9	- 1.0	55.6	97	9.9	1.48	1.54	17	...	...
89	69	84.8	71.9	78.3	- 0.8	75.3	85	7.2	24.50	- 3.98	28	...	...
85	71	82.3	74.0	78.1	- 0.3	74.4	85	2.5	3.04	2.22	14	...	...
89	...	84.7	...	...	...	71.4	83	...	11.31	- 0.18	20	...	...
86	51	81.0	56.8	68.9	- 0.6	...	76	3.6	0.00	- 0.34	0	...	...
87	42	79.8	50.8	65.3	- 1.1	...	50	0.7	0.00	- 0.26	0	10.1	84
86	41	67.1	50.9	59.0	+ 1.1	53.1	83	4.4	0.73	1.54	3	...	...
86	44	75.4	50.9	63.1	+ 3.7	49.0	39	0.9	0.05	- 0.91	2	9.7	82
79	56	75.6	62.1	66.8	- 1.3	64.8	66	6.3	1.18	- 0.12	17	7.9	66
89	33	81.8	46.0	63.9	+ 4.8	49.1	44	2.1	0.10	- 0.80	2	...	...
93	76	90.1	78.6	84.3	+ 1.3	79.7	90	7.9	7.04	- 2.83	12*	...	...
89	74	86.1	77.9	82.0	+ 1.2	77.0	87	6.9	5.33	- 5.35	11*	...	...
101	72	93.0	77.7	85.3	+ 0.2	76.9	77	6.4	2.88	- 2.11	8*	...	...
90	72	86.8	75.3	81.1	+ 0.2	77.6	76	8.4	9.18	+ 2.96	19	4.8	39
89	70	83.6	76.1	79.9	- 1.1	75.3	79	8.0	6.17	+ 3.82	17	4.9	40
91	73	88.6	75.4	82.0	+ 0.3	77.3	84	...	9.72	+ 0.33	12	...	...
81	42	64.7	49.4	57.1	- 2.1	52.2	67	5.9	3.06	+ 0.17	11	5.7	48
77	35	62.7	44.3	53.5	- 0.6	49.2	66	5.3	1.74	- 0.67	11	5.9	50
83	37	68.4	47.5	57.9	+ 0.8	50.4	49	4.1	0.91	- 1.13	7	7.5	64
80	44	68.5	52.2	60.3	+ 2.0	54.9	66	5.6	3.93	+ 0.53	15	6.8	58
85	38	69.9	45.9	57.9	- 0.7	50.7	55	4.0	1.84	+ 1.23	9	...	...
89	46	74.9	54.8	64.9	- 0.4	57.0	59	4.2	1.77	- 0.28	9	7.8	66
71	34	58.9	42.8	50.9	+ 0.1	45.4	66	6.0	1.09	- 1.04	14	5.7	49
66	37	58.4	45.5	51.9	+ 0.3	49.6	75	7.2	3.07	- 0.90	16	5.3	45
84	64	81.2	71.3	76.3	+ 1.8	71.8	80	7.4	7.13	+ 0.15	21	5.2	43
...	72	84.2	75.4	79.8	+ 1.6	75.9	74	4.5	4.20	- 0.92	12	7.9	66
92	70	89.2	73.6	81.4	- 0.1	72.8	87	4.8	1.82	- 2.21	7	7.8	64
92	75	88.2	76.6	82.4	+ 2.2	77.4	76	4.8	3.15	- 5.11	11	...	...
88	39	73.0	53.7	63.3	+ 4.1	55.5	79	4.0	1.11	- 2.07	9	7.2	58
89	28	67.4	47.2	57.3	+ 3.9	48.3	87	4.7	2.54	+ 0.26	11	5.7	45
74	34	63.4	49.2	56.3	+ 0.4	52.1	81	5.6	5.52	+ 1.78	8	...	...
77	47	62.8	51.0	56.9	+ 1.3	53.2	80	6.7	1.95	- 0.06	11	5.8	46

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

# The Meteorological Magazine



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## Pressure, Temperature and Wind Variations at Heliopolis, Egypt, associated with the warm and cold sectors of a depression

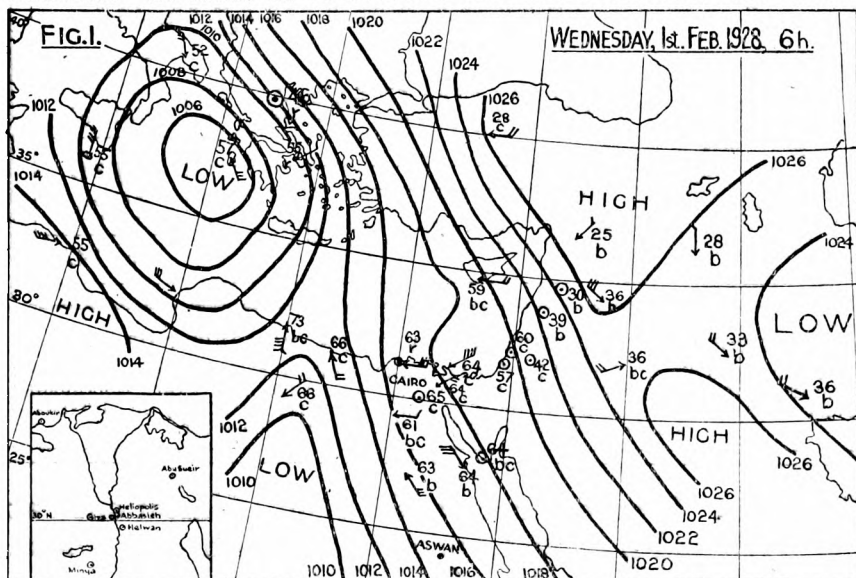
By J. DURWARD, M.A.

Some rather striking oscillations of wind, temperature, humidity and pressure occurred at Heliopolis and other stations in Egypt during the period February 1st. to 2nd, 1928, in a warm sector and behind a cold front, and the following short account of the situation may be of interest.

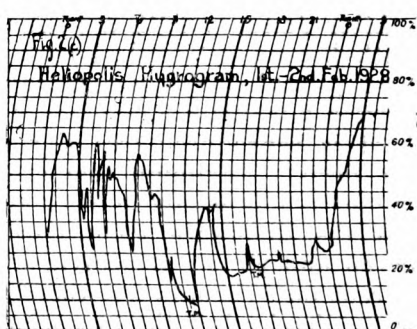
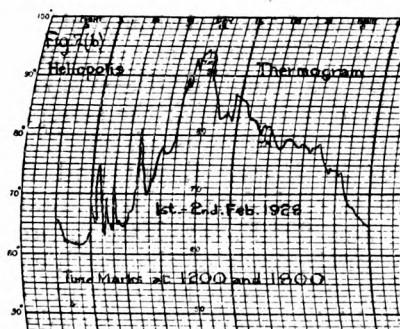
After January 29th a surface current from between east and south became established over Egypt. The current was found from pilot balloon ascents to be of no great depth—varying between 2,000 and 6,000 feet. On the day for which the synoptic chart is reproduced (see Fig. 1) the current was about 6,000 feet deep. Maximum temperatures in Upper Egypt and the Sudan had been above normal for several days. On January 31st the difference from normal was 20° F. at Helwan and Aswan and 22° F. at Minya. The continuance of the south-east current on February 1st therefore meant a very hot day in the Cairo district but the exceptionally high temperature recorded, viz., 95° F., seems to have been peculiar to Heliopolis only.

As will be seen by the autographic records which are reproduced (see Figs. 2 (a) (b) and (c)) the advance of the warm south-east current was periodically checked by the arrival of much cooler air from west or north-west. This cooler air lay over the cultivated area around the Nile where the night temperatures would naturally be lower. Actually the minimum at Giza (8 miles south-west of Heliopolis) was 7° lower than at Heliopolis. The wind direction oscillated between SE and NW

and temperature variations of  $13^{\circ}$  and humidity variations of 30 per cent. occurred from 3h. G.M.T. sometimes within a few minutes. It looks as if between the warm air over the desert



and the cooler air to the westward a sort of quasi-stationary front existed and the occasional upward movement of the warm air allowed the cooler air to reach this station at times, though the velocity of the westerly wind recorded in the vicinity of the front was naturally negligible. A temporary cessation of upward movement allowed the south-east current to advance



again and temperature to rise. From 10h. to 12h. 30m. G.M.T. the wind blew from SE with an average velocity of 4-5 m.p.h., and temperature rose to  $95^{\circ}$  F. This is probably a record for this part of Egypt for so early a date as February 1st; the highest temperature recorded in February at Abbassieh (2 miles from Heliopolis) since 1869 being  $95.5^{\circ}$  F. on February 28th, 1895. The maximum at Heliopolis was  $9^{\circ}$

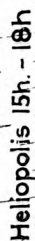
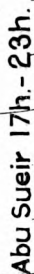
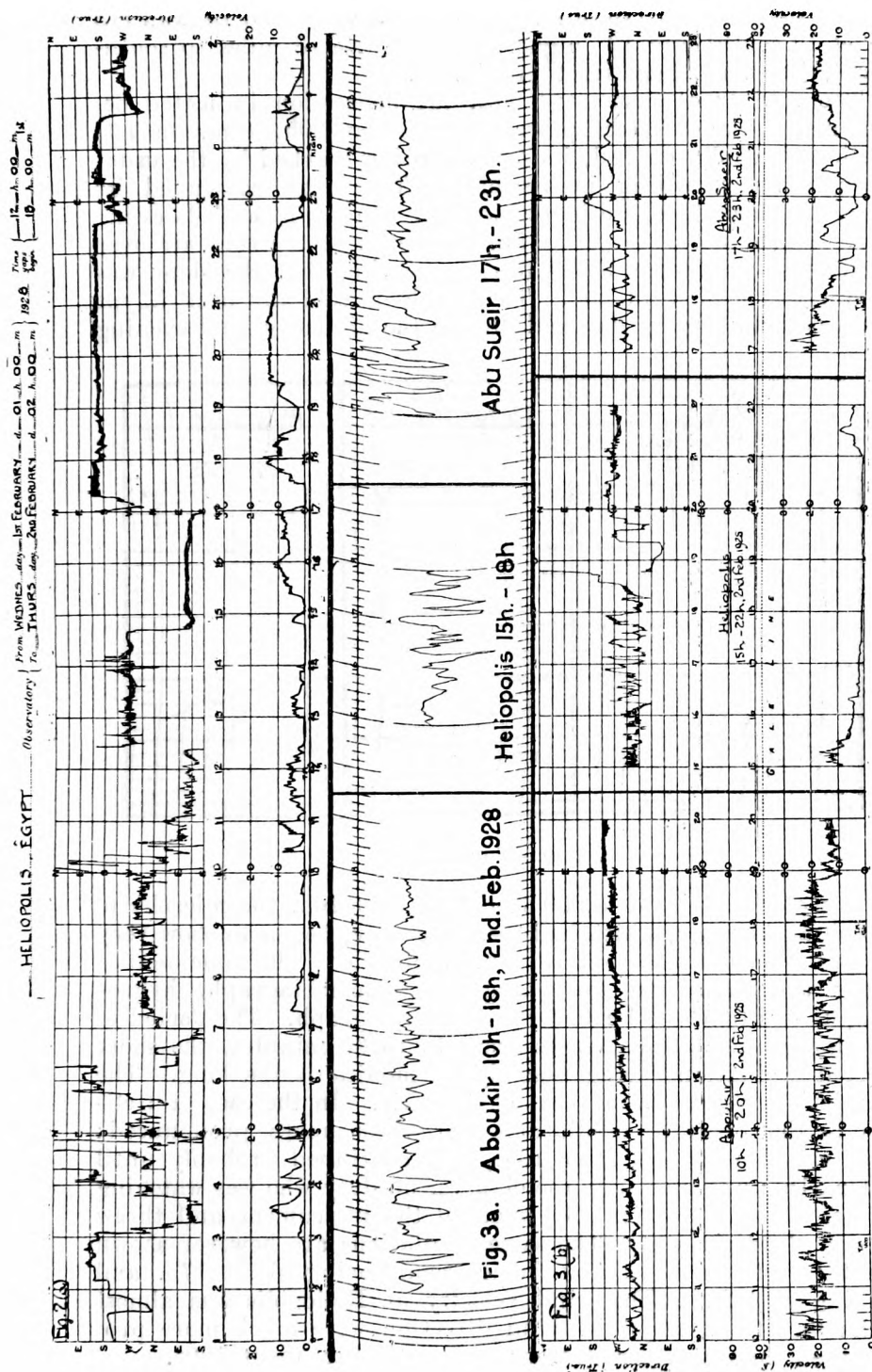


FIG. 2 (A)—WIND DIRECTION AND VELOCITY (M.P.H.). FIG. 3 (A)—MICROBA ROGRAMS. FIG. 3 (B)—WIND DIRECTION AND VELOCITY (M.P.H.).

higher than at Cairo (6 miles to west-south-west) and Helwan (18 miles to south) and  $13^{\circ}$  higher than at Giza (8 miles to south-west), (see small map inset in Fig. 1).

The cold front associated with the depression indicated between Italy and Greece passed Aboukir at 20h. 40m. on 1st, Heliopolis at 3h. on 2nd, its passage being marked by the usual changes on recording instruments. The front continued its eastward movement and by 6h. was between Egypt and Palestine and at 12h. near Gaza. At 5h. the depth of the cold air over Heliopolis was about 2,500 feet, indicating that the slope was of the order of 1 in 200. The depth of cold air over Egypt increased during the day and during the afternoon and evening

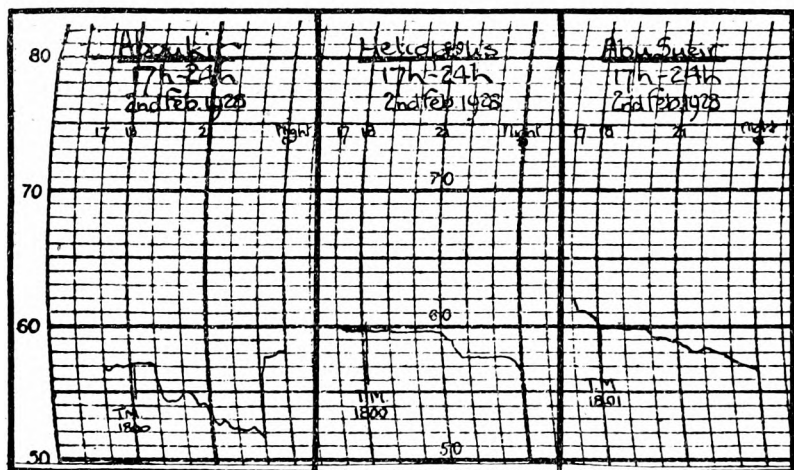


FIG. 3(c).—THERMOGRAMS.

it was of the order of 8,000 feet. At about 10h. the microbarograph at Aboukir, which had been unsteady, began to show very large oscillations of about 1.8 mb. amplitude. The same oscillations are shown on the barograph, anemobiograph, hygrogaph, and to a small extent on the thermograph. The period of the larger oscillations varies from 10 to 60 minutes, the short period oscillations being possibly harmonics of the long. The oscillations ceased about 17h. at Aboukir. In the case of Heliopolis the pressure oscillations were even more pronounced; they commenced just after 16h., and continued probably until after 21h.; unfortunately the observer on duty who was watching the oscillations accidentally knocked the instrument and threw it out of adjustment. The same oscillations are however shown on the instrument at Abu Sueir, commencing about 17h. and ending at 22h. The wind velocity at Heliopolis was almost calm and the changes in wind direction were much more pronounced than at other stations, amounting to about  $180^{\circ}$ .

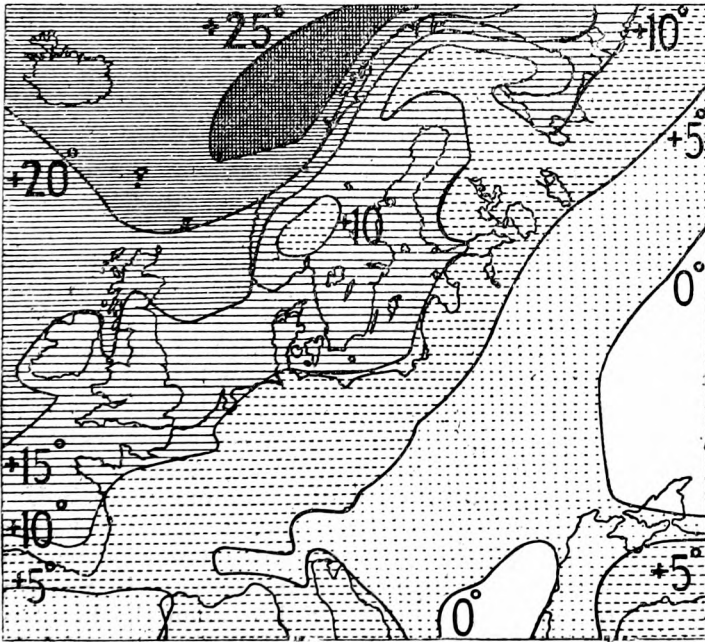


It will be noted that at Aboukir a colder supply of air arrived from south-west about 19h. and continued until 23h. This air arrived at Heliopolis between 21h. and 22h. and at Abu Sueir between 22h. and 23h. The essential features of the autographic records from all three stations are reproduced in Fig. 3 (a) (b) (c). Whilst the pressure oscillations were in evidence rain fell intermittently at all three stations and at Heliopolis much mammato-cumulus developed.

The chief point of interest is the large amplitude of the pressure waves. The amplitude of waves induced at the surface of separation of two currents is usually of the order of  $\frac{1}{2}$  mb., and one rather inclines to the idea that these oscillations are not due to waves set up at such a surface (in this case about 8,000 feet high) but that they are due to the eviction of air up secondary cold fronts present in the polar current. The intermittent character of the slight precipitation which occurred during the oscillations seem to be in favour of this view.

### **Influence of the Gulf Stream on the Winter Temperature of Europe**

That the winter temperature of the north-west coast of Norway and the ocean to westward is abnormally high for its latitude is well known. The "isanomaly," or excess over the mean tem-



(Reproduced from *Met. Zs.*, 43, 1926, p. 401)

perature of the latitude, reaches  $27^{\circ}$  C. near the Lofoten Islands in January (Fig. 1 after Ekholm) but decreases rapidly inland, the decrease in the western part of the Swedish mountains being  $1^{\circ}$  C. per 10 km. This high winter temperature is attributed to the influence of the Gulf Stream, but J. W. Sandström\* has recently set out a new theory of the way in which the abnormality is related to the air circulation in the region.

The interior of the continent is occupied by dry, cold and heavy continental air, which moves from east to west, from northern Europe towards the Atlantic. It pushes beneath the warm, humid and light Atlantic air, which moves eastward over Europe above the layer of cold air. The former movement sometimes causes a wind analogous to the Bora, and the latter, where it crosses the mountains, results in a Föhn effect. There is a considerable body of evidence for this circulation. In January, 1924, which was a very cold month, the resultant wind direction shows a general drift from south over Scandinavia, combined with a component towards the Atlantic. Surface wind roses show that east winds prevail at Bodö on the Norwegian coast, but south and south-west winds at Röst, a little way out to sea. At a height of 2,000 to 3,000 metres the clouds move from west to east, and cloud caps on the mountains always point towards east in winter. The surface of separation between the warm and cold air in winter is clearly shown on the east of the north Swedish mountains by a horizontal line, above which the trees are black with thaw, while below it they are white with rime.

Sandström discusses this surface of separation or "Scheidefläche" in detail. Its position depends on the strength of the south winds from the Atlantic on the western side and the greater density of the cold air on the eastern side. Owing to the effect of the earth's rotation, southerly winds in western Scandinavia exercise an eastward pressure. The greater the difference of temperature and the steeper the surface of separation, the greater will be the westward pressure of the cold air, and when this predominates, the surface of separation moves westward as a cold front. On the other hand, when the eastward pressure of strong Atlantic winds prevails, the surface of separation moves eastward as a warm front. Thus southerly winds in western Scandinavia are mainly responsible for winter cold in Europe by preventing the removal of cold air. The latter accumulates in consequence of radiation until its pressure pushes the surface of separation so far west that the cold air escapes.

Sandström regards the wind at the Lofotens as an index of the state of the Gulf Stream and he finds a relation between the direction of these winds and the winter temperature over the whole of Europe. The temperature at Gellivare in Sweden, over a period of ten years was  $11^{\circ}$  C. higher when the Lofoten wind

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\*Über den Einfluss des Golfstromes auf die Wintertemperatur in Europa. *Met. Zs.*, 43, 1926, p. 401.



was WNW. than when it was SSW. The results of the whole of Europe are shown by a series of 36 charts, for winds at the Lofotens differing by 10 degrees of azimuth. The progressive changes in the wind direction give such uniform changes in the temperature distribution as to produce almost a cinematograph effect. There are four main types: (1) WNW. winds at Lofoten bring warmth to northern Europe and cold to southern Europe; (2) NNE. and ESE. winds bring cold to northern Europe and warmth to southern Europe; (3) S. winds bring cold to Europe and warmth to the North Atlantic; (4) ENE. winds bring warmth to Europe and cold to the North Atlantic. The charts bring out a marked similarity between the temperature anomalies in central Russia and in Greenland, both places having an opposite deviation to that over the North Atlantic.

Sandström lays stress on the probable importance of the Lofoten wind direction in long range weather forecasting, as a criterion of the influence of the Gulf Stream on the weather of Europe.

A. WALTERS.

## Discussions at the Meteorological Office

March 12th. *Ratio of heat losses by conduction and by evaporation from any water surface.* By I. S. Bowen (Physic Rev., Minneapolis, Minn., 27, 1926, pp. 779-87. *Evaporation from lakes.* By N. W. Cummings and B. Richardson (*idem.*, 30, 1927, pp. 527-34) and other papers. *Opener*—Mr. R. Corless, M.A.

In the first paper it is shown by a method partly empirical, partly physical, that when a vessel containing water is exposed to the sky there is a definite ratio between the quantity of heat lost by the water by conduction and convection to the air, and the quantity of heat extracted from the water as latent heat of evaporation. The relation is given by the equation—

$$\frac{\text{Heat lost by conduction, \&c., to the air}}{\text{Heat lost by evaporation}} = 46 \frac{(T_w - T_a) p}{(P_w - P_a) 760}$$

where  $T_w$  = temperature of water surface in degrees Centigrade.

$T_a$  = temperature of air (dry bulb) in degrees Centigrade.

$P_w$  = saturation vapour pressure at temperature  $T_w$  expressed in millimetres of mercury.

$P_a$  = pressure of vapour actually present in the air, in millimetres.

$p$  = barometer reading in millimetres.

The ratio of the two quantities of heat is called Bowen's ratio.

The ordinary formula for the computation of vapour pressure by means of observations of the dry and wet bulbs is the par-

ticular case of this equation which is obtained by putting the ratio equal to  $-1$ .

In the second paper the authors outline a method of computing evaporation from any water surface by means of an equation which expresses the balance between the energy received and the energy lost and stored by the body of the water. The energy received consists of the radiation from sun and sky which actually penetrates through the water surface. The energy lost consists of (1) back radiation from the water surface to the sky, (2) heat lost by conduction and convection to the air, (3) heat lost by evaporation and (4) heat lost by conduction through the sides of the vessel and by any other process which may be effective. The energy stored can be measured by the increase in temperature of the body of the water, in conjunction with the mass of the water. Of these quantities that marked (2) can be expressed in terms of (3) by the use of Bowen's ratio. A method is described for dealing with the incoming and back radiations, which depends on taking observations of evaporation and of temperature on a control pan of water. Having given the temperature conditions of the body of water of which the evaporation is required it then becomes possible to compute the evaporation from that body.

The method was tested by comparing the evaporation from large tanks with that from the control pan with satisfactory results.

R. CORLESS.

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### Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday evening, March 21st, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, being in the chair. As is customary in March, the meeting took the form of a lecture (The Symons Memorial Lecture), which was delivered by Mr. H. W. Newton, of the Royal Observatory, Greenwich. The lecture was illustrated by numerous lantern slides and the following is an abstract.

#### *The Sun's Cycle of Activity.*

The cycle of activity through which the sun passes in a period of about 11 years is shown by various solar phenomena. There is the well-known variation in the number of sunspots and in the concomitant phenomena of bright calcium and hydrogen flocculi at higher levels. Above these is the region of prominences and dark hydrogen markings which show only a partial relation to the spot-zones. The extended and outermost envelope of the sun—the corona—also undergoes a cyclical change. The cause of this 11-year period, though seemingly within the sun, is not known, and phase and amplitude of a cycle ahead cannot be predicted with accuracy. Sunspots are probably vortical in

origin and are the centres of strong magnetic fields whose polarities, when similar spots are compared, have been found to be opposite in successive 11-year cycles.

A theory dealing with the sun's general circulation and that of spots in particular has been advanced by V. Bjerknes.\*

Measures of the solar-constant and of the sun's ultra-violet radiation indicate a change with the solar cycle. A similar variation in the reception of wireless signals is also suspected. The occurrence of terrestrial magnetic storms and the corresponding state of the sun was briefly considered. With increasing international co-operation, solar outbursts can be followed more thoroughly in the hope of furthering our knowledge of these solar-terrestrial relationships.

## Correspondence

To the Editor, *The Meteorological Magazine*

### Lasting Qualities of Small Rubber Balloons

The Apia Observatory receives monthly shipments of balloons from Canada. In the rain season from December to March few ascents are made so that balloons are frequently held over for four months. Although the mean temperature is 82° F., and the relative humidity 85 per cent., there is little deterioration if the balloons are plentifully covered with talc, packed separately, each in a sealed envelope and kept in an air-tight box. Balloons exposed to light and air deteriorate rapidly, and red or black coloured balloons perish sooner than uncoloured balloons.

When the balloons burst in air usually the fabric tears completely apart into two pieces of approximately equal size. There is seldom evidence of a gradual leak at pinholes.

ANDREW THOMSON.

*Apia Observatory, Apia, Samoa. January 10th, 1928.*

### Glazed Frost

In the January number of the *Meteorological Magazine*, Capt. C. K. M. Douglas raises the question as to whether a really severe ice storm has been recorded in this country. Two instances of severe glazed frost are recorded in the scarce pamphlet *Frostiana*. The first occurred in December, 1672, in the west of England, and is stated to have been accompanied with extensive damage to trees. One observer states, "I weighed the sprig of an ash tree, of just three-quarters of a pound, the ice of which weighed sixteen pounds." The second case was in February, 1809. The victims in this instance were over a hundred birds at Malling. A boy found them upon the ground

\* *Solar Hydrodynamics*. By V. Bjerknes. Astro. J. Chicago, Ill. 64, 1926, pp. 93-121.

with their bodies completely glazed over with a coating of ice after a rain which froze upon falling. A buzzard hawk after a severe struggle succeeded in freeing himself from the ice and regained his freedom, but many of the rooks and larks perished.

In the *Natural History of Selborne*, Gilbert White alludes to this phenomenon under the name of Frozen Sleet. He refers to an occasion when many rooks, attempting to fly, fell from the trees with their wings frozen together by the sleet, that froze as it fell. He gives the date of this as January 20th, but does not state the year.

C. E. BRITTON.

*New Ranges, Shoeburyness. February 7th, 1928.*

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### **Annual Variation of Cirrus Cloud**

In the *Meteorological Magazine* for October, 1927, p. 215, Dr. J. R. Sutton gives results concerning the annual variation of cirrus cloud at Kimberley, South Africa, over a period 1900-1925; and in his Table I, which deals with those occasions when cirrus cloud of any kind was observed alone in the sky, he finds that there were definite maxima and minima in the year both with regard to frequency and to quantity.

With intent to find whether any similar conclusions hold for this area—Cranwell, Lincs—we have examined the Cranwell data for the eight years 1920-1927 along practically the same lines as used by Mr. Sutton in arriving at his Table I, but can find no trace of any definite monthly maxima or minima, either in frequency or in quantity. Although this is a negative result it is thought that its recording may not lack entirely in interest, even though the number of occurrences of cirrus cloud of any kind alone in the sky was not great at Cranwell in the relatively short period examined.

W. H. PICK.

G. A. WRIGHT.

*R.A.F. Cadet College, Cranwell, Lincolnshire. January 25th, 1928.*

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### **Notes on a Meteorological Phenomenon heard at Seskin, February 8th, 1928**

A sound locally known as "wind in the mountains," was heard here all day. When first noticed before 8h. it sounded like the noise of a motor running, and distinct from the noise of the wind. It was persistent, unvarying except in the degree of loudness, and without anything like throbbing. In the afternoon its volume of sound was like that of the rush of a heavy train through a tunnel near by. (There is no railway tunnel within about twenty miles. It seemed to come from the

Comeragh mountains, a few miles to the south-west. One man who has lived in the district all his life had thought it was the noise of the Millvale stream, but as that is a slow flowing, shallow stream more than a mile away such an explanation does not seem likely.

Locally it is considered a presage of storm and rain. It was heard also about a fortnight ago for a short time we understand.

About 16½h. the SSW wind here was very light, the trees not moving but the sound was as described above, then suddenly a strong wind sprang up here which within two hours had reached force 8 or 9. The gale continued until after midnight but had lessened by 3h. Only 3.1 mm. fell of rain during the night. At 18½h. and possibly later the sound from the direction of the mountains could be heard apart from the noise of the gale.

On February 1st, 1923, a similar occurrence was reported to you from here, but then the noise was much louder and lasted for a much shorter period.\*

L., G., and I. GRUBB.

*Seskin, Carrick-on-Suir, Ireland. February 12th, 1928.*

[Carrick-on-Suir is fifteen miles, as the crow flies from the coast and separated from it by ground rising in places to about 1,000 feet.—Ed., M.M.]

### Meteorological Facilities for the Public

I think it deserves to be more widely known what useful facilities for meteorological information are provided by the Borough of Hastings. On the Esplanade in a convenient position near the Pier there is a large instrument shelter, adapted from the Stevenson pattern, standing above a small bed of low shrubs. The shelter has glass windows on the north side and is divided into three compartments. In the centre is a barograph and the side compartments contain a hygrometer, and a set of standard maximum, minimum and dry thermometers respectively. The readings are posted up daily together with the records of rainfall and sunshine. It is obviously most convenient to be able to consult public instruments at any hour in this way, and it is to be hoped that the idea will be taken up by other towns which have a meteorological service. It was most gratifying to observe the interest shown by the public, for I constantly saw passers-by stopping to read the instruments, and indeed the pavement is visibly worn by this traffic! Besides being a convenience this display must do much to stimulate interest in the science and is all the more desirable on that account.

IVAN D. MARGARY.

*Chartham Park, East Grinstead. March 16th, 1928.*

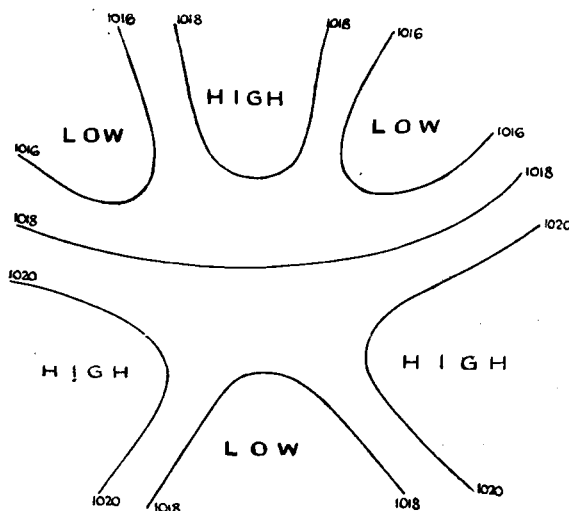
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\* See *Meteorological Magazine*, 58 (1923), p. 58.

## NOTES AND QUERIES

### An Unusual Pressure Distribution

A col or region where two highs and two lows meet is a well known and fairly common type of pressure distribution. It is equally possible to have three highs and three lows meeting, thus forming a sort of star-shaped col. Such a pressure distribution must be rare and has not been thought worthy of a distinctive name. The region surrounding the British Isles was occupied by a system of this type on the morning of March 5th, 1928.



Highs lay to the northward, south-westward and eastward with a low between each pair of highs. The situation was complicated by the fact that pressure in the northern half of the system was somewhat lower than in the corresponding sections of the southern half as shown in the figure which gives a schematic representation of the pressure

system. It will be seen that on the outer part of the system highs and lows alternated around the circumference, forming the star-shaped col. Near the centre the formation is somewhat different and perhaps the simplest way of looking at it is to regard the two 1020 isobars and the two 1018 isobars which comprise the southern part as forming a normal col, while the simple low which should occupy the 1018 isobar to the north is replaced by two lows separated by a high. The diagram is purely schematic, the isobars on the actual map being in the central region very contorted so that the tracing of them was not a simple matter, even to one used to this work.

J. S. DINES.

### Brilliant Halo Phenomena

A very fine display of solar halo phenomena occurred during the afternoon of Saturday, February 25th, and was witnessed from many places in England. The halo of  $22^\circ$  was observed generally, and some observers saw also the halo of  $46^\circ$ . The two parhelia ("sun dogs" or "mock suns") which are asso-

ciated with the points of intersection of the halo of  $22^\circ$  and the horizontal plane through the sun were striking features of the display. Many observers reported the occurrence of "an upper arc of contact" to the halo of  $22^\circ$ ; this, however, took the form of a pair of horns converging at the highest part of the halo circle of  $22^\circ$ . Each horn was curved downward at its extremity where, according to two observers, it became merged in the circle of the halo of  $46^\circ$ . Mr. J. S. Dines estimated that the angle between the horns was  $120^\circ$  at 4.30 p.m., and that it steadily decreased until it became less than  $90^\circ$  after sunset. A few observers saw a "sun pillar" stretching vertically upwards from the sun, and in Devonshire and on the South Downs the circumzenithal arc passing horizontally through the sun was also observed.

R. CORLESS.

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### Exhibit at the Royal Institution

At the request of the Managers of the Royal Institution, the Director of the Meteorological Office arranged an exhibit of instruments, charts and diagrams at the *Conversazione* held on Friday, March 9th, when a discourse on "The Sun's Outer Atmosphere" was given by Professor Edward A. Milne, F.R.S., Beyer Professor of Applied Mathematics, University of Manchester.

The instruments exhibited were those in official use for the measurement of solar radiation, and included the Campbell-Stokes sunshine recorder, Mark II, the tropical pattern sunshine recorder, the Callendar radiation recorder (receiver), the Gorczynski solarimeter, the Michelson actinometer and the sky photometer, the last being a recently designed instrument for the estimation of the brightness of the sky during gloomy periods. Records obtained with the self-recording instruments were exhibited, and the three instruments last mentioned were demonstrated in use.

The charts and diagrams exhibited illustrated the wind structure research now being carried out at the Meteorological Office, Cardington. They included actual records obtained with quick-run clocks, diagrams illustrating some of the results so far obtained, and photographs of the apparatus used during the experiments.

Two synoptic charts illustrating the meteorological conditions associated with the snowstorm of December 26th, 1927, and the Thames flood of January 7th, 1928, were also shown.

A. H. NAGLE.

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### Meteorological Units

In a letter addressed to the Meteorological Office, M. Seletsky, who writes from Kiev, Union of Soviet Socialist Republics, out-

lines certain proposals for the more consistent application of the decimal system in units, particularly as applied to meteorology.

For the unit of time, instead of dividing the day into 86,400 seconds, M. Seletsky proposes to divide it into 100,000 units. The new unit would be called the "tempe," and its multiples the "chrone" (1/100th part of the day), "decichrone" (1/1,000th part), &c. Since the unit of time enters into the specification of  $g$  a new pressure unit is involved. This unit (the "neobar") would not differ much from the present units, 750 neobars being equivalent to 753.6 millimetres of mercury, or to 1,004.7 millibars. For units of length, by subdividing the earth's entire circumference, instead of its quadrant (as in the original definition of the metre) a new series would be obtained approximately equal to 0.4 mm., 4 mm., &c. For temperature, it is proposed to adopt a scale on which the "absolute zero"—taken as  $-273.4^{\circ}$  C.—is the zero and the ice-point is taken as  $350^{\circ}$ . Thus one centigrade degree would be equivalent to 1.28 new degrees, 300 on the new scale would be approximately the freezing point of mercury, and 400 equivalent to  $102^{\circ}$  F. On this scale most published values of temperature would fall between 300 and 400 and the initial 3 could be discarded in printing.

All suggestions towards getting uniformity and consistency in scientific matters are interesting; but we feel that even if the inconveniences of the present units were greater than they are, the practical difficulties of making the changes proposed would be insuperable.

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### Rainfall, run-off and evaporation

Although observations of run-off are made for a number of catchment areas in this country, few comparisons with rainfall measurements have been published. A recent paper\* is, therefore, of particular interest. It deals with records covering 15 to 20 years for 11 areas in the southern half of Sweden. The areas concerned lie roughly between the latitudes of Edinburgh and the Shetlands, and vary in size from 50 to 1,100 thousand acres. The annual general rainfall varies from 22 to 35 in. The difference between the measured rainfall and run-off gives the evaporation, and for the whole period the mean annual amounts for the areas vary between 13 and 15 in. This is a very satisfactory agreement, and the mean value of 14 in. for the evaporation is in striking accord with the value frequently adopted in water supply schemes in this country.

In considering the seasonal evaporation attention has had to be directed also to the amount of snow in the area, to the

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\*WALLÉN AXEL. Eau tombée, débit et évaporation dans la Suède méridionale. *Geog. Ann. Stockholm*, 9, 1927, pp. 181—208.



changes in the levels of the lakes and to the amount of water stored in the ground. The distribution of the rainfall and run-off is discussed in detail for one typical area. In Sweden October is relatively dry and the time of most evaporation is rather later than in the British Isles. According to the evaporation the most natural division of the year is into the two parts, the five months June to October, when the run-off is small, and the seven months November to May with a large run-off. The net monthly loss from the area is greatest in May and June (that in May being comparable with that of June owing to the smaller rainfall). In June and July the evaporation exceeds the actual rainfall. November is the month of greatest net gain (especially as storage in the lakes), since in the preceding months the rainfall is smaller and in the following months the run-off is greater. There is a gradual change in the monthly values for the storage between these two extremes.

The marked relation between the annual values of rainfall and run-off is demonstrated by "dot diagrams" for each area, the values of run-off being corrected for the amounts stored in the lakes. This relationship has been demonstrated in this country for the Exe Valley.\* The correlation coefficients for the 11 areas vary from +0.98 to +0.95 and regression equations are given connecting the rainfall and run-off. Using the mean annual values for the areas the correlation coefficient is +0.996 and the regression equation  $D = 1.06P - 15.8$  where  $D$  and  $P$  are run-off and rainfall in inches respectively, which corresponds to a nearly constant evaporation for all values of rainfall. From each equation a value is calculated for the annual rainfall which would give no run-off. This "limit of dryness" is reached with an annual rainfall of 14—15 in. Such a small rainfall would be a most unusual occurrence, either in Sweden or in this country.

The mean rainfall and run-off is considered separately for the summer and winter periods, due allowances being made for storage in the lakes and soil and as snow during the winter. It is estimated that there is 10 in. of evaporation during the five summer months, *i.e.*, 70 per cent. of the total annual amount. For seven selected areas the individual values are given for the summer months not only for the rainfall, run-off and calculated evaporation, but for the calculated amounts stored in the lakes and the soil, both as means for the whole period and for dry and wet years separately. It is found that while the rainfall, run-off and amounts stored in the lakes and in the soil vary considerably from dry to wet summers the evaporation is nearly constant. The conclusion is also arrived at that if the rainfall of the summer

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\* The Investigation of Rivers. Final Report. By A. Strahan, N. F. Mackenzie, H. R. Mill and J. S. Owens, published by the Royal Geographical Society, London.

five months in the southern half of Sweden does not exceed 9 in., there is some risk of the cessation of the flow of certain lakes and from small catchment areas, while the larger areas will also be without run-off if in addition the reserves have been used up by the end of May.

It is stated that the largest error arises in the measurement of snow. Comparisons between the fall of snow as computed from rain-gauge readings and the subsequent run-off suggest that on the average the former measurements are about 10 per cent. too small. In the catchment areas under consideration less than one-quarter of the total precipitation occurs in the form of snow leading to a probable annual error of from 1 in. to 0.5 in. It is suggested that the net errors are not large, but that the rainfall and therefore the evaporation have been under-estimated rather than over-estimated.

The annual values for evaporation are more uniform than is generally the case; while this is in part due to the greater precision with which the evaporation has been determined, it is also probably connected with the occurrence in each area of lakes of considerable size, the extent varying from 4 to 16 per cent. of the whole catchment area. In areas devoid of large water surfaces the evaporation is usually found to be less in dry years, while the evaporation from a free water surface is greater. Since the average rainfall is small these areas have a natural advantage for the determination of evaporation. In a recent investigation\* dealing with the area drained by the River Garry in the Western Highlands of Scotland the rainfall was nearly four times greater, so that there was in that case a much greater risk of error in determining the rainfall and therefore also the evaporation.

In the case of the Thames Valley above Teddington the loss has varied from 15 to 22 in. with a mean of 19 in. during the last 20 seasonal years. All the loss is not, however, evaporation, since there is in addition the percolation into the chalk giving the artesian supply in London itself.

It is unfortunate that the evaporation of any catchment area can only be measured by indirect methods. In this paper the factors on which the correct determination of this amount depend seem to have been evaluated with greater precision than is usually possible.

J. GLASSPOOLE.

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### Das Wetter

Our well-known contemporary *Das Wetter* celebrates the first number of its 45th annual volume by a number of changes. It

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\* Rainfall and flow-off, River Garry, Inverness-shire. By W. N. McClean; *Water and Water Engin., London.* 29, 1927, pp. 475—486.

is recalled that the magazine was founded by R. Assmann in 1882 under the title *Monatschrift für praktische Witterungskunde*, which was changed to *Das Wetter* in 1884. Throughout its whole history however *Das Wetter* has devoted considerable space to the practical applications of meteorology, and with the development of flying, and the growth of borderland sciences such as agricultural meteorology, these practical aspects have come to take the chief place in its pages. The title has accordingly been changed to *Zeitschrift für Angewandte Meteorologie: Das Wetter*. The number of pages in each number has been increased; a still more welcome change is from Gothic type to Roman.

## Reviews

*The Energy of the Winds.* By V. H. Ryd, Copenhagen, Danske Meteor. Inst. Medd. 7. Meteorological Problems No. 2. Size 10 × 7 in., pp. 96. *Illus.* Copenhagen, 1927.

This paper is to some extent a continuation of an earlier paper on the *Travelling Cyclone*, by the same author. In it he discusses the possible sources from which the winds derive their kinetic energy. The paper has rather the appearance of a small text-book than of an original paper. It begins by discussing the thermodynamical equations, and gives a very large number of transformations of these equations. The equations are also given in a collected form in Appendix I, where they number 34. To the students of meteorology the reading of the paper may be recommended as a useful exercise in the algebra of thermodynamics, apart from the theoretical discussion of its main theme.

In the preface the author enumerates four sources from which, according to earlier writers, the energy of winds may be derived:—

- (a) Potential energy due to gravity.
- (b) Potential energy of the horizontal pressure distribution.
- (c) Direct transformation into kinetic energy of the heat received from the sun.
- (d) Latent heat of water vapour set free by condensation.

In his subsequent discussion the author states that the first of these is the only important source. In discussing the second, he enumerates the types of energy of air, and shows that, by including internal energy, gravitational potential energy, and kinetic energy, he has taken into account all the forms of energy which need be considered.\* It is in any case difficult to see how any potential energy which might be associated with a pressure distribution could be con-

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\* cf. The supply of energy from and to atmospheric eddies. By L. F. Richardson, *London, Proc. R. Soc. A.*, 97, 1920, pp. 354—73.

verted into kinetic energy of winds, since strong winds and strong pressure gradients occur simultaneously, and as the pressure gradients die away, so do the winds. We do not find pressure gradients disappearing and being replaced by strong winds. With regard to the direct transformation of solar radiation into kinetic energy, there is no evidence that this takes place in the atmosphere, the transformation of the energy of solar radiation being first into gravitational potential energy, which in turn may be transformed into kinetic energy. The author does not give any consideration to the effect of latent heat of water vapour set free by condensation, though the importance of this factor, in conjunction with gravitational potential energy, is obviously of great importance in the atmosphere.

In the course of the paper, it is emphasised that if a cyclone is to be formed by the removal of air vertically, the rising air must be removed horizontally by a strong wind in the upper layers. The author regards the westerly winds which occur in the upper air, in accordance with the observed horizontal gradients of temperature in the atmosphere, as the effective agents for removal of the superfluous air. But at a later stage he appears to regard the existence of the strong upper currents as sufficient for the establishment of a cyclone by convection.

The final chapter deals with the origin and development of cyclones. Here the author assumes that the effect of strong winds, generated in regions where the horizontal temperature gradients are intense, blowing into regions where the horizontal temperature gradients are slighter, would be to cause the air to be displaced towards high pressure, on account of the pressure gradient being insufficient to balance the deviating force. The result would be to give a small cyclonic centre in the upper air. The author's discussion of the mode of growth of the cyclonic circulation down to the ground is obscure. The present reviewer has not been able to satisfy himself that the existence of strong upper winds, together with a small cyclonic centre in the upper air, will by the action mentioned in the last paragraph produce the depression of middle latitudes as we know it.

There are three appendices to the paper, the first being a collection of 34 equations derived in the course of the paper, the second giving a brief discussion of the relation of work to energy, and the third giving some general remarks on theories of the origin of cyclones.

While the reviewer is not able to agree with all the arguments of the author, he feels that much credit is due to the latter for his endeavour to discuss questions which are seldom discussed in detail.

D. BRUNT.

*El Observatorio del Ebro: Idea general sobre el mismo.* By P. Ignacio Puig, S.J. Size  $9\frac{3}{4} \times 6\frac{3}{4}$ , pp. viii + 188, *Illus.* Tortosa, Impr. de Algueró y Baiges 1927. 5 pesetas.

Founded, in 1904, for the study of the effects of solar activity in terrestrial phenomena, the Observatory of the Ebro has fully justified the confidence in its usefulness expressed at the time by eminent meteorologists. The work of the Observatory has expanded progressively, and now embraces all branches of cosmical physics, including seismology, meteorology, terrestrial magnetism and solar physics.

The object of the author of this book, who is Assistant Director of the Observatory, is to give a general account of its work. Besides dealing with the aims and general history of the Institution, he discusses in detail the work of each department, describing the main characteristics of the phenomena observed, the apparatus employed and the results obtained. The book is fully illustrated with photographs and diagrams of buildings and apparatus and reproductions of records. The author has included information hitherto scattered among a number of publications, and the book enables the reader to form a very complete picture of the activities of the Observatory; it is, at the same time, a useful handbook of meteorological information. The production of the book is pleasing, the print being clear and the illustrations, on the whole, very good.

British observers note with pleasure the progress that meteorology is making in Spain, and the author is to be congratulated on producing a book that will assist this progress by making more widely known and understood the valuable work that is being done at the Observatory of the Ebro.

A. H. NAGLE.

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### Obituary

We regret to learn of the death on February 21st, 1928, at the age of 54, of Professor W. T. Askinazy, Chief of the Section of the Monthly Bulletin of the Central Geophysical Observatory, Leningrad, and Member of the International Commission for Agricultural Meteorology.

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### The Weather of March, 1928

The weather of March was mainly rather mild and unsettled with a cold wintry spell from about the 7th to 14th. During the first few days pressure was low to the north-west and south-west of the British Isles and the weather unsettled with rain in the north on the 1st, when 0.91 in. fell at Aberdeen, but much sunshine locally at times. On the 4th though the weather was still cloudy in Scotland, the day was brilliantly fine and warm in most of England and Ireland and temperature was abnor-

mally high for the time of year,  $68^{\circ}$  F. was reached at Greenwich,  $64^{\circ}$ - $67^{\circ}$  F. at other London stations and  $65^{\circ}$  F. at Cambridge, Oxford and Tottenham. Sunshine values of between 9 and 10 hrs. were recorded at some stations in the south. Subsequently high pressure became established over Iceland and Scandinavia with a wedge of high pressure extending southward over the British Isles. Cold air from north Russia flowed over the country and temperature fell considerably. At Kew a record low maximum for the time of year,  $32^{\circ}$  F., was recorded on the 11th just a week after the record high temperature. Screen minima of  $20^{\circ}$  F. and below were registered at many places; at Rhayader the screen minimum was as low as  $11^{\circ}$  F. on the 13th and the grass minimum  $7^{\circ}$  F. on the 14th. Snow and sleet fell generally from the 8th to 14th. On the evening of the 10th-11th snow occurred as far south and west as the Scilly Isles and Roches Point and on the 12th, 1 in. of snow was lying at Guernsey. On the 12th also, "snow lying" to a depth of 8 in. was recorded at Margate, 6 in. at Durham, 5 in. at Glasgow and 3 in. at many other places. Bright sunshine was experienced during this period for several hours each day, the outstanding records being 10.3 hrs. at Tiree on the 9th and at Scilly Isles on the 10th. On the 14th there was a change to southerly winds and mild unsettled conditions became established, with much rain on the 18th-20th in the west and north, *e.g.*, 2.05 in. at Fofanny (Down) on the 18th and 1.59 in. at Tynywaun (Glamorgan) on the 19th, and strong southerly winds and gales in the north on the 19th-21st, force 9 (49 m.p.h.) being recorded at Lerwick and Wick on the 21st. A complex low-pressure system remained over or to the west of the British Isles until the 31st. On the 29th a depression off north-west Ireland deepened considerably as it moved eastwards causing high winds and gales in all districts, force 9 in the extreme north. Much rain also fell, among the heaviest falls being 2.41 in. at Borrowdale and 1.93 in. at Tynywaun (Glamorgan) on the 29th. The 26th and the 28th were the sunniest days of this part of the month, over 10 hrs. being recorded in the south on the 26th and at Inverness on the 28th. The total sunshine for the month was below normal in most districts, the total of 47 hrs. at Aberdeen being 70 hrs. below normal, that of 93 hrs. at Kew being 12 hrs. below normal, while Dublin, Falmouth and Valentia were 31 hrs., 24 hrs. and 18 hrs. below normal respectively.

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Pressure was above normal over Scandinavia, Germany, Spitsbergen, Iceland and Bermuda, the greatest excess being 11.3 mb. at Stockholm and below normal over most of the British Isles, south-west Europe, the Azores and Newfoundland, the largest deficit being 8 mb. in about  $50^{\circ}$  N.  $30^{\circ}$  W. Except for south Sweden temperature was above normal over western Europe the

excess reaching nearly 6° F. at Spitsbergen and northern Norway. Precipitation was above normal at Spitsbergen but below normal over most of western Europe being only a quarter of the normal in south Sweden.

Storms swept over Portugal during the first days of the month, causing serious damage to agriculture, and on the 7th forest fires occurred in Switzerland owing to the drought which had prevailed there since the middle of February. After a fortnight of abnormally fine weather heavy snow fell in Berlin on the 9th and the cold weather extended to Switzerland on the 10th. Snow fell on the mountains down to 3,000 ft. and also on the 11th in the low valleys. These cold conditions prevailed in central Europe until about the 21st and much damage was done to the crops in Austria. Snow fell at Turin, Milan, Bologna and Trieste on the 21st, but on the same day in Switzerland a strong föhn wind caused the snow to melt rapidly causing floods in the Rhône Valley. A quantity of fruit trees also died in the flooded areas of the Principality of Liechtenstein. A gale in northern Germany on the 21st caused the loss of ten lives in an accident to the mine at Liebenwerda. Slight floods were reported from Brittany on the 26th and gales occurred in western France on the 25th, on the Cantabrian coast of Spain and south coast of France on the 29th and 30th, and over the Swiss Alps on the 31st where they were accompanied by much rain.

Heavy snowstorms were reported from the Lebanon on the 6th. A hurricane accompanied by blinding rain swept the Pacific coast of Japan on the 11th and wrecked five Japanese steamers.

A disastrous landslide partly caused by heavy rains occurred at Santos (Brazil) on the 11th, and it is estimated that 150 people were killed. Four hundred people were drowned by the bursting of the dam of the St. Francis reservoir, 45 miles north of Los Angeles on the 13th. It is believed to be due to the accumulation of silt washed down by the recent heavy rain. Five rivers in California and Nevada, fed by the melting snows of the Sierras, overflowed their banks on the 26th causing much damage, and, owing to an ice block on the Saskatchewan river, serious floods occurred in the Pike Lake district on the 30th.

The special message from Brazil states that the rainfall in the northern and southern regions was abundant with 2.5 in. and 1.4 in. above normal respectively but scanty in the central regions with 0.8 in. below normal. Six anticyclones passed across the country and many gales were experienced in the south. The crops generally were doing well. At Rio de Janeiro pressure was 0.8 mb. below normal and temperature 1.6° F. above normal.

### Rainfall, March, 1928--General Distribution

England and Wales	...	118	} per cent. of the average 1881-1915.
Scotland	...	125	
Ireland	...	153	
British Isles	...	127	

## Rainfall: March, 1928: England and Wales

Co.	STATION	In.	Per- cent- of Av.	Co.	STATION	In.	Per- cent- of Av.
<i>London</i>	Camden Square .....	1'39	76	<i>Leics</i>	Thornton Reservoir ...	1'86	101
<i>Sur</i>	Reigate, The Knowle...	2'18	99	„	Belvoir Castle.....	1'19	66
<i>Kent</i>	Tenterden, Ashenden...	1'86	87	<i>Rut</i>	Ridlington .....	1'97	...
„	Folkestone, Boro. San.	1'56	...	<i>Linc</i>	Boston, Skirbeck .....	1'94	124
„	Margate, Cliftonville...	1'74	109	„	Lincoln, Sessions House	1'66	107
„	Sevenoaks, Speldhurst	1'96	...	„	Skegness, Marine Gdns	1'26	76
<i>Sus</i>	Patching Farm .....	2'71	126	„	Louth, Westgate .....	1'66	78
„	Brighton, Old Steyne	2'85	141	„	Brigg, Wrawby St. ....	2'26	...
„	Tottingworth Park ...	2'54	102	<i>Notts</i>	Worksop, Hodsock ...	1'85	110
<i>Hants</i>	Ventnor, Roy. Nat. Hos.	2'47	120	<i>Derby</i>	Derby .....	1'70	99
„	Fordingbridge, Oaklands	2'90	124	„	Buxton, Devon Hos....	...	...
„	Ovington Rectory .....	3'56	137	<i>Ches</i>	Runcorn, Western Pt. ...	1'80	89
„	Sherborne St. John ...	2'28	102	„	Nantwich, Dorfold Hall	1'81	...
<i>Berks</i>	Wellington College ...	1'61	81	<i>Lancs</i>	Manchester, Whit. Pk.	1'76	78
„	Newbury, Greenham...	2'96	130	„	Stonyhurst College ...	2'59	70
<i>Herts</i>	Benington House .....	1'79	99	„	Southport, Hesketh Pk	2'02	91
<i>Bucks</i>	High Wycombe .....	2'21	113	„	Lancaster, Strathspey	3'40	...
<i>Oxf</i>	Oxford, Mag. College	1'66	109	<i>Yorks</i>	Wath-upon-Deane ...	2'84	163
<i>Nor</i>	Pitsford, Sedgebrook...	1'63	93	„	Bradford, Lister Pk....	3'43	141
„	Oundle .....	1'08	...	„	Oughtershaw Hall.....	6'40	...
<i>Beds</i>	Woburn, Crawley Mill	1'56	91	„	Wetherby, Ribston H.	2'59	133
<i>Cam</i>	Cambridge, Bot. Gdns.	1'08	136	„	Hull, Pearson Park ...	2'97	163
<i>Essex</i>	Chelmsford, County Lab	2'14	124	„	Holme-on-Spalding ...	2'34	...
„	Lexden, Hill House ...	2'84	...	„	West Witton, Ivy Ho.	4'51	...
<i>Suff</i>	Hawkedon Rectory ...	1'97	104	„	Felixkirk, Mt. St. John	2'70	137
„	Haughley House .....	1'95	...	„	Pickering, Hungate ...	2'92	...
<i>Norfolk</i>	Beccles, Geldeston .....	1'24	72	„	Scarborough .....	2'85	158
„	Norwich, Eaton.....	1'68	88	„	Middlesbrough .....	2'12	135
„	Blakeney .....	1'56	95	„	Baldersdale, Hury Res.	2'62	...
„	Little Dunham .....	1'87	98	<i>Durh</i>	Ushaw College .....	3'00	136
<i>Wilts</i>	Devizes, Highclere.....	2'10	100	<i>Nor</i>	Newcastle, Town Moor	2'54	120
„	Bishops Cannings .....	2'22	99	„	Bellingham, Highgreen	4'50	...
<i>Dor</i>	Eversholt, Melbury Ho.	3'87	129	„	Lilburn Tower Gdns....	3'81	...
„	Creesh Grange .....	3'54	...	<i>Cumb</i>	Geltsdale.....	3'26	...
„	Shaftesbury, Abbey Ho.	2'23	95	„	Carlisle, Scaleby Hall	2'65	108
<i>Devon</i>	Plymouth, The Hoe ...	4'72	162	„	Borrowdale, Rosthwaite	9'45	...
„	Polapit Tamar .....	4'72	158	„	Keswick, High Hill ...	4'48	...
„	Ashburton, Druid Ho.	6'35	142	<i>Glam</i>	Cardiff, Ely P. Stn. ....	4'59	143
„	Cullompton.....	3'75	137	„	Treherbert, Tynywaun	9'10	...
„	Sidmouth, Sidmount...	3'07	126	<i>Carm</i>	Carmarthen Priory ...	4'17	110
„	Filleigh, Castle Hill ...	3'87	...	„	Llanwrda, Dolaeouthy	4'80	104
„	Barnstaple, N.Dev.Ath.	3'67	140	<i>Pemb</i>	Haverfordwest, School	5'85	171
<i>Corn</i>	Redruth, Trewirgie ...	7'51	208	<i>Card</i>	Gogerddan .....	2'45	71
„	Penzance, Morrab Gdn.	5'60	175	„	Cardigan, County Sch.	3'68	...
„	St. Austell, Trevarna...	7'28	212	<i>Brec</i>	Crickhowell, Talymaes	4'80	...
<i>Soms</i>	Chewton Mendip .....	4'57	128	<i>Rad</i>	Birm W.W. Tyrmynydd	4'54	85
„	Street, Hind Hayes ...	2'59	...	<i>Mont</i>	Lake Vyrnwy.....	4'08	95
<i>Glos</i>	Clifton College .....	...	...	<i>Denb</i>	Llangynhafal .....	1'60	...
„	Cirencester, Gwynfa ...	3'00	130	<i>Mer</i>	Dolgelly, Bryntirion...	2'80	57
<i>Here</i>	Ross, Birchlea .....	4'10	202	<i>Carn</i>	Llandudno .....	1'68	75
„	Ledbury, Underdown	3'67	193	„	Snowdon, L. Llydaw 9	10'90	...
<i>Salop</i>	Church Stretton.....	3'32	141	<i>Ang</i>	Holyhead, Salt Island	2'88	110
„	Shifnal, Hatton Grange	1'39	76	„	Lligwy.....	2'68	...
<i>Worc</i>	Ombersley, Holt Lock	2'10	123	<i>Isle of Man</i>	Douglas, Boro' Cem....	4'11	189
„	Blockley, Upton Wold	2'65	123	„	St. Peter P't. Grange Rd.	3'53	143
<i>War</i>	Farnborough .....	2'47	117	<i>Guernsey</i>			
„	Birmingham, Edgbaston	2'27	119				



## Rainfall: March, 1928: Scotland and Ireland

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	4.73	182	<i>Suth.</i>	Loch More, Achfary ...	3.66	57
"	Pt. William, Monreith	5.44	...	<i>Caith.</i>	Wick .....	1.69	74
<i>Kirk.</i>	Carsphairn, Shiel .....	8.35	...	<i>Ork.</i>	Pomona, Deerness .....	2.35	84
"	Dumfries, Cargen .....	5.96	165	<i>Shet.</i>	Lerwick .....	2.38	76
<i>Dumf.</i>	Eskdalemuir Obs. ....	6.71	137	<i>Cork.</i>	Caheragh Rectory .....	6.06	...
<i>Roosb.</i>	Bransholm .....	4.49	155	"	Dunmanway Rectory...	6.79	138
<i>Selk.</i>	Ettrick Manse .....	7.06	...	"	Ballinacurra .....	5.91	208
<i>Peeb.</i>	Castlecraig .....	...	...	"	Glanmire, Lota Lo. ....	7.80	252
<i>Berk.</i>	Marchmont House.....	4.12	155	<i>Kerry.</i>	Valentia Obsy. ....	5.40	119
<i>Hadd.</i>	North Berwick Res. ...	1.78	95	"	Gearahameen .....	8.70	...
<i>Mtdl.</i>	Edinburgh, Roy. Obs.	1.48	83	"	Killarney Asylum .....	5.31	113
<i>Ayr.</i>	Kilmarnock, Agric. C.	2.04	73	"	Darrynane Abbey .....	5.73	140
"	Girvan, Pinmore .....	5.86	156	<i>Wat.</i>	Waterford, Brook Lo. ...	5.69	207
<i>Renf.</i>	Glasgow, Queen's Pk. .	2.87	110	<i>Tip.</i>	Nenagh, Cas. Lough...	4.10	133
"	Greenock, Prospect H.	5.58	113	"	Roscrea, Timoney Park	3.78	...
<i>Bute.</i>	Rothsay, Arden Craig.	5.37	150	"	Cashel, Ballinamona...	4.46	162
"	Dougarie Lodge .....	4.86	...	<i>Lim.</i>	Foynes, Coolnanes.....	3.07	104
<i>Arg.</i>	Ardgour House .....	5.84	...	"	Castleconnel Rec. ....	3.41	...
"	Manse of Glenorehy ...	6.72	...	<i>Clare.</i>	Inagh, Mount Callan...	4.69	...
"	Oban .....	3.52	...	"	Broadford, Hurdlest'n.	3.16	...
"	Poltalloch .....	5.84	152	<i>Weaxf.</i>	Newtownbarry .....	8.29	...
"	Inveraray Castle.....	4.82	76	"	Gorey, Courtown Ho ..	8.56	370
"	Islay, Eallabus .....	5.03	132	<i>Kilk.</i>	Kilkenny Castle.....	4.38	192
"	Mull, Benmore .....	10.30	...	<i>Wic.</i>	Rathnew, Clonmannon	7.83	...
"	Tiree .....	...	...	<i>Carl.</i>	Hacketstown Rectory..	7.69	275
<i>Kinr.</i>	Loch Leven Sluice.....	3.15	105	<i>QCo.</i>	Blandsford House .....	4.82	184
<i>Perth.</i>	Loch Dhu .....	11.70	177	"	Mountmellick.....	4.03	...
"	Balquhiddie, Stronvar	7.01	...	<i>KCo.</i>	Rirr Castle .....	3.24	135
"	Crieff, Strathearn Hyd.	6.39	200	<i>Dubl.</i>	Dublin, FitzWm. Sq....	3.99	206
"	Blair Castle Gardens ...	6.16	235	"	Balbriggan, Ardgillan..	4.18	208
<i>Forf.</i>	Kettins School .....	5.56	253	<i>Me'th.</i>	Beaupare, St. Cloud....	3.78	...
"	Dundee, E. Necropolis	4.67	226	"	Kells, Headfort .....	3.96	144
"	Pearsie House .....	6.23	...	<i>W.M.</i>	Moate, Coolatore .....	2.97	...
"	Montrose, Sunnyside...	3.99	192	"	Mullingar, Belvedere..	3.06	103
<i>Aber.</i>	Braemar, Bank .....	4.93	165	<i>Long.</i>	Castle Forbes Gdns.....	3.36	114
"	Logie Coldstone Sch....	3.06	118	<i>Gal.</i>	Ballynahinch Castle ...	4.48	87
"	Aberdeen, King's Coll.	3.57	148	"	Galway, Grammar Sch.	3.72	...
"	Fyvie Castle .....	3.01	...	<i>Mayo.</i>	Mallaranny.....	3.31	...
<i>Mor.</i>	Gordon Castle .....	1.66	72	"	Westport House.....	3.46	89
"	Grantown-on-Spey ...	1.68	64	"	Delphi Lodge.....	6.81	...
<i>Na.</i>	Nairn, Delnies .....	1.57	84	<i>Sligo.</i>	Markree Obsy.....	3.57	103
<i>Inv.</i>	Ben Alder Lodge .....	...	...	<i>Cav'n.</i>	Belturbet, Cloverhill...	3.20	116
"	Kingussie, The Birches	2.18	...	<i>Ferm.</i>	Enniskillen, Portora...	2.81	...
"	Loch Quoich, Loan .....	18.00	...	<i>Arm.</i>	Armagh Obey.....	3.17	135
"	Glenquoich .....	8.83	91	<i>Down.</i>	Fofanny Reservoir.....	14.62	...
"	Inverness, Culduthel R.	2.45	...	"	Scaforde .....	6.56	225
"	Arisaig, Faire-na-Squir	3.86	...	"	Donaghadee, C. Stn ...	4.44	202
"	Fort William .....	6.03	88	"	Banbridge, Milltown...	3.31	151
"	Skye, Dunvegan .....	5.57	...	<i>Antr.</i>	Belfast, Cavehill Rd ...	3.65	...
<i>R &amp; C.</i>	Aliness, Ardross Cas. ...	3.89	119	"	Glenarm Castle .....	5.90	...
"	Ullapool .....	2.80	...	"	Ballymena, Harryville	4.22	134
"	Torricon, Bendamph...	5.73	76	<i>Lon.</i>	Londonderry, Creggan	3.41	107
"	Achnashellach .....	4.16	...	<i>Tyr.</i>	Donaghmore .....	3.95	...
"	Stornoway .....	3.48	85	"	Omagh, Edenfel.....	3.62	115
<i>Suth.</i>	Lairg .....	2.53	...	<i>Don.</i>	Malin Head.....	2.32	100
"	Tongue .....	2.71	81	"	Dunfanaghy .....	2.57	70
"	Malvick .....	1.92	67	"	Killybegs, Rockmount.	3.43	67

## Climatological Table for the British Empire, October, 1927.

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity	Mean Cloud Am't	PRECIPITATION		BRIGHT SUNSHINE				
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values			Mean	Days			Diff. from Normal	Am't	Days	Hours per day	Per- cent- age of possi- ble		
			Max.	Min.	Max.	Min.	1/2 and										Diff. from Normal	Wet Bulb
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	%	0-10	in.	in.						
London, Kew Obsy.	1017.8	+ 3.8	64	34	57.4	44.6	51.0	46.9	94	8.4	1.27	-	11	2.3	21			
Gibraltar	1016.3	- 0.9	78	58	71.9	62.6	67.3	61.9	86	6.6	3.48	+	12	..	..			
Malta	1016.5	- 0.1	82	58	72.8	64.5	68.7	64.9	86	5.1	0.35	-	6	7.1	63			
St. Helena	1014.6	+ 2.3	64	53	60.3	54.3	57.3	55.2	94	9.7	1.56	-	17	..	..			
Sierra Leone	1012.1	+ 0.5	91	69	86.6	72.1	79.3	75.7	83	6.5	12.63	+	25	..	..			
Lagos, Nigeria	1012.0	+ 0.3	86	70	84.7	74.2	79.5	75.6	83	3.8	13.33	+	22	..	..			
Kaduna, Nigeria	1015.0	+ 2.7	90	58	87.2	62.1	74.7	72.2	78	1.7	5.93	+	17	..	..			
Zomba, Nyasaland	1011.1	- 0.2	90	56	85.1	62.4	73.7	..	83	3.3	0.26	-	5	..	..			
Salisbury, Rhodesia	1010.7	- 0.4	89	53	82.8	58.0	70.4	..	54	3.3	2.26	+	8	8.5	68			
Cape Town	1018.4	+ 1.0	88	47	72.1	54.8	63.5	56.6	73	3.7	0.77	+	7	..	..			
Johannesburg	1014.8	+ 0.7	87	43	73.1	53.3	63.2	52.5	54	3.8	4.68	+	9	6.6	52			
Mauritius	1019.3	+ 1.1	83	57	73.8	64.0	71.4	67.5	64	5.5	1.49	+	14	9.3	74			
Bloemfontein	1009.6	..	91	44	81.1	52.7	66.9	56.0	58	4.3	1.23	-	4	..	..			
Calcutta, Alipore Obsy	1009.9	+ 0.2	92	69	89.8	75.3	82.5	76.2	86	3.1	2.92	-	4*	..	..			
Bombay	1010.6	+ 0.8	93	75	87.6	77.8	82.7	76.5	85	3.6	7.30	+	7*	..	..			
Madras	1010.0	+ 1.1	96	72	91.6	76.5	84.1	76.6	77	5.5	2.46	+	7*	..	..			
Colombo, Ceylon	1011.8	+ 1.5	89	71	86.9	74.6	80.7	77.4	73	6.6	10.12	-	19	8.2	68			
Hongkong	1014.6	+ 1.0	88	60	79.6	70.9	75.3	69.0	71	4.2	5.42	+	7	7.5	66			
Sandakan	1017.9	..	91	73	88.6	74.9	81.7	77.0	84	..	12.49	+	16	..	..			
Sydney	1017.7	+ 3.0	98	42	72.2	55.7	63.9	58.3	61	5.1	3.48	+	17	6.9	56			
Melbourne	1017.7	+ 3.0	92	38	70.4	50.4	60.4	54.0	58	5.8	2.45	+	10	5.9	45			
Adelaide	1017.9	+ 1.9	91	43	75.1	52.6	63.9	54.2	42	5.6	0.48	-	5	7.7	60			
Perth, W. Australia	1017.6	+ 0.8	86	45	71.3	53.5	62.4	56.9	61	5.1	2.67	+	13	8.3	65			
Coalgardie	1015.6	+ 0.4	90	43	78.4	50.8	64.6	54.1	43	3.9	0.12	-	1	..	..			
Brisbane	1019.5	+ 3.3	83	51	76.3	59.2	67.7	62.6	64	5.4	7.15	+	12	8.6	68			
Hobart, Tasmania	1014.5	+ 3.9	80	37	63.7	46.4	55.1	48.2	57	6.7	1.43	+	17	7.2	55			
Wellington, N.Z.	1016.1	+ 3.0	71	38	62.2	49.6	55.9	52.2	67	5.4	1.92	-	8	6.7	51			
Suva, Fiji	1013.2	0.0	87	67	81.4	71.7	76.5	73.0	82	8.0	17.93	+	22	3.5	28			
Apia, Samoa	1012.1	+ 0.6	87	73	85.1	75.1	80.1	77.4	77	5.6	12.90	+	18	6.9	56			
Kingston, Jamaica	1010.6	- 0.9	92	71	87.3	73.2	80.3	73.1	89	5.8	10.56	+	17	6.1	52			
Grenada, W.I.	1007.1	- 3.5	92	70	87.4	76.4	81.9	77.6	79	5.2	10.00	+	19	..	..			
Toronto	1015.3	- 2.7	77	35	61.2	44.8	53.0	46.2	83	5.2	2.19	-	11	5.7	51			
Winnipeg	1013.2	- 2.1	75	29	54.6	37.2	45.9	38.1	87	5.8	3.17	+	9	3.7	34			
St. John, N.B.	1012.9	- 3.6	72	29	55.3	44.0	49.7	47.2	86	6.7	5.01	+	15	..	..			
Victoria, B.C.	1015.8	- 1.8	64	38	55.5	46.2	50.9	48.5	86	8.1	4.74	+	19	3.6	33			

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

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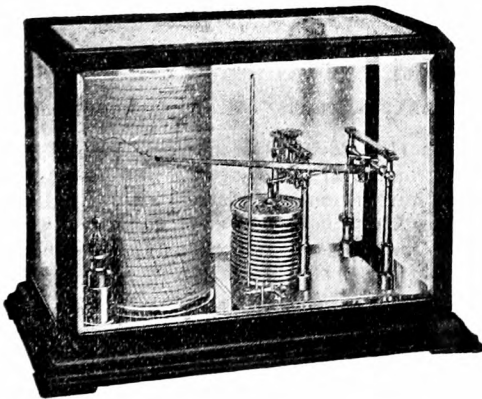
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## Long-Range Weather Forecasting

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

It is a fundamental axiom of economics that demand creates supply, and this seems to be true, not only of material commodities, but also of intangible things of the mind. Mankind has always wanted to know what weather the future had in store, and so from very early times the "public" could always obtain a forecast. Dwellers in the country relied on the behaviour of animals and plants, or on curious atmospheric phenomena, as interpreted in many wise saws and sayings, while their brothers of the town consulted an almanac or an astrologer, and so attained vicarious communion with the stars. The methods may not have been scientific, but there were inevitably a few striking coincidences, and in the absence of any public record of weather to serve as a check, everyone was satisfied. It was not until the middle of the nineteenth century that the first regular official daily forecasts were issued, and replaced the almanac for day-to-day purposes, and it was only with the advent of broadcasting that they penetrated freely into the country.

Forecasts for twenty-four hours ahead are very useful for a variety of purposes, but there is also a demand for information as to the probable weather over a longer period, in the form of "long-range" or "seasonal" forecasts. This demand has been most insistent in agricultural countries such as India, many parts of which are on the borderline of aridity and famine; in that country research in the subject has been carried on for

some fifty years and reasonably successful seasonal forecasts have been issued regularly throughout the present century. In Egypt the place of long-range weather forecasts is taken by forecasts of the Nile flood. In other countries such as our own the demand has not been so insistent, but of recent years general interest has awakened in the subject, and a great deal of research is being carried out, both by the official meteorological services and by private investigators. The methods in use are very diverse, but, leaving the stars out of account, they may be classified under four headings: Periodicities; Variations of solar activity; Relations between meteorological conditions in different parts of the world, with which we may include ocean temperatures; and Extensions of the method of synoptic forecasting.

As soon as regular meteorological observations became available, meteorologists began to search for periodicities in the hope of finding the golden cycle of weather. As early as 1842 Luke Howard\* announced a periodicity of 18 years which he thought would be of use for forecasting. Since then there has been a great deal of research into periodicity, which has helped our insight into the working of the world's weather, but has proved of little use in forecasting. Weather cycles have not the regularity and permanence of astronomical cycles, and when applied to prediction have an annoying habit of breaking down or changing phase. A remarkable example of this occurred in connexion with a series of rainfall forecasts for South Africa published in 1889†, in which the main cycle which had previously remained constant for many years completely reversed its phase in the year following publication, and so made the forecasts worse than useless.

Reasonably successful rainfall forecasts are being made in Java on the basis of a three-year periodicity, but these are controlled by a careful watch on the course of pressure variation and other factors.§

The latest development in the method of forecasting from weather cycles was originated in Italy in 1923 by F. VerCELLI,‡ who assumes that in place of true periodicities the pressure distribution and hence the weather is governed by series of waves in the atmosphere which persist for a few weeks and then die away. Hence instead of assuming the existence of various fixed and unalterable periodicities, VerCELLI forms a continuous

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\* L. HOWARD. *A cycle of 18 years in the seasons of Britain deduced from meteorological observations made at Ackworth in the West Riding of Yorkshire from 1824 to 1841.* London, 1842.

† S. E. HUTCHINS. *Cycles of drought and good seasons in South Africa.* Wynberg, 1899.

‡ F. VERCELLI. *Nuovi esperimenti di previsioni meteorologiche.* Roma, 1923.

§ H. P. BERLAGE, *East Monsoon forecasting in Java.* Batavia, 1927. See *Meteor. Magazine*, 62, 1927, p. 268.

curve from a set of barograms covering about two months, and analyses this curve into its component waves. These waves are then prolonged for a week into the future, and their composition gives the forecasted variations of pressure for that period. The forecasts met with a certain amount of success, and the study of the method is being energetically continued in Europe. Reference may be made to an elaborate paper by L. Weickmann,\* in which the technique of the method is fully set out, and several long series of daily weather charts are analysed. The best known practical application of periodicities to long range forecasting in this country is that employed in Lord Dunboyne's forecasts in the *Daily Mail*, which are briefly described in *Nature* for January 29th, 1927. Here it appears that some fifteen cycles are employed, some of which are regarded as permanent and others as evanescent, but full details are not available.

Forecasting from the variations of solar activity is chiefly associated with the name of Mr. H. H. Clayton, who has found various highly complex relations between the occurrence of maxima and minima on the curve of solar radiation obtained at the Smithsonian observatories and the subsequent development of anticyclones and depressions in South America. Weekly forecasts of temperature at Buenos Aires have been issued regularly for some years, but the series of measurements of solar radiation is not yet long enough to solve all the problems of solar relationships. In this country no relationship has yet been demonstrated between solar phenomena and the weather.

The great majority of the successful methods of long-range forecasting at present in use have arisen from the study of the relations between the meteorological conditions in different parts of the world, a branch of investigation chiefly associated with the names of Sir Gilbert Walker, Mr. E. W. Bliss and Professor Exner. The work in India and Egypt, already alluded to, falls into this category, and makes use of antecedent conditions as far away as South America; investigations on similar lines are being carried out in Rhodesia, and altogether it seems probable that in most tropical countries the problem of long-range forecasting depends for its solution on the co-ordination of the succession of the seasons in all parts of the world. Again, the ice conditions in the Barents Sea have been found by W. Wiese to depend on a number of antecedent conditions extending at least as far as the equator, which offer a practical method of forecasting, and studies by Lieut.-Commander E. H. Smith†

\* Wellen im Luftmeer. Neuere Untersuchungen über Gesetzmässigkeiten im Gange und in der Verteilung des Luftdruckes. 1 Mitt. *Leipzig, Abh. Sächs. Akad. Wiss.* 39, II., 1924.

† The International Ice Patrol. *London, Meteor Mag.* 60, 1925, p. 229.

suggest a similar possibility for the ice on the Newfoundland Banks. But very little progress has been made as yet in applying this method to long-range forecasts for the British Isles. There appear to be two main reasons for this: first, this method of forecasting is essentially "seasonal," i.e., it is only applicable to countries where the meteorological conditions usually remain sensibly constant for several months; and secondly, the weather of the British Isles is not bound up with the fluctuations of intensity of any one "centre of action," but is influenced in turn by at least three such centres—Iceland, the Azores and Siberia. The importance of the first difficulty is easily seen from a consideration of the weather of the winter of 1927-8, which gave us a dry December, excessively wet weather in January and the first half of February, and another fine spell in the last half of February. The individual characteristics of the months would be largely lost by taking a mean of the conditions over the three. With regard to the second difficulty, a study of the droughts and wet seasons in the British Isles has shown that abnormal seasons depend much less on variations in the intensity of the Icelandic minimum or the Azores high than on displacements of their position. Hence it appears that the real problem for these islands is to forecast such displacements.

Both variations in the intensity of centres of action and displacements of their position show up on charts much more vividly if we plot the deviations from the normal values than if we plot the actual sea-level pressures. It was for this reason that when the Meteorological Office undertook, at the request of the International Meteorological Committee, the preparation and publication year by year of the monthly summary of the meteorological conditions over the globe, which has become widely known under the title of the *Réseau Mondial*, the charts which were drawn to accompany the tables for the years 1910 and 1911 gave, not the actual pressures and temperatures, but the differences from normal values. A considerable series of these charts has now been accumulated and has been subjected to detailed examination. The result is somewhat surprising; it is found that the maps present closed areas in which the pressure is above normal or below normal, which have a close superficial resemblance to the anticyclones or depressions of an ordinary daily weather map, and which also move across the charts from one month to the next in much the same way as anticyclones and depressions, but more slowly, covering only some 700 miles a month instead of about 500 miles a day. It has even been found possible to lay down standard tracks along which the centres tend to move.\* An example of a series of such centres moving regularly from west-south-west to east-north-east

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\* Variations of pressure from month to month in the region of the British Isles. *London, Q. J. R. Meteor. Soc.*, 52, (1926), p. 263.



occurred during the spring and early summer of 1924, and was illustrated in the *Meteorological Magazine* for September of that year.

This discovery seems to open the way for monthly forecasts in general terms of the weather over the British Isles. Before such forecasts can attain a high degree of success, however, a good deal of further research will be necessary. In the first place, the month is too large a unit, but the month is the unit normally adopted in the publication of climatological results, and the labour of repeating the work with a smaller unit would be very great. Secondly, these centres, and especially centres in which the pressure is below normal, often depart from the usual tracks, or die out, and this would falsify the forecasts. To discover the reasons for these irregularities is likely to require a great deal of laborious research, only a small part of which has yet been carried out. Hence, although this method seems at present to offer the best prospect of real long-range forecasts being ultimately practicable in this country, the time is not just yet.

The use of ocean temperatures as indicators of coming weather is at first sight a very promising line of attack. It is well known that the warm water of the Gulf Stream drift exercises a marked effect on the climate of the British Isles, and it seems a logical extension of the argument to assume that variations of the Gulf Stream are of equal importance in causing variations of weather. Actually a slight influence has been traced,\* but it represents only a very small fraction of the variability of our weather. The fallacy in the reasoning is that the Gulf Stream is not only an important factor of our climate but it is also an extremely stable factor, and the differences from year to year in the amount of heat which it carries into the North Atlantic are very small compared with the average amount of heat which it brings in any one year. Nevertheless the effect is sufficiently important to make good its claim to be taken into our counsels. In California, where conditions are much less complicated than in western Europe, the temperature of the coastal water has been found by G. F. McEwen to be a useful guide to the probable rainfall.†

The fourth suggested method is the extension of synoptic forecasting from daily weather charts. For a long time now certain stable barometric situations have been recognised as likely to give several days of fine weather in this country, and others as offering no prospect of the cessation of unsettled conditions. With the extension of the area covered by the synoptic charts,

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\* The effect of fluctuation of the Gulf Stream on the distribution of pressure over the eastern North Atlantic and western Europe. *London, Meteor. Office, Geophys. Mem.* 4, No. 34.

† Forecasting seasonal rainfall from ocean temperatures. *Bull. Amer. Meteor. Soc.*, 5, 1924, p. 137.

and especially with the receipt of wireless messages from ships in the Atlantic, the possibilities in this direction have steadily increased. Unofficial forecasts for a week in advance, based on synoptic charts covering a large area, actually appeared in the *Times* for a considerable period. These weekly forecasts were reasonably successful; from a consideration of the occasional failures it appeared that the cause of failure was the suppression of the detailed sequence of events which would normally result from the situation revealed on a given synoptic chart owing to a change in the more general, more permanent characteristics of the barometric situation. To take a definite example, at the beginning of June, 1925, a depression over the Atlantic was advancing directly towards these islands, and the natural forecast was for a continuance of unsettled weather. The monthly chart for May, however, showed a marked excess of pressure over the Azores which, following the usual track of such centres, would pass directly over Britain. In the conflict of these two tendencies the latter prevailed; the depression over the Atlantic rapidly filled up, and a long spell of fine weather set in, which lasted the whole of the month. This example suggests that the study of the general tendencies of the pressure distribution revealed by the monthly pressure charts may at times assist the forecaster from daily synoptic charts, especially when he is considering the "further outlook," and so lead to the more frequent issue of what may be termed "medium-range" forecasts, perhaps the most useful form of all for the general public.

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## Great Storms

From time to time the newspapers startle us with graphic accounts of terrible havoc wrought by great storms of wind, floods, earthquakes and eruptions, but the wave of sympathy soon subsides and the events are forgotten outside the affected area.

In this interesting volume\* we are reminded of some of the most notable storms on record and the authors have collected a great deal of authentic information regarding them. Most of the events referred to are connected with the sea and the book is therefore of particular interest to sailors as well as to meteorologists. It was not until 1838 that the important discovery of the "Law of Storms" made it possible for an observer to deduce the approximate position of the storm centre and its track. Previous to this seamen had nothing of the sort to guide them and it is probable that if such information had been available many

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CARR LAUGHTON AND V. HEDDON. *Great Storms*.—Illustrated by Cecil King. 8vo., 8½ x 5½ in., pp. vi + 251. London: P. Allan & Co., Ltd., 1927, 10s. 6d. net.

of the stories told of the tragic results of these storms might have been very different.

When Admiral Fitzroy in 1858 began the charting of the weather, he also turned his attention to precautions against destructive storms and a few years later introduced the now well-known "Gale Warnings." Since Fitzroy's days there has been a gradual development in the drawing of weather charts and 220 stations in this country now receive "Gale Warnings."

It is difficult to compare the force of the wind in the storms which occurred before the nineteenth century with that of the storms of more modern days for, as the authors say, "Naturally we could not expect to find a nineteenth century Beaufort Scale of winds with its ascending scale of breezes and gales reaching at its upper limits to a storm and finally to a hurricane in use in the sixteenth century." It is of interest to note however that before the nineteenth century a scale giving designations for winds of different strengths was in use but no numbers were given. The writer of an historical account of the great storm of 1703 referred to in this magazine, points out the contrast of what a ship could stand in his time (1769) and what she could stand in 1703. He says:—"What our sailors call a topsail gale would have driven the navigators of those days into harbour. When our hard gale blows they would have cried a tempest and about the Fret of wind they would have been all at their prayers."

With the advance of wireless it has now been made possible for weather information to be received and distributed over large areas and the seaman to-day has a great advantage over his less fortunate brother of earlier days. Under normal conditions the modern seaman need never find himself in the vicinity of a storm centre as did the brig *Chas Heddel*, an account of which is given in the first chapter. This unfortunate ship succeeded in running no less than 5 times round the centre of a storm.

Thrilling episodes are recounted in each chapter of this book. The account of the tragic end of such ships of the Armada as escaped capture is, so far as I am aware, a hitherto unpublished story. The authors follow the fortune of these ships as they grope their way struggling with head winds round the north of Scotland, until each succumbs to her ultimate fate. One ship alone, the flagship, eventually reaches a Spanish port.

In Chapter IV an account of the great storm of 1703 is given. It is said to have destroyed more property and caused the death of more people both on land and sea than any other known English storm. In view of the recent Thames floods it is interesting to find the following remarks in this chapter:—"It is a well-known thing that a strong gale blowing in the direction of the flood tide into a narrowing channel will greatly raise the level of the water at the head of that channel. We have frequent

experience of this in London where a northerly gale at the time of spring tides raises the river to the top of its embankments and even overflows some roads near the waterside."

In the chapters dealing with West Indian Hurricanes and China Typhoons, some interesting accounts are given of the great storms which have occurred in that area. The loss of the S.S. *Antinoe* and H.M. Sloop *Valerian* in 1926 in the North Atlantic is mentioned as a reminder that the wind and sea can still be dangerous to well-found ships with powerful engines. The terrific force of the wind in these storms is emphasised by a description of havoc and devastation wrought by them. In one case a 12-pounder gun is recorded as having been hurled from one battery to another, a distance of 140 yards. It is indeed rare, as the authors say, to meet with a detailed description of what it feels like to be in a typhoon but such interesting details are given in an account of a storm quoted from a letter written by a naval officer who in a destroyer explored, by force of circumstance, the centre of one of these storms.

The tragic facts related in the account of the "Last Voyage of the Elizabeth" in 1764 fill one with admiration for the crew of this old ship. In the last stages of senile decay she made the voyage from Bombay to Spithead. Battered by storms in the Indian Ocean and well-nigh falling to pieces with steering gear gone she eventually arrived at the Cape of Good Hope after a voyage of 85 days. In spite of her terribly bad condition, hogged and frapped together by means of ropes, she continued her voyage and eventually arrived at Spithead where the shipwrights and caulkers, we are told, were surprised beyond expression to see the ship frapped together fore and aft and refused to work on the vessel for fear she would sink at her anchorage. All honour to the brave crew.

Chapter IX recalls the Tay Bridge disaster which occurred in December, 1879, only 7 months after it had been opened. A train was passing over the bridge at the time and out of the 75 passengers not one survived the accident. The authors give an illuminating account of the disaster and the subsequent inquiry.

The story of the complete destruction of St. Pierre by a volcano cloud is graphically told. Tales of heroism always stir the hearts of the British people, and what more gallant story could be told than that of the escape from St. Pierre Harbour of the S.S. *Roddam* on the morning of May 8th, 1902. Eighteen ships were destroyed by fire in the harbour, the *Roddam* alone escaping. "Captain Freeman saw a tremendous cloud of smoke, glowing with live cinders, rushing with terrific rapidity over town and port. He saw the town disappear under the fiery cloud, he saw the ships north of him break into flames, and then the cloud was upon the *Roddam*. . . . So she alone

went free with her burnt captain at the wheel steering with his elbows because his hands were too badly burnt to hold the spokes, with her deck hands lying about the deck dead or unconscious and with a hail of hot ashes continuing to fall." The authors justly say, "To stand alone at the helm through long hours, the only man on whom the salvation of the ship depended, implied an endurance and devotion amounting to heroism."

The drawings are excellent, and those who go down to the sea in ships and have experienced such storms as those recounted in the pages of this volume will not say that the roughness of the sea is exaggerated. The book is an ably executed and most attractive and interesting work and is well worth reading.

L. G. GARBETT.

## Official Publications

### GEOPHYSICAL MEMOIRS—

No. 37. *Studies of Wind and Cloud at Malta.* By J. Wadsworth, M.A. (M.O. 286g)

Malta is a small island, only some 15 miles across, with high ground exceeding 600 feet in the west and a low coastal plain in the east. The two meteorological stations, Pieta and University, are on this coastal plain, the former on a deep bay, the latter near the open sea. The prevailing direction of the surface winds in summer is from the north-west, becoming more northerly in the morning and more westerly in the evening, while the velocity is greatest in the afternoon and least in the early morning. This is interpreted as the usual diurnal variation at an inland station modified by a slight sea-breeze from north-east during the day and a faint katabatic wind during the night from the hills to the west-south-west. The diurnal variation is greater with westerly than with easterly winds. In winter the variation resembles that of summer but is much less regular. Pilot-balloon ascents show that in summer north-westerly winds prevail at all heights, while in winter north-westerly winds preponderate up to 3,000 feet, above which they tend to become westerly. Except near the ground the velocity in summer is generally between 11 and 20 miles per hour, the highest velocities occurring with winds from west.

The cloud observations show that the cloudiest skies occur with easterly winds and the clearest skies with calms and northerly winds. The most frequent type of cloud is cumulus, and the sky tends to clear in the evening, especially with westerly winds.

### Corrigendum

March, 1928, p. 52, line 23, for "by the Osler swinging plate anemometer" read "by the Dines pressure tube anemometer."

## Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, April 18th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, in the Chair.

*C. K. M. Douglas.*—*Some Alpine cloud forms.*

A number of excellent lantern slides were shown to illustrate the distinction between "banner" clouds, which are turbulent clouds formed as the result of an eddy drawing air up the lee side of a steep mountain in a strong wind, and lenticular caps or "föhn clouds," which are smooth in appearance, and are formed in a damp current crossing the mountain top with vertical displacements which do not seem to be large as a rule, most of the air apparently flowing round the mountain. Banner clouds appear to draw their moisture from lower down than caps, so that the two forms often exist independently though both are produced by strong winds. The existence of caps but no banners may be attributed to a damp layer with dry air below, a condition known frequently to exist.

*N. K. Johnson.*—*A strong wind of small gustiness.*

This paper discussed the records of wind velocity and direction obtained at Leafeld, Oxon, on two days in December, 1926. On the first of these days the weather was that corresponding to equatorial air, with overcast sky, slight rain and a strong wind. The autographic traces of wind velocity and direction possess considerable width although the mean values of both are nearly constant. The second occasion related to polar air, the sky being practically clear but the wind velocity being approximately equal to that on the first occasion. The records of wind velocity and direction in this case are characterised by the extreme narrowness of the traces, thus indicating a degree of atmospheric turbulence unexpectedly low in view of the strong wind. Whilst polar air normally gives somewhat narrower traces than equatorial, it is shown that the great difference found in the present examples is to be attributed to the difference in the lapse rates obtaining on the two occasions. During the clear night an inversion of nearly 3° F. existed between heights of 1 metre and 87 metres in spite of the wind velocity being 40 miles per hour.

*T. N. Hoblyn.*—*A statistical analysis of the daily observations of the maximum and minimum thermometers at Rothamsted.*

Mr. Hoblyn gave an account of the work carried out on 48 years' temperature records at Rothamsted. The labour entailed where so large a mass of data had accumulated was considerable and the method adopted to reduce these data to a more convenient form is given in some detail in a hope that it may be of some value to other stations where records of a similar nature exist. It is pointed out that the interest in temperature in this country lies chiefly in its variation at different periods of the

year not only from day to day but also from year to year. It is shown that at this station both maximum and minimum temperatures do vary significantly from year to year at all periods of the year, although this variation is much greater in some months than in others. The variation of the different measures of temperature is demonstrated by a number of smooth curves.

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### Wind in the Mountains

I was interested in the note in your last issue from Seskin, Carrick-on-Suir. I have no doubt that your correspondent is right as to the origin of the noise being in the mountains.

The same phenomenon occurs in the Presteign district of Radnorshire, situate about 6 miles east of the Radnor Forest mountains; the noise is known locally as "The Forest Roaring." The forest is 2,100 feet above sea level and is generally of a smooth wooded formation, and I gather that the noise is only heard in stormy conditions.

R. P. DANSEY.

*Kentchurch Rectory, Hereford. May 2nd, 1928.*

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### Halo Phenomena

On April 24th at 7.30 a.m. (G.M.T.), there was seen from the station here a brilliant tangent arc to the outer solar halo, although that itself could not be traced. The inner halo was very perfect with a well-developed mock sun on the west. I watched it for some ten minutes before taking my train.

On the afternoon of April 25th a solar halo, at times well developed, was seen here from arrival at about 3.45 (G.M.T.) for over two and a-half hours. A mock sun developed about 5.45 on the east side and became very brilliant, lasting about a quarter of an hour. On both occasions the medium appeared to be a lofty film of cloud, not markedly broken up at the time into cirrus wisps or flocculi. In the evening there was no sign of the outer halo or its tangent arc.

26th, In very similar filmy cloud the tangent arc to the inner halo was bright at 5.45 a.m. (G.M.T.), fading as the halo itself developed later on. The latter was seen here to 7.30 a.m. and then in the City up to 11.30.

27th, At 5.30 a.m. at Purley the inner halo was well formed in the upper quadrant, clouds obscuring lower. At 6.15 it had gone, but the outer halo was formed faintly on the same type of film cloud as on the previous days. Halo seen about 10.30 in the City.

This is the first occasion so far as I can recall, when I have recorded solar halo effects on four successive days. At times on the 28th there were filmy clouds similar in look to those of the 24th-27th, but no sign whatever of halos.

J. EDMUND CLARK.

41, Downscourt Road, Purley, Surrey. April 29th, 1928.

### Weather Notes from a Florentine Diary

The following extracts are from the diary kept at Florence by the apothecary Luca Landucci from 1450 to 1516, and continued by another till 1542. The translation used is the recent one by Alice de Rosen Jervis (1927).\*

“ 1490. 10th January. The Arno froze entirely so that ‘palla’ (tennis) was played upon it and bonfires were made. The cold was great.

17th January. This night there began and continued until the 18th a certain fine rain which froze while it fell and made icicles upon the trees. There was such a quantity of it that the weight bowed the trees down to the ground and broke the branches. Note by the way that this was on the hills. For about half a mile near the river it did no injury. . . . The stacks appeared roofed with glass, and it was too dangerous for anyone to walk in the country.

1493. 20th January. The Day of San Bastiano there was the severest snowstorm in Florence that the oldest people living could remember. Amongst other extraordinary things it was accompanied by such a violent wind that for the whole day it was impossible to open the shops or the doors and windows. . . . All along the street one saw heaps of snow so that in many places neither man nor beasts could pass. In fact these mountains lasted a week. It is difficult to believe without having seen it.

19th May. Our Lady of Santa Maria Imprunta was brought into the city in hopes that the rain might cease and our prayers were granted.

1500. 2nd July. We heard that there had been a hailstorm at Rome in which the hailstones lay two braccia deep with such a violent wind and tempest that the Pope's palace was ruined and part of the room where the Pope (Alexander VI) was sitting fell on the top of him; but as pleased the Lord . . . he was not killed.

1511. 4th September. We heard there had been a terrible hailstorm at Crema in Lombardy with meteoric stones of the weight of 150 pounds each the larger ones and some of the hailstones weighed 30 pounds each, so that roofs were broken and many men and beasts were killed. At the same time great fires were also seen in the air in the evening at the castle of Carpi,

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\* Published by J. M. Dent and Sons, London.



and then the fire was seen to divide into three parts with loud thunderclaps (Ball lightning?) this being followed with hail and wind that carried away roofs and belfries and did immense damage.

1522. In this year manna fell almost everywhere and it was so hot that the grapes dried on the vines."

There are also numerous allusions to "thunderbolts," notably one on 5th April, 1492, which damaged Santa Maria del Fiore and "was considered a great marvel and significative of some extraordinary event, especially as it happened suddenly when the weather was calm and the sky without a cloud."

CICELY M. BOTLEY.

17, *Holmesdale Gardens, Hastings. January 24th, 1928.*

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## NOTES AND QUERIES

### A New Wireless Station at South Georgia

Information has been received that the arrangements for the broadcasting of daily weather bulletins from Cumberland Bay, South Georgia, have been completed. This is in accordance with a resolution, passed by the International Meteorological Conference at Utrecht in 1923, that "it is highly desirable in the interest of synoptic meteorology in the southern hemisphere . . . to augment information from the surrounding coasts" of South Africa and South America. This daily meteorological report from Cumberland Bay will be sent by wireless *via* Stanley, Falkland Islands, to Monte Video, whence it will be relayed to Rio de Janeiro, the headquarters of the Brazilian Meteorological Service. Here the information will be incorporated on the Brazilian daily weather maps, to which it will form a welcome addition, and here also it will be included in the national and international bulletins broadcast daily from Rio de Janeiro.

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### The May Cold Spell.

Many attempts have been made to prove or disprove the existence of recurrent cold or warm periods by various treatments of the temperature values, such as the plotting of three-day and five-day means, harmonic analysis, and by the examination of the curves of mean daily temperature. These methods, however, have not resulted in any generally accepted conclusions.

In Europe, perhaps the most celebrated of the interruptions in the annual march of temperature is associated with the festivals of St. Mamertius, St. Pancras and St. Gervais, on May 11th, 12th and 13th, hence called the "Ice Saints," and this particularly has been the subject of considerable investigation. It has

been pointed out in a previous number of the *Meteorological Magazine*\* that the curve of mean daily temperature does not show a very marked depression around these days. The means of temperature at Kew which accompanied that article showed a slight minimum on May 10th, but the depression amounted to only 0.5°F. These figures referred to the period 1871 to 1900, and it is interesting to notice that the addition of another 27 years has failed to modify this result, a depression of 0.5°F. still leading to a minimum on the 10th. This attributes a surprising amount of constancy to such a minor feature of the curve. If we split up the fifty-seven years 1871 to 1927 into three periods of nineteen years each we have the following means:—

May	7th	8th	9th	10th	11th	12th	13th
1871-1889	50.5	50.6	50.1	49.7	49.9	51.4	51.7
1890-1908	51.3	51.6	51.7	51.8	52.4	54.2	53.7
1909-1927	52.6	52.5	52.2	51.6	53.2	53.9	53.4

A minimum on the 10th is found in the first and last periods, but not in the middle one. One possible reason for this irregularity is that the cold spell does not recur on exactly the same dates each year, so that by taking averages we smooth it away. According to popular conviction the period lasts about three or four days, and it should reveal itself in the curves of daily mean temperatures for individual years. The accompanying diagram shows the fluctuations of the daily mean temperature at Kew during the period May 1st-25th for the 57 years 1871-1927. The curves are drawn to a scale in which 10°F. = 0.12 in. It will be observed that although in some years—1876 for instance—the temperature rose almost smoothly throughout May, the majority of years show a cold spell during the month which in many cases is very pronounced.

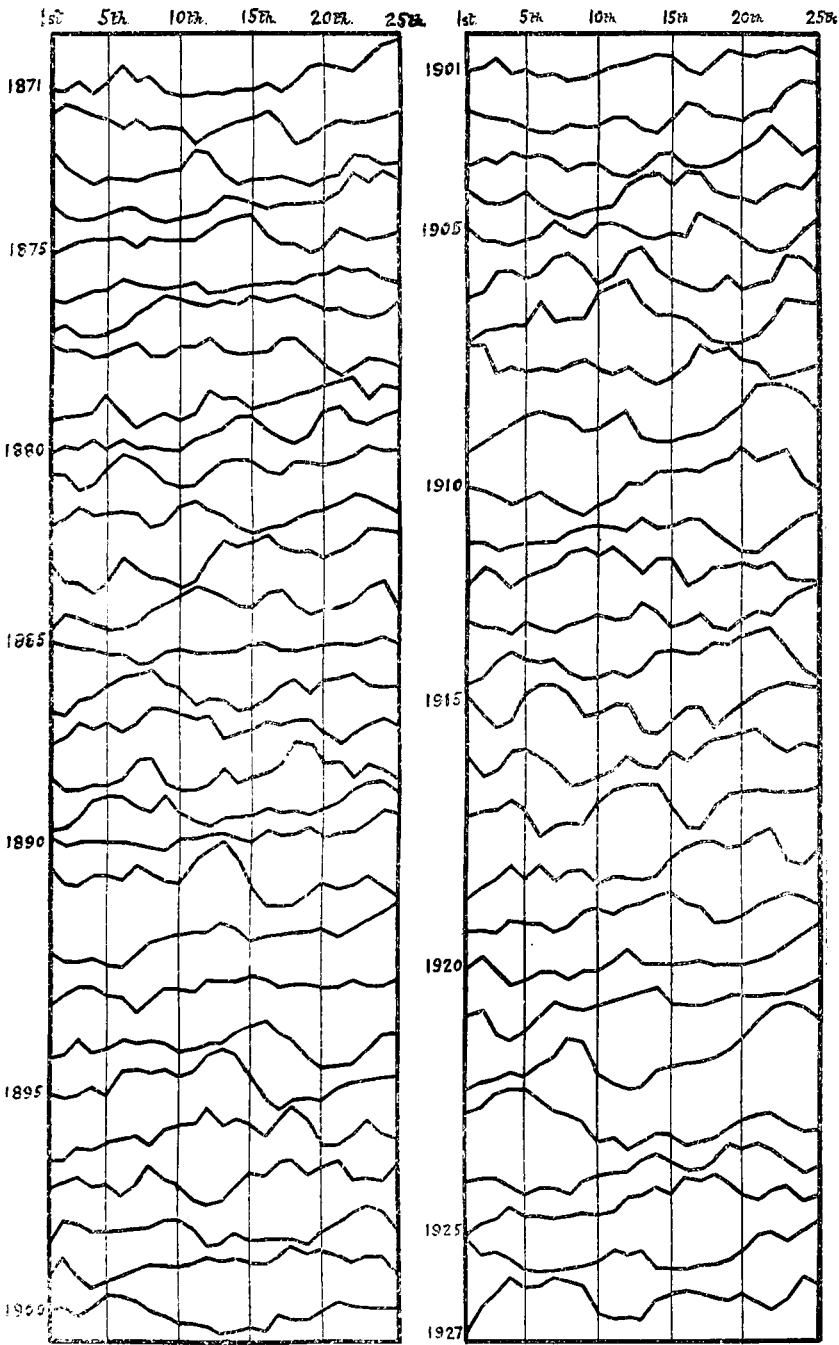
The diagram shows that there is a rather wide range in the time of occurrence—the middle date of the spell may be as early as the 7th and as late as the 22nd, so that the reason why the feature is almost eliminated from the curve of mean daily temperature is obvious. In 1890, one of the years in which the spell does not show definitely in the diagram, a cold period occurred later, centering at the 27th, when the mean temperature was 11.6°F. below that of the 25th. This, however, was very late. Some low temperatures have been experienced at times during the period used in the diagram; in 1877 the minimum on the 5th was as low as 30.0° F.

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\* Vol. 57, 1922, p. 177.

# KEW DAILY MEAN TEMPERATURE

MAY 1<sup>st</sup> - 25<sup>th</sup>. 1871-1927.



The frequency with which the lowest daily mean of the period May 5th-20th occurred at Kew on each of those days is shown in the following table:—

Date	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Frequency of occurrence of lowest mean }	6	3	7	4	3	4	2	7	3	5	1	1	2	1	3	5
Smoothed values }		5	5	4.5	3.5	3	4	5	4.5	3.5	2	1	1.5	2	3	

It is readily calculated that if the distribution were perfectly random the odds against the occurrence of seven minima on any particular day would be 24 to 1; as there are sixteen days in the period the odds in favour of at least one day with seven occurrences are about 2 to 1. Hence the table provides no evidence of any real tendency for a cold spell to occur about May 12th.

In other parts of Europe Ion St. Murat and Gregor Friesenhof have pointed out that other cold periods occur in May, but both agree as to the existence of the Ice Saints' spell—the former giving the date as May 10th-12th for Roumania, and the latter as May 12th-15th for Hungary. It may be considered that two or more cold periods have occurred occasionally at Kew, as in 1872, 1906 and 1917. Buchan in an examination of the temperature records of Scotland, found\* that the interruptions which occur in that country include one for the period May 9th-14th.

The bibliography of the subject of abnormalities in the mean daily temperature curve is extensive, and the majority of the publications refer to the cold spell in May. It is interesting to note that the occurrence has been attributed to such diverse causes as the melting of ice in circumpolar latitudes (Fitzroy), the evaporation from newly expanded foliage (Ney), and the cutting off of a certain amount of solar radiation from the earth by meteor showers (Erman).

L. H. POWERS.

### Bulletin de l'Observatoire de Talence

After an interval of fifteen years the publication of the *Bulletin de l'Observatoire de Talence (Gironde)* has been recommenced by M. Henri Mémery, the director of the Talence Observatory, the first number of the new series being issued on January 15th, 1928. The main activities of the Observatory are concerned with the relationship between solar physics and meteorology, and the bulletin is to be devoted to "Etudes des questions relatives à l'action présumée des phénomènes solaires

\* BUCHAN, A. *Handy Book of Meteorology*. 2nd Ed. p. 141.

en météorologie." Thus the aim of the new bulletin is to be the same as that of the old one. The first number contains an article on "Les causes des phénomènes météorologiques sont-elles terrestres ou solaires?", a summary of the sun spots observed at Talence between 1923 and 1927, and an appeal to Observatories which publish daily observations to send these to Talence in order that a daily comparison may be made with the variations of solar phenomena.

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### The Retirement of Prof. C. Dorno

On April 1st Prof. C. Dorno retired from all active association with the Physical Meteorological Observatory at Davos. Prof. Dorno founded this important observatory in 1907, and from then until October, 1926, he was solely responsible for its work. For the first fifteen years he maintained it at his own private expense, but from 1922 the Swiss Research Institute at Davos has supported it. In October, 1926, Dr. Lindholm, formerly the principal State Meteorologist of Sweden, was released by his Government specially to work with Prof. Dorno in order to get a thorough insight and grasp of the working of the observatory, and now on the retirement of Prof. Dorno he has been appointed the new Director.

During the twenty years of the existence of the Observatory, Prof. Dorno established relations with meteorologists all over the world and maintained close contact with several foreign institutions, especially, in his work on radiation, with the Weather Bureau of the United States, and in his work on "medical meteorology," or, as he afterwards preferred to call it, "physiological meteorology," with Prof. Leonard Hill, of the National Institute of Medical Research at Hampstead, who often quotes Prof. Dorno in *Sunshine and Open Air* and other works.

Among Prof. Dorno's chief papers may be mentioned *Medical Climatology and High Altitude Climate*; *Klimatologie im Dienste der Medizin*; *Grundzüge des Klimas von Muottas-Muraigh*; *Progress in Radiation Measurements*. The holding of the International Climatological Congress at Davos in 1925 was really a personal triumph for Prof. Dorno. We wish him many years of health and happiness in his retirement.

### Reviews

*Über die Staubtrübung der Atmosphäre 1909 bis 1926.* By F. Lindholm. Reprinted from Gerlands Beiträge zur Geophysik, Leipzig 18, 1927, pp. 127-144.

Since 1908 Prof. Dorno has maintained at the Davos Observatory an almost unbroken record of the intensity of solar

radiation, and since 1921 these measurements have been autographic. Taking the monthly means of the measurements on clear days the author has calculated the loss due to scattering in moist dust-free air and that due to selective absorption, and thus arrived at the loss caused by dust and condensation-nuclei. The years 1912 and 1913 were omitted because of the eruption of Katmai. The individual monthly means of this loss are given, with the average diurnal and annual variations. Within the limits of the measurements (sun's altitude  $15^{\circ}$  or more) there is no appreciable variation of the loss with the height of the sun, but there is, a well-marked annual variation with a maximum in March to July. There is a clear correlation between the transparency of the air and the number of rain-days. The author also seeks for a relation with sunspot relative numbers, and finds an indication that the transparency is greatest at sunspot minimum, but the correlation coefficients are scarcely high or systematic enough to amount to proof.

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*The Climates of the Continents.* By W. G. Kendrew, M.A.  
2nd edition. Size  $9 \times 5\frac{1}{2}$ , pp. xvi + 400. *Illus.* Oxford.  
At the Clarendon Press, 1927. £1 1s. net.

For many years meteorologists in this country and in America were reproached with the absence of any adequate handbook of world climatology in the English language. The first volume of J. von Hann's monumental *Handbuch* had been translated into English by Professor R. de C. Ward, who had also written a delightful companion volume entitled *Climates Considered Especially in Relation to Man*, but these works dealt only with the general principles of the science, and hardly at all with the local details. It was a matter almost for tears that the one man who could have vied with Hann in the production of a text-book of climatology, Alexander Buchan, contented himself with a pictorial presentation of the subject, and though Part V of Volume II of the *Report on the Scientific Results of the Voyage of H.M.S. Challenger*, and Volume III of *Bartholomew's Physical Atlas* are unrivalled to this day as climatological atlases, it is not everyone who can read a map. Even prior to 1914 this gap in English meteorological literature was sufficiently notable, but the war, with its widening of all geographical interests and especially the great impetus which it gave to the study of all branches of meteorology, rendered the provision of an English text-book of climatology imperative. That is the genesis of Mr. W. G. Kendrew's *Climates of the Continents*, the first edition of which was published in 1922. The opening sentence in the Preface reads: "This book aims at filling a gap in the sources available for the study of the geography of the Earth." That the book attained its object is shown by the fact that a second edition has now been called for.

The reasons are not far to seek: the exposition is very clear, and is helped by a wealth of illustration (there are no fewer than 153 maps and diagrams) and the arrangement is simple. The Oxford Clarendon Press have also played their part by providing good paper, clearly legible type and a neat binding. The arrangement, as the title suggests, is by continents, the definition of a continent being extended to include New Zealand. One wishes that Mr. Kendrew had chosen a slightly longer title—The Climates of the Continents and Islands—but he must have found sufficiently arduous the collection of the great amount of material which he has already compiled. The collection of data has evidently been made with care, the works of J. von Hann being the chief standby, but in the first edition the author appeared to have missed a number of papers in our own *Quarterly Journal*, including Col. Sir Henry Lyons' important contributions to the climatology of Africa in Vol. XLII, p. 65, and Vol. XLIII, p. 116 and p. 175. In the second edition references to a number of recent papers have been added to the bibliography, but the reviewer cannot find corresponding changes in the text, except that the tale of the continents has now been completed by the addition of a very useful and interesting chapter on Antarctica.

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### News in Brief

We are informed that Dr. Gorczynski has retired from the Directorship of the Polish Meteorological Institute. He is succeeded by Dr. G. R. Dobrowolski.

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Mr. L. S. Woodhead, of Barcombe, near Lewes, reports that on April 27th he saw what appeared to be a small waterspout in the sky at 7.50 p.m. G.M.T. A conical-shaped protuberance appeared from the middle of a cloud and reached about a quarter of the way to earth, when it suddenly broke up and disappeared. The actual time from its first appearance until it broke up was about 10 minutes. The weather was very thundery at the time and a heavy shower had just fallen.

### The Weather of April, 1928

The weather of April was variable, with two periods of warm, sunny conditions separated by a cold wintry spell with snow in most places. During the first two or three days the weather was cold and unsettled, with rain at times, but considerable bright intervals; 1.00 in. fell at Ford on the 2nd, and minimum temperatures in the screen were mostly below 30° F. After the 4th the winds backed gradually from NW or W to S, and the air was drawn from the western Mediterranean. There was a gradual

rise in temperature over the whole kingdom, culminating on the 9th and 10th, when the maxima were above 65° F. in many places, and reached 68° F. at Tottenham on the 9th and Greenwich on the 10th. The night of the 9th-10th, too, was exceptionally warm, temperature not falling below 50° F. at several stations, while the minimum, 55° F., at Kew Observatory, constituted a record there for April. During this period bright sunshine was experienced on several days, the 4th, 6th, 8th and 11th being the sunniest; 11·9 hrs. were recorded at Portsmouth on the 8th and at Clacton on the 11th. Thunderstorms occurred locally from the 10th-12th. After the 10th temperature fell decidedly, as the winds backed first to east and then to north. Strong winds and heavy rain in the south on the 14th were associated with a secondary depression over the English Channel, 2·62 in. of rain fell at Glanmire (Cork), 2·52 in. at Roches Point (Cork), and 2·05 in. in the Scilly Isles. By the 15th the rain had turned to sleet and snow, and from then until the 21st snow, sleet and hail showers occurred in all parts of the kingdom. On the 14th, 15th and 16th at some places temperature did not rise above 40° F., and at Lympne the maximum was 37° F. on the 16th. The lowest temperatures for the month were, in the screen, 22° F. at Ford on the 16th, and on the grass, 13° F. at Rhayader on the 17th, 18th and 20th, and at Huddersfield on the 18th. On the 22nd the winds changed to south-west, and the second period of warm weather lasted from then to the end of the month, reaching its highest point on the 26th, when the temperature exceeded 70° F. even as far north as Dumfries, and reached 75° F. at Southport and Cranwell and 74° F. at Kew, Manchester and Hoylake. Strong winds and gales with much rain occurred at times from the 24th to 26th in the west, 1·50 in. being measured at Nenagh (Tipperary) on the 26th. During the last two days the weather became cloudy or overcast generally, with slight rain locally. The 19th, 24th and 28th were the sunniest days in the month, when between 12 and 13·5 hrs. bright sunshine were registered in many parts, *e.g.*, 13·4 hrs. at Margate on the 28th. The total sunshine for the month was below normal in most places, the total of 120 hrs. at Aberdeen being 38 hrs. below normal, that of 155 hrs. at Falmouth being 29 hrs. below normal, while Valentia, Kew and Dublin were 28 hrs., 26 hrs. and 22 hrs. below normal respectively. Stornaway and Birr Castle (King's Co.) had 3 hrs. in excess of the normal.

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Pressure was below normal generally over western Europe and the North Atlantic, the greatest deficit being 9·6 mb. at Roches Point. Pressure was above normal over northern Scandinavia, Newfoundland and Bermuda, the greatest excess being 2·9 mb. at Bermuda. Temperature was above normal in northern



Europe, but below normal in Spain. The rainfall distribution was variable. At Spitsbergen the total was 2 in. above normal, in Svealand and western Gothaland only half the normal, and in Kalmar and Gotland above normal.

Snow fell heavily in Switzerland down to 3,000 ft. on the 2nd, interrupting telephone and road communications, and a violent hailstorm occurred in eastern Switzerland on the 11th. Holy week in Spain was so wet that most of the great processions had to be abandoned. There was a cold spell over central Europe on the 17th and 18th. This was accompanied by heavy rain and wind over France, and by snowstorms in Switzerland and Poland. A thunderstorm with heavy rain and hail passed over Paris on the morning of the 29th, and in the evening severe thunderstorms occurred in western Germany doing much material damage.

Four people and 50 cattle were killed as the result of a heavy hailstorm on the 5th in Torsappar Hills, near Peshawar.

Heavy floods throughout the coastal belt of south-eastern Queensland about the 24th caused much damage to the towns in that district.

On the 6th, while New York and the Eastern States were experiencing unseasonably hot weather with a temperature rising towards 80°, heavy snow fell in the Central States interrupting communications in parts of Nebraska and Iowa. Large areas of Arkansas were repeatedly flooded between the 4th and 8th. Floods also occurred in Kansas, Oklahoma and Texas. At the end of the month storms and floods caused the loss of a dozen lives and did considerable damage in the Central and Eastern States. Heavy snow fell in Pennsylvania on the 28th, and also as far south as Maryland, Virginia and North Carolina. Three people were killed in a gale which raged along the New Jersey and Delaware coasts on the 27th and 28th. Serious floods occurred in many parts of Ontario and Quebec about the 9th. The mean temperature for the month was below normal over most of the United States. This cold weather with frequent frosts was very injurious to the crops.

The special message from Brazil states that the rainfall was scarce in the northern and central districts being 2·80 in. and 2·20 in. below normal respectively, but that it was plentiful in the south where the total was 2·64 in. above normal. Seven anticyclones passed across the country and the weather was variable in the south. The cotton, cocoa and coffee crops were generally in good condition. At Rio de Janeiro pressure was 0·5 mb. below normal and temperature 2·3° F. below normal.

### Rainfall, April 1928—General Distribution

England and Wales	...	81	} per cent. of the average 1881-1915.
Scotland	...	72	
Ireland	...	102	
British Isles	...	83	

**Rainfall: April, 1928: England and Wales**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond</i>	Camden Square .....	1'32	86	<i>Leics</i>	Thornton Reservoir ...	1'36	80
<i>Sur</i>	Reigate, The Knowle...	1'82	117	"	Belvoir Castle.....	'58	38
<i>Kent</i>	Tenterden, Ashenden...	2'73	169	<i>Rut</i>	Ridlington .....	'91	...
"	Folkestone, Boro. San.	3'18	...	<i>Linc</i>	Boston, Skirbeck .....	1'15	85
"	Margate, Cliftonville...	1'57	116	"	Lincoln, Sessions House	'67	48
"	Sevenoaks, Speldhurst	2'15	...	"	Skegness, Marine Gdns	1'13	84
<i>Sus</i>	Patching Farm .....	2'76	158	"	Louth, Westgate .....	1'26	75
"	Brighton, Old Steyne	3'77	233	"	Brigg, Wrawby St.	1'00	...
"	Tottingworth Park ...	2'73	148	<i>Notts</i>	Worksop, Hodsock ...	'79	54
<i>Hants</i>	Ventnor, Roy. Nat. Hos.	2'33	139	<i>Derby</i>	Derby .....	1'19	73
"	Fordingbridge, Oaklands	1'81	99	"	Buxton, Devon Hos....	1'34	46
"	Ovington Rectory .....	2'04	108	<i>Ches</i>	Runcorn, Western Pt.	'84	49
"	Sherborne St. John .....	1'72	97	"	Nantwich, Dorfold Hall	1'51	...
<i>Berks</i>	Wellington College ...	1'54	96	<i>Lancs</i>	Manchester, Whit. Pk.	'85	44
"	Newbury, Greenham...	2'01	110	"	Stonyhurst College ...	1'33	49
<i>Herts</i>	Benington House .....	1'35	88	"	Southport, Hesketh Pk	1'39	75
<i>Bucks</i>	High Wycombe .....	1'50	96	"	Lancaster, Strathspey	1'64	...
<i>Oxf</i>	Oxford, Mag. College	'98	64	<i>Yorks</i>	Wath-upon-Dearne ...	'94	60
<i>Nor</i>	Pitsford, Sedgebrook...	1'97	129	"	Bradford, Lister Pk....	1'05	52
"	Oundle .....	'94	...	"	Oughtershaw Hall.....	1'68	...
<i>Beds</i>	Woburn, Crawley Mill	1'11	74	"	Wetherby, Ribston H.	'78	44
<i>Cam</i>	Cambridge, Bot. Gdns.	'65	48	"	Hull, Pearson Park ...	'92	59
<i>Essex</i>	Chelmsford, County Lab	'81	63	"	Holme-on-Spalding ...	1'02	...
"	Lexden, Hill House ...	'92	...	"	West Witton, Ivy Ho.	'71	...
<i>Suff</i>	Hawkedon Rectory .....	1'48	96	"	Felixkirk, Mt. St. John	'90	54
"	Haughley House .....	1'05	...	"	Pickering, Hungate ...	1'22	...
<i>Norw</i>	Beccles, Geldeston .....	1'23	84	"	Scarborough .....	1'78	114
"	Norwich, Eaton.....	1'50	88	"	Middlesbrough .....	'78	57
"	Blakeney .....	1'49	116	"	Baldersdale, Hury Res.	'94	...
"	Little Dunham .....	...	...	<i>Durh</i>	Ushaw College .....	'71	40
<i>Wills</i>	Devizes, Highclere.....	1'15	61	<i>Nor</i>	Newcastle, Town Moor	'93	57
"	Bishops Cannings .....	1'75	87	"	Bellingham, Highgreen	'93	...
<i>Dor</i>	Evershot, Melbury Ho.	1'88	80	"	Lilburn Tower Gdns....	1'43	...
"	Creech Grange .....	1'93	...	<i>Cumb</i>	Geltsdale .....	'60	...
"	Shaftesbury, Abbey Ho.	1'43	67	"	Carlisle, Scaleby Hall	'95	49
<i>Devon</i>	Plymouth, The Hoe ...	1'46	64	"	Borrowdale, Rosthwaite	4'69	...
"	Polapit Tamar .....	2'21	94	"	Keswick, High Hill ...	1'65	...
"	Ashburton, Druid Ho.	3'41	112	<i>Glam</i>	Cardiff, Ely P. Stn. ...	1'53	61
"	Cullompton .....	1'28	56	"	Treherbert, Tynywaun	2'60	...
"	Sidmouth, Sidmouth...	1'49	70	<i>Carm</i>	Cardmarthen Friary ...	1'67	61
"	Filleigh, Castle Hill ...	1'74	...	"	Llanwrda, Dolaucothy	2'30	70
"	Barnstaple, N. Dev. Ath.	1'63	77	<i>Pemb</i>	Haverfordwest, School	1'43	55
<i>Corn</i>	Redruth, Trewirgie ...	3'23	112	<i>Card</i>	Gogerddan .....	...	...
"	Penzance, Morrab Gdn.	2'57	106	"	Cardigan, County Sch.	1'01	...
"	St. Austell, Trevarna...	2'18	77	<i>Brec</i>	Crickhowell, Talymaes	1'40	...
<i>Soms</i>	Chewton Mendip .....	1'88	63	<i>Rad</i>	Birm W. W. Tyrmynydd	2'44	66
"	Street, Hind Hayes ...	...	...	<i>Mont</i>	Lake Vyrnwy .....	2'67	89
<i>Glos</i>	Clifton College .....	...	...	<i>Denb</i>	Llangynhafal .....	1'22	...
"	Cirencester, Gwynfa ...	1'44	77	<i>Mer</i>	Dolgelly, Bryntirion...	2'96	81
<i>Here</i>	Ross, Birchlea .....	1'08	57	<i>Carn</i>	Llandudno .....	'85	47
"	Ledbury, Underdown ...	1'23	68	"	Snowdon, L. Llydaw 9	5'21	...
<i>Salop</i>	Church Stretton .....	1'92	89	<i>Ang</i>	Holyhead, Salt Island	'80	38
"	Shifnal, Hatton Grange	1'40	83	"	Lligwy .....	'83	...
<i>Worc</i>	Ombersley, Holt Lock	1'18	78	<i>Isle of Man</i>			
"	Blockley, Upton Wold	1'03	53	"	Douglas, Boro' Cem....	1'66	68
<i>War</i>	Farnborough .....	1'65	84	<i>Guernsey</i>			
"	Birmingham, Edgbaston	1'48	85	"	St. Peter P't. Grange Rd.	2'85	142

Erratum for March, Cambridge for 136 read 74 per cent.

## Rainfall: April, 1923: Scotland and Ireland

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt</i>	Stoneykirk, Ardwell Ho	2.38	118	<i>Suth</i>	Loch More, Achfary	3.00	62
"	Pt. William, Monreith	1.85	...	<i>Caith</i>	Wick	1.60	80
<i>Kirk</i>	Carsphairn, Shiel	2.89	...	<i>Ork</i>	Pomona, Deerness	1.61	78
"	Dumfries, Cargen	1.91	72	<i>Shet</i>	Lerwick	1.58	69
<i>Dumf.</i>	Eskdalemuir Obs.	1.78	52	<i>Cork</i>	Caheragh Rectory	5.02	...
<i>Roab</i>	Branxholm	1.08	57	"	Dunmanway Rectory	5.82	140
<i>Selk</i>	Ettrick Manse	1.57	...	"	Ballinacurra	6.05	234
<i>Peeb</i>	West Linton	1.03	...	"	Glanmire, Lota Lo.	5.85	209
<i>Berk</i>	Marchmont House	1.45	72	<i>Kerry</i>	Valentia Obsy.	5.00	136
<i>Hadd</i>	North Berwick Res.	.64	46	"	Gearahameen	8.90	...
<i>Midl</i>	Edinburgh, Roy. Obs.	.56	41	"	Killarney Asylum	5.16	156
<i>Ayr</i>	Kilmarnock, Agric. C.	1.28	62	"	Darrynane Abbey	4.89	142
"	Girvan, Pinmore	2.09	70	<i>Wat</i>	Waterford, Brook Lo.	2.74	108
<i>Renf</i>	Glasgow, Queen's Pk.	1.06	54	<i>Tip</i>	Nenagh, Cas. Lough	2.71	108
"	Greenock, Prospect H.	3.46	95	"	Roscrea, Timoney Park	1.70	...
<i>Bute</i>	Rothsay, Ardenraig	2.63	88	"	Cashel, Ballinamona	2.85	114
"	Dougarie Lodge	2.36	...	<i>Lim</i>	Foynes, Coolanans	3.77	154
<i>Arg</i>	Ardgour House	4.86	...	"	Castleconnel Rec.	2.71	...
"	Manse of Glenorchy	3.74	...	<i>Clare</i>	Inagh, Mount Callan	4.90	...
"	Oban	2.95	...	"	Broadford, Hurdlest'n	2.85	...
"	Poltalloch	3.32	110	<i>Wexf</i>	Newtownbarry	2.90	...
"	Inveraray Castle	3.44	75	"	Gorey, Courtown Ho	2.44	111
"	Islay, Eallabus	2.62	91	<i>Kilk</i>	Kilkenny Castle	2.11	97
"	Mull, Benmore	8.70	...	<i>Wic</i>	Rathnew, Clonmannon	2.00	...
"	Tiree	2.15	...	<i>Carl</i>	Hacketstown Rectory	3.08	116
<i>Kinr</i>	Loch Leven Sluice	.78	41	<i>QCo</i>	Blandsfort House	2.03	78
<i>Perth</i>	Loch Dhu	5.15	109	"	Mountmellick	1.94	...
"	Balquhiddie, Stronvar	2.82	...	<i>KCo</i>	Birr Castle	1.84	86
"	Crieff, Strathearn Hyd.	1.58	72	<i>Dubl</i>	Dublin, FitzWm. Sq.	1.25	66
"	Blair Castle Gardens	.85	40	"	Balbriggan, Ardgillan	1.39	70
<i>Forf</i>	Kettins School	1.18	71	<i>Me th</i>	Beaupare, St. Cloud	1.33	...
"	Dundee, E. Necropolis	1.01	59	"	Kells, Headfort	1.70	68
"	Pearsie House	1.43	...	<i>W.M</i>	Moate, Coolatore	1.55	...
"	Montrose, Sunnyside	...	...	"	Mullingar, Belvedere	1.41	59
<i>Aber</i>	Braemar, Bank	.59	25	<i>Long</i>	Castle Forbes Gdns.	1.54	64
"	Logie Coldstone Sch.	1.23	61	<i>Gal</i>	Ballynahinch Castle	4.23	119
"	Aberdeen, King's Coll.	2.57	137	"	Galway, Grammar Sch.	2.36	...
"	Fyvie Castle	2.47	...	<i>Mayo</i>	Mallaranny	3.01	...
<i>Mor</i>	Gordon Castle	.81	46	"	Westport House	2.75	102
"	Grantown-on-Spey	1.20	61	"	Delphi Lodge	5.75	...
<i>Na</i>	Nairn, Delnies	.88	59	<i>Sligo</i>	Markree Obsy.	1.78	67
<i>Inv</i>	Ben Alder Lodge	...	...	<i>Cav'n</i>	Belturbet, Cloverhill	2.71	92
"	Kingussie, The Birches	1.07	...	<i>Ferm</i>	Enniskillen, Portora	2.47	...
"	Loch Quoich, Loan	5.20	...	<i>Arm</i>	Armagh Obsy.	1.78	85
"	Glenquoich	5.35	82	<i>Down</i>	Fofanny Reservoir	5.21	...
"	Inverness, Culduthel R.	.96	...	"	Seaforde	2.25	86
"	Arisaig, Faire-na-Squir	...	...	"	Donaghadee, C. Stn	1.96	98
"	Fort William	4.19	94	"	Banbridge, Milltown	1.05	51
"	Skye, Dunvegan	3.21	...	<i>Antr</i>	Belfast, Cavehill Rd	1.67	...
<i>R &amp; C.</i>	Alness, Ardross Cas.	1.64	68	"	Glenarm Castle	2.27	...
"	Ullapool	2.12	...	"	Ballymena, Harryville	2.31	87
"	Torridon, Bendamph	4.61	88	<i>Lon</i>	Londonderry, Creggan	1.71	67
"	Achnashellach	3.46	...	<i>Tyr</i>	Donaghmore	1.85	...
"	Stornoway	2.44	81	"	Omagh, Edenfel	2.27	86
<i>Suth</i>	Lairg	1.30	...	<i>Don</i>	Malin Head	1.32	67
"	Tongue	1.81	69	"	Dunfanaghy	2.25	...
"	Melvich	1.38	59	"	Killybegs, Rockmount	1.39	39

## Climatological Table for the British Empire, November, 1927

STATIONS	PRESSURE			TEMPERATURE						Relative Humidity	Mean Cloud Amt	PRECIPITATION			BRIGHT SUNSHINE		
	Mean of Day M.S.L.	Diff. from Normal	mb.	Absolute		Mean Values						Am't from Normal	Diff. from Normal	Days	Hours per day	Per-cent- age of possi- ble	
				Max.	Min.	Max.	Min.	1/2 and 3/4 min.	Diff. from Normal								Wet Bulb
London, Kew Obsy. . . . .	1014.8	+ 0.2	62	28	48.4	39.0	43.7	- 0.3	40.1	91	7.8	2.69	0.47	13	1.4	16	
Gibraltar. . . . .	1015.5	- 2.5	75	43	65.5	53.5	59.5	- 1.0	52.9	81	5.7	6.52	0.13	9	..	..	
Malta. . . . .	1018.2	+ 1.7	75	53	69.5	62.3	65.9	+ 2.0	62.9	88	5.8	3.31	0.26	8	6.1	60	
St. Helena. . . . .	1013.1	+ 1.8	66	55	63.6	56.0	59.8	- 0.3	56.6	94	9.5	0.60	1.08	8	..	..	
Sierra Leone. . . . .	1011.2	+ 0.3	90	70	86.9	73.4	80.1	- 1.1	76.5	82	6.4	4.48	0.64	12	..	..	
Lagos, Nigeria. . . . .	1009.9	- 0.9	91	72	88.1	76.8	82.5	+ 1.1	77.7	82	5.2	2.38	0.20	5	..	..	
Kaduna, Nigeria. . . . .	1014.5	+ 3.2	94	60	90.6	67.6	79.1	+ 2.9	69.2	62	1.0	0.00	0.12	0	..	..	
Zomba, Nyasaland. . . . .	1009.7	+ 0.8	94	53	87.7	63.3	75.5	- 0.1	..	80	6.1	2.02	3.06	8	..	..	
Salisbury, Rhodesia. . . . .	1010.8	+ 0.4	91	48	80.7	57.6	69.1	- 1.6	61.8	59	4.9	3.71	0.01	12	8.0	62	
Cape Town. . . . .	1014.8	- 1.0	101	48	77.6	58.4	68.0	+ 3.6	60.7	72	4.7	1.52	0.44	7	..	..	
Johannesburg. . . . .	1012.9	+ 1.3	87	44	78.6	54.1	66.3	+ 2.8	56.1	57	2.2	1.85	3.11	7	9.4	71	
Mauritius. . . . .	1016.3	+ 0.2	88	64	81.9	68.4	75.1	- 0.4	70.5	65	5.9	0.74	0.84	15	8.3	64	
Bloemfontein. . . . .	1013.8	+ 0.5	94	40	84.5	56.2	70.3	+ 1.9	58.5	55	4.0	0.93	1.34	2	..	..	
Calcutta, Alipore Obsy. . . . .	1011.5	+ 0.5	90	58	83.9	65.2	74.5	+ 1.4	65.7	82	1.3	0.23	0.43	1*	..	..	
Bombay. . . . .	1011.5	- 0.2	88	65	84.3	72.0	78.1	- 2.4	68.5	76	2.6	5.48	5.03	3*	..	..	
Madras. . . . .	1011.5	+ 0.2	88	62	84.5	72.2	78.3	- 0.6	72.4	79	6.1	15.22	0.97	13*	..	..	
Colombo, Ceylon. . . . .	1011.1	+ 1.0	89	71	86.4	73.8	80.1	+ 0.4	75.9	75	7.1	7.43	4.36	15	6.3	53	
Hongkong. . . . .	1016.7	- 0.9	82	59	75.9	67.1	71.5	+ 1.9	63.8	63	3.6	1.83	0.16	6	7.7	70	
Sandakan. . . . .	1015.3	+ 1.6	90	73	88.2	74.9	81.5	+ 0.7	77.4	87	..	15.65	0.99	19	..	..	
Sydney. . . . .	1015.3	+ 1.6	83	53	72.0	59.9	65.9	- 1.2	62.2	70	6.4	6.06	3.25	11	6.6	47	
Melbourne. . . . .	1015.5	+ 1.3	102	46	75.2	54.3	64.7	+ 3.4	57.6	55	5.6	1.19	1.03	8	7.5	54	
Adelaide. . . . .	1015.6	+ 0.5	103	48	82.9	57.3	70.1	+ 3.2	58.1	35	5.0	1.47	0.31	4	9.8	71	
Perth, W. Australia. . . . .	1015.9	+ 0.6	94	49	77.0	57.3	67.1	+ 1.1	60.3	55	4.1	0.43	0.36	6	10.3	75	
Coalgardie. . . . .	1013.7	+ 0.6	105	43	88.3	57.5	72.9	+ 2.1	60.0	47	2.6	0.18	0.50	3	..	..	
Brisbane. . . . .	1014.7	+ 0.2	87	59	80.6	64.9	72.7	- 0.9	66.9	67	6.5	5.82	2.16	15	7.8	58	
Hobart, Tasmania. . . . .	1014.4	+ 5.0	84	40	66.6	48.0	57.3	+ 0.1	51.1	55	6.6	1.31	1.21	14	8.5	59	
Wellington, N.Z. . . . .	1011.6	- 0.5	66	38	61.1	48.7	54.9	- 2.0	51.7	71	7.0	5.72	2.20	19	5.1	35	
Suva, Fiji. . . . .	1009.6	- 1.5	88	68	83.5	73.1	78.3	+ 1.1	74.4	81	7.2	15.38	5.87	29	4.9	38	
Apia, Samoa. . . . .	1008.4	- 1.1	89	74	85.5	75.5	80.5	+ 1.8	78.0	78	5.8	13.22	3.93	20	6.1	48	
Kingston, Jamaica. . . . .	1011.7	- 0.7	91	69	86.5	71.6	79.1	- 0.2	70.6	89	5.6	2.85	0.18	5	7.3	65	
Grenada, W.I. . . . .	1006.8	- 3.5	91	73	86.3	75.7	81.0	+ 1.7	76.7	78	4.8	12.25	3.86	17	..	..	
Toronto. . . . .	1017.0	+ 0.2	69	22	47.7	34.2	40.9	+ 4.6	38.1	85	8.8	4.37	1.42	22	2.1	22	
Winnipeg. . . . .	1019.2	+ 2.5	48	- 10	23.0	11.5	17.3	- 3.5	..	..	7.0	0.95	0.01	9	3.5	38	
St. John, N.B. . . . .	1017.6	+ 3.7	63	19	45.9	33.4	39.7	+ 3.0	36.8	79	6.4	4.07	0.34	15	2.6	27	
Victoria, B.C. . . . .	1014.1	- 1.4	58	35	47.7	40.5	44.1	- 0.3	42.2	86	8.4	5.98	0.48	26	2.0	22	

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

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## The British Airship Mission, 1927

It is probably unique in the records of the British Meteorological Office that an opportunity should arise for the deputation of one of its members as a delegate on an Imperial Mission. Such an opportunity was furnished, however, when in May, 1927, the Airship Mission set sail for a tour of the Dominions for the purpose of advising as to the siting of Airship bases and laying down Airship routes as an outcome of the Imperial Conference which met in London in the autumn of 1926. The members of the mission were Group Captain P. F. M. Fellowes, D.S.O., A.D.C., R.A.F. (Director of Airship Development), Mr. M. A. Giblett (Superintendent, Airship Services Division, Meteorological Office), and Flight Lieutenant S. Nixon, O.B.E., R.A.F., of the Royal Airship Works.

As it was impossible in the space of time available for the single mission to cover the whole extent of the Empire on the routes which it is visualised that airships will eventually cover, if regular transport services are established, a second mission consisting of Major G. H. Scott, C.B.E., of the Royal Airship Works, and Mr. A. R. Gibbs, of the Works and Buildings Department of the Air Ministry, visited Canada, and working in close liaison with the Meteorological Offices in London and Toronto, supplied that Dominion with an outline of the essential meteorological requirements. In order further to lighten the onerous work of the main mission, Flight Lieutenant Nixon anticipated their departure and visited the British Colonies on the east and west coasts of Africa and in a similar manner took account of meteorological factors in his recommendations as to possible sites for intermediate bases.

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The original itinerary of the main mission included primarily South Africa and Australia, but on the urgent request of the New Zealand Government it was extended to embrace that dominion. St. Helena and Ceylon were also visited. Thus during the year a meteorological survey from the airship standpoint was made of almost the entire Empire.

The main results of the missions, as given in an article published in the *Times* of January 7th, may be summarised as follows:—

A skeleton has now been prepared of main and intermediate bases on what are likely to be the chief commercial airship routes of the future.

Each Dominion has now had placed at its disposal a full statement of the prime necessities for the operation of these routes.

A choice of sites for bases has been tabulated in Canada, South Africa, Australia (including Tasmania), New Zealand, Ceylon and India, and certain intermediate bases have been prospected on the east and west coasts of Africa and in the Cocos Islands.

The existing meteorological information required along the proposed routes has been added to where possible during the survey, and the Dominion authorities have been made acquainted in detail and by personal discussion with the essential weather and wireless services needed before airships can hope to operate on long-distance routes.

At each point visited it was found that there was a vivid interest in the prospect of Airship communications, especially among the business communities, and it is increasingly being realised how important to such communications are the meteorological factors. It is understood that practically throughout the Empire an early commencement of meteorological work to meet the special requirements outlined by the missions is to be made. In Australia the members of the mission, at the request of Mr. Bruce, made numerous public statements to chambers of commerce and other bodies on the present position of airships and the prime necessities for their efficient operation as regards ground organisation. In New Zealand the interest was such that the Premier convened a joint session of the Houses of Parliament, and Group Captain Fellowes addressed the assembly for nearly an hour. For another hour Mr. Giblett and Flight Lieutenant Nixon answered questions on various aspects of the problem, and at the request of the Premier the former gave a short address on the meteorological problems involved.

During the course of the tour the opportunity of gaining first-hand knowledge by both aeroplane and motor car of the topographical features in the vicinity of prospective bases was invaluable to the meteorological member of the mission, as it enabled him to form an opinion of the meteorological effect of such features that no written records could convey.

In addition to the more tangible results of this mission, it is not to be overlooked that it has established a most important liaison between the British Meteorological Office and those engaged in the practice of meteorology throughout the Empire, a liaison which, as aviation spreads across the face of the globe, cannot fail to grow closer.

During the return journey the opportunity was taken of visiting India and Egypt, where the organisation for the England-Egypt-India route already initiated was reviewed and the discussion of details carried a stage further. In this, assistance was rendered by the presence in Egypt of the Superintendent, Meteorological Office, Malta, and the Meteorological Officer, Iraq, so that they were able to be consulted as well as the Meteorological authorities in Egypt.

The mission returned to England in December, 1927, having spent seven months on its Empire Survey.

## **The Effects of Height and Situation on Screen Temperatures**

Meteorologists are generally familiar with the difficulty of securing observations of air temperature which shall be properly representative of the locality in which they are taken and comparable with observations from other places and countries. Accurate instruments are now readily obtained and the Stevenson screen has been proved reasonably satisfactory for screening the thermometers from radiation both solar and terrestrial. The remaining condition necessary for comparable temperatures is standardisation of the site in which the screen is placed. This is secured with sufficient accuracy for practical purposes if a plot of ground covered by turf for an area of about 20 feet by 30 feet is provided in an unobstructed situation. Local exigencies occasionally necessitate the erection of a screen in an unorthodox situation and at a height differing from the standard height of 4 feet and it is therefore a matter of interest to know what sort of conditions may be anticipated owing to the unorthodox exposure of the screen. Naturally it is impracticable to deduce accurately comparable temperatures from the records so obtained but it is possible to obtain an approximate idea of the more important effects.

The differences arise in two ways:—

- (1) Owing to the difference from the standard height;
- (2) Owing to the difference between the nature of the surface of the ground or roof on which the screen is erected and the standard surface.

The general effect of the difference in height is to produce higher temperatures at night and lower temperatures in the middle of sunny days at the greater height. The effect of the difference of

surface from the standard surface is in general to produce lower temperatures at night and higher temperatures in the middle of sunny days. Usually the magnitude of the differences is greatest in calm weather.

Some idea of the magnitude of the difference due to height may be obtained from some observations made at Kew Observatory in screens placed at 17 feet and 4 feet respectively above a level grass plot. In winter the minimum temperature at 17 feet was, on the average, about  $1^{\circ}$  F. higher than the minimum temperature at 4 feet and practically the same in summer. The maximum temperature, on the other hand was less than  $\frac{1}{2}^{\circ}$  lower in winter at 17 feet than at 4 feet, whereas in summer it was more than  $1^{\circ}$  F. lower. The high screen at Kew Observatory was placed on an open stand, so that the whole difference arose from the difference of height.

In some observations recently made at Pieta in Malta the high screen was placed on the flat roof of the building and the readings from it compared with the readings from a screen in a garden adjoining. These observations were made simultaneously with the regular observations on the roof of the University at Valletta. It was indeed the differences between the readings on the roof of the University and in the garden at Pieta which instigated the comparisons. The height of the roof at Pieta above the garden is approximately 28 feet, the garden itself being 90 feet above mean sea level. There is a row of houses on the south-west side of the garden: they are 28 feet high and 40 feet from the thermometer screen. The University observatory is distant from Pieta about 2,000 yards. The height of the roof of the observatory above the ground in its neighbourhood is approximately 71 feet, and above sea level 200 feet.

If the three sites are denoted by :—

P.R. Pieta Roof; P.G. Pieta Garden; and U. University, the relations deduced from the observations may be briefly expressed as follows, where  $>$  means "is greater than";

	7h.	13h.	18h.
Summer	P.G. $>$ P.R. $>$ U.	P.G. $>$ P.R. $>$ U.	P.G.=P.R.=U.
Winter	U. $>$ P.R. $>$ P.G.	U.=P.R. $>$ P.G.	U. $>$ P.R. P.G.

It will be noticed that in winter the relations at 7h., 13h. and 18h. are the reverse of the relations in summer. (Times are G.M.T.)

For the maximum temperature :—

P.G. $>$ P.R. $>$ U. in summer  
and P.R. $>$ P.G. $>$ U. in winter.

while for the minimum temperature :—

U. $>$ P.R. $>$ P.G. all the year round.

This indicates that the effect of the surface on the minimum temperature is outweighed by the difference in height all the year



round. The effect of the surface of the roof on the maximum temperature is, on the other hand, greater in the winter months and less in the summer months than the effect of the difference of height of 28 feet at Pieta. In winter the readings at 7h. correspond roughly with night temperatures, *i.e.*, with stratified lower layers, the coldest air being near the ground, and the same is true of the observations at 18h. In summer on the other hand the observations at 7h. correspond with the turbulent atmosphere of the daytime in which temperature diminishes from the ground upwards.

In both seasons the effect of the difference of height outweighs any effect arising from the difference in surface beneath the screens. On calm days in summer the temperature in the garden probably rises in the morning considerably faster than it would in an open situation, partly due to "pocketing" of the air in the garden and partly to warming by direct or reflected radiation from the wall of the house. A rapid rise between 7 a.m. and 8 a.m. local time is very noticeable on the thermograms.

The observations at 13h. in winter are at first sight more difficult of explanation. One would have anticipated that the effect of difference of height would have preponderated at this hour of observation both in the winter and in summer: it appears however that in winter the greater part of the garden at Pieta is in the shadow of the house by noon and remains in shadow throughout the rest of the day; the ground in the garden remains relatively cold and on calm days the air in the garden also remains cold: in fact the thermograms show that by 13h. the temperature is falling.

The result of these observations as far as they go, indicates that the objection to a roof exposure is due more to its elevated position than to the nature of the surface of the roof so long as the roof is an open one.

Another result of the comparisons of temperatures on the roof and in the garden at Pieta is that the diurnal ranges in the garden will normally be appreciably in excess of those on the roof, while the mean temperatures deduced from the observations of maximum and minimum temperature on the roof and in the garden will be in close agreement. The following figures of mean diurnal range illustrate this point very well. (The figures for the University are also given but in connexion with these some allowance must be made for the difference of situation which is (a) relatively more maritime than the situation at Pieta; (b) in Valletta, whose congested roofs form almost a new ground level). At Pieta there is a katabatic wind from WSW on clear nights.\*

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\* See London, Meteor. Office, *Geophys. Memoir* No. 37, p. 8.

## MEAN DIURNAL RANGES.

		University.	Pieta Roof.	Pieta Garden.
1926.				
May ...	...	9.5° F.	12.4° F.	14.0° F.
June ...	...	11.1	15.3	16.7
July ...	...	11.0	14.0	14.8
August ...	...	10.1	15.2	17.6
September ...	...	9.5	13.8	15.8
October ...	...	9.0	13.8	15.3
November ...	...	6.7	9.6	10.4
December ...	...	6.2	9.3	10.0
1927.				
January ...	...	6.0	9.4	10.1
February ...	...	8.4	11.6	12.7
March ...	...	9.0	12.1	13.3
April ...	...	8.5	11.7	12.8
May ...	...	9.6	12.5	14.0
Mean ...	...	8.8	12.4	13.7

## MEAN OF MAXIMUM AND MINIMUM TEMPERATURES.

		University.	Pieta Roof.	Pieta Garden.
1926.				
May ...	...	65.3° F.	65.6° F.	66.0° F.
June ...	...	70.7	71.4	71.7
July ...	...	74.8	75.1	75.5
August ...	...	75.7	75.8	75.8
September ...	...	76.7	76.7	76.8
October ...	...	72.6	72.3	72.1
November ...	...	68.7	68.7	68.4
December ...	...	57.8	57.2	56.9
1927.				
January ...	...	55.2	54.7	54.0
February ...	...	54.1	53.6	52.6
March ...	...	58.2	58.2	58.0
April ...	...	60.3	60.3	60.3
May ...	...	67.3	68.3	68.5
Mean ...	...	66.0	66.0	65.9

It is to be noted that the summer of 1926 was exceptionally windy and cool in Malta and the summer differences are probably less marked than they would be on the average.

### Royal Meteorological Society

At the meeting of the Royal Meteorological Society, held on Wednesday, May 16th, the following three memoirs were discussed:—

1. "On periodicity and its existence in European weather," by Sir Gilbert T. Walker, F.R.S. (Memoir, Vol. I, no. 9.)
2. "Harmonic analysis and the interpretation of periodogram investigations," by D. Brunt. (Memoir, Vol. II, no. 15.)
3. "Periodicities in Nile floods," by C. E. P. Brooks. (Memoir, Vol. II, no. 12.)

In the first of these three papers, Sir Gilbert Walker emphasises the importance of considering the distribution of amplitudes which might be derived from a chance distribution of numbers, in any attempt at interpreting the results of periodogram investigations. An estimate is given of the probable greatest amplitude in the analysis of a series of figures distributed according to chance, and the result is compared with the computations of periodicities in European weather by Brunt. A later section of the paper indicates the number of significant figures which need be retained in harmonic analysis, it being usually sufficient to use group intervals equal to about one-third of the standard deviation.

The second paper gives a general discussion of the whole question of periodogram analyses. A new derivation is given of Schuster's formula for the distribution of the amplitude of a Fourier series representing a random distribution of observations. A formula is given by means of which the standard deviation can be corrected for the effect of one or more harmonic terms, and it is shown that this formula can be used to determine what fraction of the variability of the original observations is due to harmonic variations. It is suggested that the distribution of the computed amplitudes should be directly compared with the distribution corresponding to Schuster's formula. These methods are applied to twelve series of observations, and it is shown that whereas a number of periodicities in temperature records appear to be real, they only account for a small fraction, about one-seventh, of the variations of the original observations. Pressure and rainfall appear to show no important permanent periodicities.

The third paper is an analysis of data for the Nile floods from A.D. 641 to 1451. Periods with appreciable amplitudes are found between 1.91 years and 76.8 years, most of the 19 periods found being multiples or submultiples of 22.12 years. The surprising feature of Brooks' results is a fairly regular oscillation in the lengths of the periods found, the oscillation in each case having a period of about 500 years.

In the course of the discussion on the first two papers it was

emphasised that whereas it would have been reasonable to expect the 11-year sunspot cycle to show up in temperatures, yet only one of six series of temperature records actually showed an 11-year cycle. On the other hand, these records showed periods of curious lengths, such as 13, 29, 37, 42 months, &c., having lengths which appear to correspond to no known physical oscillation in the atmosphere or elsewhere. The existence of the same curious periods with substantially the same phase, at widely separated places, was held to indicate that their occurrence was not an artificiality due to changing exposure or other varying conditions of observation.

In the course of the discussion on the third paper, Dr. Brooks pointed out that the apparent variation in the lengths of his periods could not be explained as an effect of interference by a period of length 500 years. No explanation of the variation could be suggested.

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### A Brilliant Parhelion of 120°

The recently published *Transactions of the Devonshire Association for the Advancement of Science* for 1927 contains a description, copied from the *Western Morning News*, July 23rd, 1925, of an interesting optical phenomenon. The observer, whose name is not given, says that on Tuesday, July 21st, about 9 p.m. he took up a position near the pier at Exmouth. The sky was overcast. He continues:—"My eyes wandered along the horizon; and just off Berry Head I noticed a faint suggestion of colour. First impressions were that of a portion of a rainbow, but closer observation revealed only a single colour, and that a pale red or pink. So far there was nothing to excite, but when the colour became brighter and assumed a definite shape, I realized it was something unusual, and my curiosity grew. It stood out in relief like a huge elongated toy balloon standing on end, and remained visible only a few minutes."

The phenomenon was called a sun-dog by the local fishermen, and was followed after an hour by rain.

The bearing of Berry Head from Exmouth is a little west of south, so the "sun-dog" may well have been 120° from the sun. The parhelion of 120° shows no rainbow colours, the pale red observed in this case was no doubt due to atmospheric absorption.

F. J. W. WHIPPLE.

*Kew Observatory, Richmond, Surrey, January 14th, 1928.*

### Unusual Thunderstorm Phenomena

On a number of occasions I have noticed a sharp "vit" or "click" to accompany lightning that has struck something in the immediate neighbourhood and to precede the thunder by a perceptible fraction of a second. I have known this to occur both in cases where trees or wires have been struck. Will you be good enough to let me know the explanation why the sound of the contact should reach the ear before the thunder?

I have three times noticed animals to show alarm immediately before a flash. In one case, a dog, walking on grass, turned rapidly and began to bark angrily in the direction of a very strong flash that came  $\frac{1}{4}$  of a second after, striking several of a group of trees 200 yards away. On the two other occasions bantam fowls started to rush for shelter from the open in alarm before a very near discharge actually took place. In each case the discharge was a very powerful one, taking place on dry soil before rain had fallen. May I take it that the sensitive feet of the dog and fowls were able to detect vibrations before the discharge had actually determined what course to take?

It may be of interest that I recently, without question, timed thunder to reach me 200 seconds after flashes from a distant storm. The storm was due west of this place, very low on the horizon, about on the coast line and the wind here was very light from the east. The volume of sound, having come so far, was quite sufficient to carry several miles further. I might add that it is not rare for thunder to be heard 180 seconds after the lightning during the distant February and March storms. Have you other instances of thunder travelling so far?

R. S. BRETON.

*Siam Commercial Bank, Tung Song, S. Siam.*

[Mr. Breton's account of the "vit" or "click" accompanying lightning which has struck close by appears to be new; no reference to any similar observation can be found in the literature, and at present it is not possible to offer any explanation.

Many observers have reported cases in which they consider that they have detected the effect of thunderstorms on the behaviour of animals, but such observations are difficult to make with certainty. In the present state of our knowledge it is best to maintain an open mind on the reality of such phenomena and to offer no suggestions as to their cause if they should prove to be real.

Thunder is rarely heard more than 75 seconds after the lightning but very long intervals between lightning flashes and the corresponding thunder are occasionally noted. Veneema (*Das Wetter*, 1917, p. 192) quotes observations of 255 and 310 seconds on September 5th, 1899, at Nordeney and later (p. 261) he describes an instance in which he heard soft thunder from a storm on the horizon, at a distance subsequently estimated as

200 km.; this would correspond with an interval of about 600 seconds! These observations, however, are wholly exceptional, and are not entirely free from the suspicion that the "thunder" was simulated by some other noise, such as the rumble of a distant train. Veneema remarks that only the thunder associated with downward striking flashes is ever audible at great distances; also that the wind direction—at least up to the level of the clouds—makes very little difference, and that all irregularities of the earth's surface diminish the audibility.—Ed., *M.M.*]

### The May Cold Spell

The whole difficulty in connexion with this subject (discussed in the last number by Mr. Powers) has always seemed to me to lie in a wrong interpretation of the facts. Now it is obvious that if a period be taken as long as three weeks centred upon May 12th, there will inevitably occur in most years something of a cold spell within that period, as in any other three weeks throughout the year. After all, the temperature is constantly fluctuating on either side of the seasonal normal throughout the year; English weather is made up of such fluctuations. How does the temperature rise in any individual spring? Typically it does so not steadily, but in a series of major and minor perturbations or jerks, and every deviation above or below the value which over a long period of years comes out as the seasonal normal is simply a "normal abnormality." And summer passes through autumn into winter in exactly the same way except that the changes from day to day are rather less sudden, as a rule, than in spring. Why, therefore, should a cold spell occurring in May be regarded in any other light than an ordinary fluctuation below the seasonal normal. If, as Mr. Powers shows, there is no real statistical evidence for a special tendency to a set back in temperature about May 12th in London, I am really very glad, for as a result of the most careful watching of the weather from year to year I have never taken this or any other of Buchan's cold or warm periods seriously. Experience has led me to feel as ready to put my money on a hot spell at the close of May, or a cold spell in the middle of June, as on a cold spell in the second week of May.

L. C. W. BONACINA.

27, *Tanaka Road, Hampstead, N.W.* May 22nd, 1928.

### Surface Wind and Day Horizontal Visibility

An examination has been undertaken of the Cranwell, Lincolnshire, observations during the period April 1st, 1920, to December 31st, 1927, in order to express the relationships existing between the ground horizontal day visibility on the one

hand and the direction and velocity of the surface wind taken at the same hours on the other. The observations utilised are those taken from 9h. to 17h. G.M.T. (both inclusive).

All the wind readings employed are those taken by a pressure-tube anemometer whose head is 43 feet above ground level, the ground itself being approximately 240 feet above sea level. No observations were available from 14h. to 17h. on Sunday or Bank Holiday afternoons, whilst others had to be neglected owing to missing or faulty anemometer readings either for direction or velocity alone, or for both.

The distribution of visibility with regard to wind direction is shown in the first of the two following tables, and with regard to wind velocity in the second.

WIND DIRECTION	Total No. of Observations	Percentage of such observations when visibility was—		
		13 miles or more	2½ miles or more but not reach- ing 13 miles	Less than 2½ miles
N'W - NNE	1849	29.7	60.9	9.4
NE'N - ENE	2152	36.9	55.7	7.4
E'N - ESE	1911	26.4	57.9	15.7
SE'E - SSE	1996	15.1	58.8	26.1
S'E - SSW	2980	39.0	53.9	7.1
SW'S - WSW	5559	30.4	63.1	6.5
W'S - WNW	4277	24.0	65.2	10.8
NW'W - NNW	2689	19.9	67.5	12.6
CALM	448	16.5	55.8	27.7

WIND VELOCITY m.p.h.	Total No. of Observations	Percentage of such observations when visibility was—		
		13 miles or more	2½ miles or more but not reach- ing 13 miles	Less than 2½ miles
0 - 5	4098	17.3	59.5	23.2
6 - 10	5626	18.5	64.6	16.9
11 - 15	6691	27.4	65.2	7.4
16 - 20	4771	36.8	60.4	2.8
over 20	2561	49.1	49.6	1.3

The outstanding results that become evident from a consideration of the tables are:—

- that the visibility shows a progressive improvement with increase of wind velocity.
- that winds in the groups SE'E to SSE and Calm give easily the highest percentages of bad visibilities and the lowest percentages of good visibilities.

- (c) that winds in the groups S'E-SSW and NE'N-ENE give the highest percentages of good visibilities.
- (d) that winds in the groups SW'S-WSW, S'E-SSW, and NE'N-ENE give the lowest percentages of bad visibilities.

WILLIAM H. PICK.

*R.A.F. Cadet College, Cranwell, Lincolnshire. February 15th, 1928.*

## NOTES AND QUERIES

### Upper Air Observations in the Azores

The Upper Air Supplement to the *Daily Weather Report* of May 10th includes a pilot balloon report from the Azores for the first time. Both nephoscope observations on clouds and pilot balloon observations are now being received in London with the regular cabled reports from Horta. They are published in the Upper Air Supplement and also issued on the British wireless synoptic messages.

Major Agostinho, who succeeded the late Colonel Chaves as Director of the Meteorological Service of the Azores in 1926, is to be congratulated on his enterprise in inaugurating regular upper air observations in a region which is of peculiar importance for the study of world weather.

### Cirrus at Low Levels

Previous letters on this subject appeared in the *Meteorological Magazine* for July, October, November and December, 1920. Clouds which one would class as cirrus were it not for the fact that they are obviously below 10,000 feet seem to be rather frequent in Egypt. They were observed frequently at the end of January, 1928, and Captain Woolley-Dod, Imperial Airways, informs me that he has frequently seen on the route Cairo-Basrah clouds which he would have classed as cirrus, but which were not more than 7,000 or 8,000 feet high. One point not mentioned by other observers is that such clouds do not appear to move with the velocity of the air.

For example, on January 31st, 1928, alto-cumulus at 11,500 feet was observed moving from  $270^\circ$  with a relative velocity of 14.3 radians per hour, which implies a velocity of about 30 m.p.h., a result in good agreement with pilot balloon observations. But the cirrus which in this case obscured the alto-cumulus had a relative velocity of 23.4 radians per hour, which does not agree with the wind velocity at such a level. There was evidence of a wave motion in the cirrus bands.

Again on January 25th, 1928, cirrus, obviously very low, was observed moving from west with a relative velocity of 32 radians per hour, but the winds up to 6,000 feet were NNE 15 m.p.h. and N by W 15 m.p.h. from 6,000 to 11,000 feet, so



that in this case neither the direction of the movement nor the speed agreed with any measured wind velocity or direction. In both cases we seem to be measuring the rate of progress in the wave motion responsible for the cloud formation and not the speed of the wind which is carrying the cloud along.

J. DURWARD.

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### **"Pearl Necklace" Lightning**

Miss C. M. Botley of 17, Holmesdale Road, Hastings, informs us that on May 4th at the height of a severe thunderstorm a bright white single flash in a southerly direction was noted at Hastings at 21h. 55m. This passed into, or was succeeded by, a number of luminous points of a golden colour lying along its path like the trail of a rocket. Though it was raining heavily at the time there was no question of reflection from drops as the trail followed the flash. The storm began at 21h. 30m., lasted three-quarters of an hour, and was followed by slight flooding in low-lying parts of Hastings.

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### **Fifty Years' Observations at Belper, Derbyshire**

Observations of temperature and rainfall have been made at Belper, 8 miles to the north of Derby, since November, 1876, by Mr. John Hunter and his sister, Miss Margaret J. Hunter. Summaries of these observations were published by the Royal Meteorological Society in the *Meteorological Record* from 1881-1911 and have subsequently appeared in the *Monthly Weather Report* of the Meteorological Office. The rainfall data have been published also in the annual volumes of *British Rainfall* since 1877.

The Meteorological Office has received recently from Mr. J. Hunter a monograph entitled *Summary of observations of Rainfall and Temperature during the 50 years 1877 to 1926*. The monograph contains some general remarks on the observations and tables which include serial monthly and annual values and normal values for 50 years of temperature (maximum, minimum and 9h. dry bulb temperatures and depression of wet bulb at 9h.) and rainfall (amount and number of days) together with absolute extremes of temperature and maximum rainfall in 24 hours for each month and year during the period 1877-1926. The tables include also monthly and annual values of the temperature of the River Derwent during the period 1877 to 1926 except for a break extending from October, 1885, to November, 1889.

The site of the rain-gauge has been changed twice during the 50 years and since 1899 the measurements have been made at

Quarry Bank. The author states, however, that the effects on the continuity of the rainfall record of the changes in elevations and exposure were relatively slight. Two graphs show the secular variation of rainfall (expressed as a percentage of the normal) and temperature at Belper while a third graph shows the rainfall for each of the fifty years arranged in ascending order of amount, from the driest, 1887, "Jubilee Year," with a fall of 20.23 in., to the wettest, 1882, with a fall of 42.90 in., together with the corresponding number of "rain-days" (days of measurable precipitation) and "wet days" (days with .04 in. or more). An interesting result which this last graph establishes is that the variation in the number of "rain-days" or "wet days" is much less than the variation in the rainfall amounts for the corresponding year.

Mr. J. Hunter's monograph forms a valuable contribution to our knowledge of the climate of Belper.

P. I. MULHOLLAND.

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### Meteorological Instruments

Messrs. C. F. Casella and Co.'s new catalogue (No. 548) is a very comprehensive and attractive publication. The instruments listed cover the whole range of meteorological requirements at an up-to-date station, including equipment for pilot-balloon and sounding-balloon work. A striking feature of the catalogue is the number of new instruments designed recently in the Meteorological Office. We see, for instance, on p. 7 the portable receiver for use with the electric cup anemometer,\* on p. 12 the new shielded form of Dines anemometer head, on p. 18 the official pattern of anemometer mast, on p. 50 the protected form of thermometer now adopted for use at sea, and on p. 74 the taper-pattern rain measure.† The firm is to be commended for its enterprise in offering to the public instruments of similar type to those used at official stations, though the source of the design might perhaps have been more clearly acknowledged in some cases.

The text of the catalogue is written in a clear and readable form and much useful information is incorporated. The illustrations are excellent.

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### Reviews

*The Present Status of Radio Atmospheric Disturbances.* By L. W. Austin. (From the Smithsonian Report for 1926, pp. 203-8.) Pub. 2885, Washington, D.C., U.S.A., 1927.

This paper summarises very briefly the views of a number of writers on the subject of atmospheric, and indicates that at

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\* *London, Meteor. Mag.* 61, 1926, p. 14.

† *London, Meteor. Mag.* 59, 1924, p. 193.

present there is a considerable divergence of opinion as to the sources of the disturbances.

It is known that many atmospherics originate in thunderstorms, though according to the writer it is not certain that the lightning flashes are themselves always the actual sources. Cold fronts, particularly when they approach mountainous regions, produce atmospherics. There still remain, however, a number of problems to be solved, particularly as to the physical differences between crashes, grinders, etc., and the origin of individual atmospherics of different types.

D. BRUNT.

*Meteorology.* By David Brunt, M.A., B.Sc. The World's Manuals. Size  $7\frac{1}{4} \times 5$  in., pp. 111, *Illus.* Published by Humphrey Milford at the Oxford University Press, London, 1928. Price, 2s. 6d. net.

The contents of this excellent little book may be conveniently indicated by the titles of the chapters which follow the interesting historical introduction:—The Atmosphere: its Constitution and some of its Physical Properties; The Standard Meteorological Observations and their Use; The General Circulation of the Atmosphere; Solar Radiation and its Reception in the Atmosphere; The Variation of Temperature in the Atmosphere and some of its Physical Effects; The Weather Map; Theories of the Origin of Cyclonic Depressions; Other Travelling Disturbances in the Atmosphere; Thunderstorms; Some further Notes on the Circulation of the Atmosphere. It is something of an achievement to have covered this wide field in little more than one hundred pages. The style is clear and the treatment lucid and interesting. The Press, too, has done its work well and has produced a volume attractive in type and set-out, on good paper and in a pleasant binding. Probably even the professional meteorologist will find advantage in this wide and rapid survey of his subject, while for the amateur it forms a valuable and interesting introduction. In such a book the specialist may find details with which he does not wholly agree, but in a brief treatment it is sufficient to give the generally accepted view without undue dogmatism on controversial matters, and on the whole the book conforms well to this policy.

It will be seen that it deals chiefly with the physical principles underlying weather phenomena, and possibly the title "Weather" would better indicate its character than the wider title chosen. Some of its readers may be unaware of the wider extensions of meteorology such as atmospheric optics, auroræ, atmospheric tides, and the phenomena of the upper atmosphere associated with the earth's magnetism, radio and sound transmission, meteors, ozone, and so forth; as far as this book is concerned they will be left in substantial ignorance even as to

the existence of these problems. It seems a pity that some brief reference is not made to them, with indications as to where further information can be found.

To the reviewer it appears a duty on the author's part to guide interested readers to further sources of knowledge on the topics with which he deals; the bibliographical references actually given are very meagre, and the prices of the few books quoted are not stated. It would not have been difficult to indicate a suitable selection of the not very numerous good modern books on meteorology; also reference might usefully have been made to the *Meteorological Magazine* and some particulars given of the Royal Meteorological Society. Of course the almost sufficient answer to these remarks is the limited size of the book, and the undoubted fact that the subjects dealt with are the most central, important, and generally interesting parts of meteorology. Certainly it would be difficult to compress what has been given so as to afford more than five or six pages for these desiderata.

If the book runs to further editions, as is to be expected, references to the figures should be supplemented by an indication of the page on the book where they are to be found; at present it is necessary to turn to the index of illustrations first in order to find the diagrams referred to.

S. CHAPMAN.

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### Obituaries

*Mr. J. A. Curtis.*—All friends of the Office will have heard with regret of the death of Mr. J. A. Curtis, which took place at his home in Fulham on Thursday, May 31st. Mr. Curtis underwent a serious operation about twelve months ago, from the effects of which he never fully recovered. He was born in 1849 at St. Budeaux, on the borders of Devon and Cornwall, but his parents migrated to London when he was only four years old, so that we may almost claim him as a Londoner. He joined the Office staff in 1869 at the age of twenty, and did not finally retire until November, 1920, so that his active work for the Office extended over more than fifty years. When I first knew the Office Mr. Curtis was in charge of what we now call the climatology division, and his elder brother Richard looked after the so-called observatory branch. In addition to the *Weekly* and *Monthly Weather Report*, the division was then responsible for the annual volume of *Returns from Stations of the Second Order*, a publication of daily observations and monthly summaries, which was finally discontinued in 1907. In those days a far greater proportion than at present of the data used in compiling the official publications was derived from stations maintained by private observers. The fostering of the love of meteorological observation among these enthusiastic amateurs

was thus an important part of the work of the head of the climatological division, but it was an aspect of it which made a strong appeal to one of Mr. Curtis's temperament. Perhaps my most vivid recollection of Curtis in those days was to see him seated at his desk near the window in the low-ceilinged room of the first floor at 63, Victoria Street, in which the statistical branch was housed, surrounded by half-a-dozen members of the Press and supplying to them the latest reports received and comparing them with the statistics for earlier years, or discussing the forecasts prepared by the forecast division which lived on the floors above. Such interruptions to the routine of a day's work, especially on the eve of a holiday, generally resulted in Mr. Curtis being kept at the Office long after 5 p.m., but that aspect of the matter never seemed to trouble him.

A few years later, in 1906, on the retirement of Mr. James Harding, Mr. Curtis became Chief Clerk and Cashier, a position which he continued to hold until his own retirement in the spring of 1914. That retirement was not to last long, for in the following year, knowing that the Office was hard pressed to carry on its work owing to the absence of so many members of the staff on war service and the transfer of others to war work in the Office, he volunteered his services for part-time work. The offer was gladly accepted, but part-time work soon became almost whole-time work, and it was not long before Mr. Curtis was reinstated in the position of Cashier. It was not until November, 1920, some six months after the transfer of the Office to the Air Ministry, that it was found practicable to release him from his responsibilities. Thus ended 51 years of service in the Office, but his friends have often had the pleasure of meeting him at the annual soirées.

Outside the Office Mr. Curtis's activities were many. Religion was to him a very vital thing, and he took a very active part in religious work. For 35 years he was Sunday School Superintendent of the Onslow Baptist Chapel, and for ten years he served it as deacon and Church Secretary. In later years he was associated with the Fulham Baptist Church, where he again served as deacon. Many were the positions of trust which Mr. Curtis held: President of the London Baptist Association, Treasurer of the United Kingdom Alliance, Treasurer of the Fulham Free Church Council, Treasurer of the London Sunday School Choir. Municipal work also claimed his attention. Though not a member of the Council, he was invited to stand for the Mayoralty and was duly elected Mayor of Fulham in 1903, a post which he filled with quiet distinction. Among Mr. Curtis's cherished possessions was an illuminated address presented to him by Councillors of all political parties, placing on record their high appreciation of the services which he (and be it said also Mrs. Curtis) had rendered to the Borough during his term

of Office. In 1914, on his retirement from the Office, he was appointed a Justice of the Peace, thus adding one more to the many channels through which his activities found their outlet. Mr. Curtis was married in 1875, and during the whole of his married life he lived in Fulham in the house in which he died. The sympathy of all his meteorological friends will go out to Mrs. Curtis and the members of her family in their loss.

R. G. K. LEMPFERT.

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*Mr. W. E. Plummer.*—We regret to learn of the death, on May 22nd, at the age of 79, of Mr. W. E. Plummer, Director of the Liverpool Observatory, Bidston, one of the telegraphic reporting stations of the Meteorological Office. Mr. Plummer had been Director of this Observatory since 1892; previous to this he had held appointments at the Royal Observatory, Greenwich, at Mr. George Bishop's private observatory at Twickenham, and at the University Observatory at Oxford, where he assisted in many astronomical researches. He was much interested in the study of comets and contributed papers to the *Monthly Notices* of the Royal Astronomical Society on cometary observations.

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*Prof. Otto Nordenskjöld.*—We regret to record the death on June 2nd at the age of 58 of Prof. Otto Nordenskjöld. Primarily a geologist, Prof. Nordenskjöld inherited an interest in polar exploration—he was the nephew of Baron A. E. Nordenskjöld who, in the *Vega*, first completed the north-east passage from Norway across the Arctic Ocean and through the Bering Straits—and in 1899 he put forward plans for a Swedish Antarctic expedition. This expedition under his leadership sailed from Sweden in October, 1901, on board the *Antarctic*, and landed on Seymour Island off the east coast of Graham land in February, 1902. Here winter quarters were established, but owing to the severe ice conditions of the summer of 1902-1903 the *Antarctic* was crushed and sunk in an attempt to relieve the party, and it was not until November, 1903, that both the winter party and the shipwrecked crew were rescued by a ship from the Argentine. Nordenskjöld became Professor of Geography at Gothenburg University and spent several years in preparing the scientific results of the expedition. His popular account was translated into English and published under the title *Antarctica*.

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## The Weather of May, 1928

The weather was generally fine, warm and sunny at the beginning and end of the month, but during the middle period it was mainly overcast and cool. Easterly winds prevailed for the first few days and the temperature exceeded 70° F. in most

parts on each of the four days, 3rd to 6th, rising to 74° F. at Tottenham on the 3rd and at Brighton and Southampton on the 4th. During this period much bright sunshine was experienced, over 13 hours being reported from several stations, while Deerness had 15·0 hrs. and Lerwick 14·5 hrs. on the 3rd and Portsmouth and Calshot 13·9 hrs. on the 6th. Thunderstorms occurred at many places in the south on the 3rd and 4th, and these were in a few cases associated with heavy rain; 0·91 in. fell at Cul-lompton on the 4th and 0·81 in. at Appledore, Kent, on the 3rd. Subsequently pressure became high over the North Atlantic and northerly winds prevailed generally with a low temperature until about the 23rd. The lowest minimum readings were, in the screen, 26° F. at Ford on the 9th and at Marlborough on the 10th, and on the ground 19° F. at Marlborough and Rhayader on the 10th. On the 15th-21st a depression moving south across the North Sea caused rain in most districts, among the largest amounts being 1·21 in. at Lyminge on the 21st, 1·20 in. at Emsworth on the 17th and 0·81 in. at Bradford on the 19th. Thunderstorms occurred locally from the 18th to 21st. From the 23rd a depression developed off south-west Ireland and there was a gradual change to southerly winds. Quiet, fine, warm weather prevailed generally over the greater part of England, but rain fell at times in Scotland and Ireland. The highest temperatures reached were 81° F. at Camden Square and 80° F. at Greenwich on the 28th, and 80° F. at Southampton on the 29th, while over 13 hrs. bright sunshine occurred at many places on each of these days. Stornoway had as much as 15·4 hrs. on the 31st and Valentia 15·1 hrs. on the 29th. By the 31st the winds had shifted to east and the temperature had dropped considerably. The total sunshine for the month was below normal in most places, the total of 124 hrs. at Aberdeen being 63 hrs. below normal and that of 165 hrs. at Kew being 36 hrs. below normal, while deficits of 36 hrs. were recorded at Liverpool, 19 hrs. at Falmouth, 14 hrs. at Dublin and 4 hrs. at Stornoway. On the other hand Valentia and Birr Castle received respectively 13 hrs. and 11 hrs. more than the normal duration. The total rainfall for the month was very small in many parts, the percentage of the normal being only 20 at Cardiff. At Sway, Hants, there were 22 consecutive rainless days from April 22nd to May 13, and at Abergorloch (Carmarthen) 21 rainless days from April 24th to May 14th.

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Pressure was above normal in a belt stretching from Spitsbergen and northern Scandinavia across Iceland and the western British Isles to Newfoundland and Bermuda, the greatest excess being 6·8 mb. at Seydisfjord and Isafjord. Pressure was below normal elsewhere in western and central Europe and at the Azores, the greatest deficits being 4·1 mb. at Horta and 3·9

**Rainfall: May, 1928: England and Wales**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond</i>	Camden Square .....	1'81	103	<i>Leics</i>	Thornton Reservoir ...	1'28	64
<i>Sur</i>	Reigate, The Knowle...	2'02	119	„	Belvoir Castle.....	1'79	85
<i>Kent</i>	Tenterden, Ashenden...	3'09	197	<i>Rut</i>	Ridlington .....	1'84	...
„	Folkestone, Boro. San.	2'93	...	<i>Linc</i>	Boston, Skirbeck .....	1'70	97
„	Margate, Cliftonville...	2'37	150	„	Lincoln, Sessions House	1'29	69
„	Sevenoaks, Speldhurst	2'34	...	„	Skegness, Marine Gdns	1'76	104
<i>Sus</i>	Patching Farm .....	1'01	54	„	Louth, Westgate .....	1'35	67
„	Brighton, Old Steyne	1'55	96	„	Brigg, Wrawby St. ...	1'32	...
„	Tottingworth Park ...	1'79	99	<i>Notts</i>	Worksop, Hodsock ...	1'66	83
<i>Hants</i>	Ventnor, Roy. Nat. Hos.	2'03	119	<i>Derby</i>	Derby .....	'87	46
„	Fordingbridge, Oaklands	1'47	71	„	Buxton, Devon Hos....	'70	23
„	Ovington Rectory .....	1'43	66	<i>Ches</i>	Runcorn, Western Pt.	1'29	56
„	Sherborne St. John ...	1'94	100	„	Nantwich, Dorfold Hall	'94	...
<i>Berks</i>	Wellington College ...	1'66	89	<i>Lancs</i>	Manchester, Whit. Pk.	1'20	57
„	Newbury, Greenham...	1'33	71	„	Stonyhurst College ...	'91	32
<i>Herts</i>	Benington House .....	1'62	86	„	Southport, Hesketh Pk	1'45	69
<i>Bucks</i>	High Wycombe .....	1'51	86	„	Lancaster, Strathspey	'86	...
<i>Oxf</i>	Oxford, Mag. College	'65	37	<i>Yorks</i>	Wath-upon-Deane ...	1'99	98
<i>Nor</i>	Pitsford, Sedgebrook...	1'05	55	„	Bradford, Lister Pk....	1'91	91
„	Oundle .....	2'06	...	„	Oughtershaw Hall.....	1'72	...
<i>Reds</i>	Woburn, Crawley Mill	1'43	74	„	Wetherby, Ribston H.	2'34	113
<i>Cam</i>	Cambridge, Bot. Gdns.	2'60	148	„	Hull, Pearson Park ...	1'16	60
<i>Essex</i>	Chelmsford, County Lab	1'85	129	„	Holme-on-Spalding ...	'98	...
„	Lexden, Hill House ...	1'88	...	„	West Witton, Ivy Ho.	2'35	...
<i>Suff</i>	Hawkedon Rectory ...	1'94	105	„	Felixkirk, Mt. St. John	1'46	78
„	Haughley House .....	1'75	...	„	Pickering, Hungate ...	1'34	...
<i>Norfol</i>	Beccles, Geldaston ...	2'01	113	„	Scarborough .....	1'29	68
„	Norwich, Eaton.....	1'97	102	„	Middlesbrough .....	1'19	62
„	Blakeney.....	1'58	100	„	Baldersdale, Hury Res.	1'77	...
„	Little Dunham .....	2'37	122	<i>Durh</i>	Ushaw College .....	1'51	71
<i>Wilts</i>	Devizes, Highclere.....	1'14	63	<i>Nor</i>	Newcastle, Town Moor	1'31	65
„	Bishops Cannings .....	1'13	58	„	Bellingham, Highgreen	1'32	...
<i>Dor</i>	Evershot, Melbury Ho.	1'70	83	„	Lilburn Tower Gdns....	1'42	...
„	Creech Grange .....	1'12	...	<i>Cumb</i>	Geltsdale.....	1'56	...
„	Shaftesbury, Abbey Ho.	1'77	84	„	Carlisle, Scaleby Hall	1'23	51
<i>Devon</i>	Plymouth, The Hoe ...	1'42	69	„	Borrowdale, Rostwaite	1'01	...
„	Polapit Tamar .....	1'28	63	„	Keswick, High Hill ...	2'08	...
„	Ashburton, Druid Ho.	1'11	41	<i>Glam</i>	Cardiff, Ely P. Stn. ...	'50	20
„	Cullompton.....	1'87	87	„	Treherbert, Tynywaun	'67	...
„	Sidmouth, Sidmount...	1'32	67	<i>Carm</i>	Carmarthen Friary ...	'92	33
„	Filleigh, Castle Hill ...	1'08	...	„	Llanwrda, Dolaucothy	1'10	33
„	Barnstaple, N. Dev. Ath.	'85	41	<i>Pemb</i>	Haverfordwest, School	'95	38
<i>Corn</i>	Redruth, Trewirgie ...	...	...	<i>Card</i>	Aberystwyth .....	'67	...
„	Penzance, Morrab Gdn.	1'16	52	„	Cardigan, County Sch.	'72	...
„	St. Austell, Trevarna...	1'69	70	<i>Brec</i>	Crickhowell, Talymaes	1'80	...
<i>Soms</i>	Chewton Mendip .....	1'19	43	<i>Rad</i>	Birm W. W. Tyrmynydd	1'13	33
„	Long Ashton .....	1'11	...	<i>Mont</i>	Lake Vyrnwy.....	1'49	47
„	Street, Hind Hayes ...	...	...	<i>Denb</i>	Llangynhafal .....	2'78	...
<i>Glos</i>	Cirencester, Gwynfa ...	1'11	54	<i>Mer</i>	Dolgelly, Bryntirion...	1'18	36
<i>Here</i>	Ross, Birchlea.....	'86	40	<i>Carn</i>	Llandudno .....	'95	50
„	Ledbury, Underdown	'92	45	„	Snowdon, L. Llydaw 9	3'23	...
<i>Salop</i>	Church Stretton.....	1'43	55	<i>Ang</i>	Holyhead, Salt Island	1'28	65
„	Shifnal, Hatton Grange	'76	37	„	Lligwy.....	1'06	...
<i>Worc</i>	Ombersley, Holt Lock	1'08	53	<i>Isle of Man</i>			
„	Blockley, Upton Wold	1'09	51		Douglas, Boro' Cem....	1'33	53
<i>War</i>	Farnborough .....	'74	33	<i>Guernsey</i>			
„	Birmingham, Edgbaston	'46	21		St. Peter P't. Grange Rd.	3'00	176



## Rainfall: May, 1928: Scotland and Ireland

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	1'44	57	<i>Suth.</i>	Loch More, Achfary ...	3'66	83
	Pt. William, Monreith	2'28	...	<i>Caith.</i>	Wick .....	...	...
<i>Kirk.</i>	Carsphairn, Shiel .....	1'61	...	<i>Ork.</i>	Pomona, Deerness .....	1'51	76
	Dumfries, Cargen .....	2'10	70	<i>Shet.</i>	Lerwick .....	1'22	58
<i>Dumf.</i>	Eskdalemuir Obs. ....	1'54	47	<i>Cork.</i>	Caheragh Rectory .....	2'33	...
<i>Roob.</i>	Branxholm .....	...	...		Dunmanway Rectory...	2'31	68
<i>Selk.</i>	Ettrick Manse .....	1'99	...		Ballinacurra .....	2'45	103
<i>Peeb.</i>	West Linton .....	1'70	...		Glaumire, Lota Lo. ...	2'50	102
<i>Berk.</i>	Marchmont House .....	1'13	46	<i>Kerry.</i>	Valentia Obsy. ....	2'42	77
<i>Hadd.</i>	North Berwick Res. ...	1'30	65		Gearahameen .....	2'70	...
<i>Midl.</i>	Edinburgh, Roy. Obs.	1'43	77		Killarney Asylum .....	1'31	43
<i>Ayr.</i>	Kilmarnock, Agric. C.	1'79	78		Darrynane Abbey .....	2'13	71
	Girvan, Pinmore .....	1'28	43	<i>Wat.</i>	Waterford, Brook Lo...	1'99	86
<i>Renf.</i>	Glasgow, Queen's Pk.	2'00	82	<i>Tip.</i>	Nenagh, Cas. Lough...	1'47	60
	Greenock, Prospect H.	1'97	57		Roscrea, Timoney Park	1'45	...
<i>Bute.</i>	Rothsay, Ardenraig.	2'35	78		Cashel, Ballinamona...	1'67	70
	Dougarie Lodge .....	1'72	...	<i>Lim.</i>	Foynes, Coolnanes.....	'98	42
<i>Arg.</i>	Ardgour House .....	1'45	...		Castleconnel Rec. ....	1'65	...
	Manse of Glenorchy ...	1'40	...	<i>Clare.</i>	Inagh, Mount Callan...	1'51	...
	Oban .....	'94	...		Broadford, Hurdlest'n.	1'39	...
	Poltalloch .....	1'29	45	<i>Wexf.</i>	Newtownbarry .....	1'44	...
	Inveraray Castle...	1'29	33		Gorey, Courtown Ho ..	1'15	82
	Islay, Eallabus .....	1'27	48	<i>Kilk.</i>	Kilkenny Castle.....	1'51	68
	Mull, Benmore .....	3'20	...	<i>Wic.</i>	Rathnew, Clonmannou	1'10	...
	Tiree .....	...	...	<i>Carl.</i>	Hacketstown Rectory..	1'36	52
<i>Kinr.</i>	Loch Leven Sluice.....	1'62	66	<i>QCo.</i>	Blandsford House .....	1'27	52
<i>Perth.</i>	Loch Dhu .....	2'05	46		Mountmellick.....	1'58	...
	Balquhider, Stronvar	1'47	...	<i>KCo.</i>	Birr Castle .....	2'17	97
	Crieff, Strathearn Hyd.	2'18	88	<i>Dubl.</i>	Dublin, FitzWm. Sq...	'82	40
	Blair Castle Gardens ...	1'13	56		Balbriggan, Ardgillan.	1'13	54
<i>Forf.</i>	Kettins School .....	1'74	72	<i>Me'th.</i>	Beaupare, St. Cloud...	1'51	...
	Dundee, E. Necropolis	1'36	65		Kells, Headfort .....	1'38	51
	Pearsie House.....	1'49	...	<i>W.M.</i>	Moate, Coolatore .....	1'74	...
	Montrose, Sunnyside...	1'29	63		Mullingar, Belvedere..	1'90	78
<i>Aber.</i>	Braemar, Bank .....	...	...	<i>Long.</i>	Castle Forbes Gdns.....	1'73	67
	Logie Coldstone Sch. ...	1'39	56	<i>Gal.</i>	Ballynahinch Castle ...	1'69	47
	Aberdeen, King's Coll.	1'60	69		Galway, Grammar Sch.	'72	...
	Fyvie Castle .....	1'87	...	<i>Mayo.</i>	Mallaranny.....	1'24	...
<i>Mor.</i>	Gordon Castle .....	1'38	65		Westport House.....	'91	32
	Grantown-on-Spey .....	2'55	109		Delphi Lodge .....	2'23	...
<i>Na.</i>	Nairn, Delnies .....	1'85	103	<i>Sligo.</i>	Markree Obsy.....	1'32	47
<i>Inv.</i>	Ben Alder Lodge .....	...	...	<i>Cav'n.</i>	Belturbet, Cloverhill...	1'66	67
	Kingussie, The Birches	1'73	...	<i>Ferm.</i>	Enniskillen, Portora...	1'58	...
	Loch Quoich, Loan ...	1'40	...	<i>Arm.</i>	Armagh Obsy.....	'80	34
	Glenquoich .....	1'38	25	<i>Down.</i>	Fofanny Reservoir.....	1'87	...
	Inverness, Culduthel R.	2'06	...		Seaforde .....	1'24	47
	Arisaig, Faire-na-Squir	...	...		Donaghadee, C. Stn ...	...	...
	Fort William .....	'85	...		Banbridge, Milltown...	'97	43
	Skye, Dunvegan .....	1'85	...	<i>Antr.</i>	Belfast, Cavehill Rd ...	1'69	...
<i>R &amp; C.</i>	Alness, Ardress Cas. ...	3'17	122		Glenarm Castle .....	1'15	...
	Ullapool .....	1'37	...		Ballymena, Harryville	1'38	48
	Torridon, Bendamph...	2'41	53	<i>Lon.</i>	Londonderry, Creggan	1'13	43
	Achnashellach .....	1'89	...	<i>Tyr.</i>	Donaghmore .....	1'38	...
	Stornoway .....	...	...		Omagh, Edenfel.....	1'54	59
<i>Suth.</i>	Lairg .....	1'39	...	<i>Don.</i>	Malin Head.....	1'20	61
	Tongue .....	1'86	78		Dunfanaghy .....	'92	...
	Melvich .....	1'43	70		Killybegs, Rockmount.	2'26	63

## Climatological Table for the British Empire, December, 1927.

STATIONS	PRESSURE		TEMPERATURE								Relative Humidity.	Mean Cloud Am't	PRECIPITATION		BRIGHT SUNSHINE	
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values				Mean	Am't in.			Diff. from Normal	Days	Hours per day	Percentage of possible
			Max.	Min.	Max.	Min.	Diff. from Normal	Wet Bulb								
mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° o	0-10	in.	in.				
London, Kew Obsy: ..	1012.6	- 1.1	54	21	39.9	33.6	36.7	- 3.6	86	8.1	3.70	+ 1.41	11	0.9	12	
Gibraltar: .....	1013.8	- 6.3	67	44	61.2	51.9	56.5	+ 0.5	83	7.1	14.39	+ 8.78	18	..	..	
Malta: .....	1011.5	- 5.1	69	48	63.3	56.1	59.7	+ 1.8	83	7.4	5.69	+ 1.98	16	4.7	49	
St. Helena: .....	1013.2	+ 2.5	69	57	66.6	57.6	62.1	- 0.1	93	9.0	1.50	- 0.46	13	..	..	
Sierra Leone: .....	1011.2	+ 0.3	91	70	88.8	74.9	81.9	+ 0.5	77	2.7	0.23	- 1.19	1	..	..	
Lagos, Nigeria: .....	1009.1	- 1.4	91	74	88.7	77.5	83.1	+ 1.6	84	6.8	1.17	+ 0.37	4	..	..	
Kaduna, Nigeria: .....	1015.6	+ 2.8	94	65	89.2	68.5	78.9	+ 5.6	84	1.0	0.00	+ 0.00	0	..	..	
Zomba, Nyasaland: ..	1009.0	+ 0.7	94	56	82.4	63.8	73.1	0.0	97	7.5	11.80	+ 0.93	18	..	..	
Salisbury, Rhodesia: ..	1009.3	- 0.3	85	56	79.2	60.2	69.7	+ 0.1	71	6.8	4.72	- 1.06	17	6.2	47	
Cape Town: .....	1014.2	- 0.1	86	49	77.6	59.1	68.3	+ 0.4	72	4.1	1.28	+ 0.46	9	..	..	
Johannesburg: .....	1010.2	- 0.1	85	51	73.8	55.0	66.9	+ 1.8	67	5.7	3.83	- 1.60	11	8.8	64	
Mauritius: .....	1014.2	+ 0.2	92	67	84.6	71.8	78.2	- 0.1	69	6.9	6.35	- 1.62	17	7.5	56	
Bloemfontein: .....	..	..	94	50	85.5	59.4	72.5	+ 0.7	57	3.2	1.70	- 0.75	6	..	..	
Calcutta, Alipore Obsy: ..	1016.1	+ 0.4	82	51	79.2	57.8	68.5	+ 2.0	84	1.6	0.00	- 0.20	0*	..	..	
Bombay: .....	1013.1	- 0.4	87	64	84.0	71.3	77.7	+ 0.2	77	2.7	0.09	+ 0.04	1*	..	..	
Madras: .....	1014.2	+ 0.7	86	65	84.0	70.2	77.1	+ 0.4	71	3.7	2.33	- 3.48	7*	..	..	
Colombo, Ceylon: .....	1011.5	+ 0.8	90	69	88.0	72.7	80.3	+ 1.3	74	4.7	3.63	- 1.74	6	8.1	69	
Hongkong: .....	1018.5	- 1.2	80	49	70.2	61.9	66.1	+ 3.1	71	5.7	1.37	+ 0.24	3	5.7	53	
Sandakan: .....	..	..	90	73	88.0	74.8	81.4	+ 1.3	87	..	16.27	- 1.39	24	..	..	
Sydney: .....	1013.5	+ 1.6	92	56	75.1	62.7	68.9	- 1.2	67	6.6	2.35	- 0.56	9	6.1	42	
Melbourne: .....	1013.0	+ 0.5	102	49	78.3	57.6	67.9	+ 3.6	59	5.3	1.32	- 1.02	9	7.1	48	
Adelaide: .....	1013.2	0.0	103	51	82.9	60.2	71.5	+ 0.4	39	4.8	1.46	+ 0.46	8	10.4	72	
Perth, W. Australia: ..	1012.7	- 0.5	106	54	86.5	64.0	75.3	+ 4.6	45	3.1	0.19	- 0.39	5	10.3	73	
Coolgardie: .....	1012.4	+ 1.2	103	50	90.1	60.0	75.1	- 0.7	47	2.4	1.08	+ 0.38	2	..	..	
Brisbane: .....	1012.7	+ 0.7	91	62	80.6	65.8	73.2	- 3.2	66	6.9	5.58	+ 0.74	20	5.9	43	
Hobart, Tasmania: .....	1011.5	+ 1.8	92	43	70.3	52.7	61.5	+ 1.1	56	6.5	2.73	+ 0.77	14	7.4	49	
Wellington, N.Z.: .....	1015.0	+ 2.8	79	41	65.0	51.9	58.5	- 1.9	72	6.9	3.17	- 0.05	12	6.5	43	
Suva, Fiji: .....	1007.7	- 0.9	97	72	87.3	75.4	81.3	+ 2.4	77	5.9	17.39	+ 5.28	27	7.6	58	
Apia, Samoa: .....	1008.5	+ 0.1	89	73	85.0	75.7	80.3	+ 1.0	79	2.1	20.08	+ 6.46	24	5.4	42	
Kingston, Jamaica: .....	1014.2	+ 0.2	88	65	85.3	67.9	76.6	- 1.1	87	2.9	0.00	- 1.59	0	7.8	70	
Grenada, W.I.: .....	1008.0	- 3.5	87	71	84.4	74.5	79.5	+ 1.4	75	3.9	8.10	+ 0.83	17	..	..	
Toronto: .....	1017.2	- 0.2	54	8	35.0	23.4	29.2	+ 3.0	77	7.4	3.14	+ 0.31	14	2.1	23	
Winnipeg: .....	1022.6	+ 4.7	23	-28	3.9	-9.5	-2.8	- 8.5	..	2.6	0.66	+ 0.81	5	3.8	46	
St. John, N.B.: .....	1012.6	- 1.6	55	4	35.2	21.4	28.3	+ 3.9	77	6.0	4.98	+ 0.81	18	2.5	28	
Victoria, B.C.: .....	1018.8	+ 2.0	54	16	40.6	33.3	36.9	- 4.6	84	7.2	3.11	- 2.80	15	2.6	31	

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

## Climatological Table for the British Empire, Year, 1927

STATIONS	PRESSURE		TEMPERATURE						Relative Humidity	PRECIPITATION			BRIGHT SUNSHINE			
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values					Mean Cloud Am't	Am't in.	Diff. from Normal	Days	Hours per day	Percentage of possible	
			Max.	Min.	Max.	Min.	1/2 max. and min.	Diff. from Normal								Wet Bulb
London, Kew Obsy.	1013.4	- 2.0	80	21	56.0	43.8	49.9	+ 0.2	45.2	7.1	32.12	+ 8.32	163	3.6	30	
Gibraltar	1017.5	- 0.4	94	42	70.9	57.7	64.3	0.0	56.9	5.0	36.07	+ 0.25	90	..	..	
Malta	1015.8	- 0.1	98	45	71.4	62.3	66.9	+ 0.8	62.3	4.6	14.93	+ 4.93	69	8.5	70	
St. Helena	1013.7	+ 2.2	73	52	64.1	57.4	60.8	- 1.2	58.4	5.3	27.39	- 12.73	..	..	..	
Sierra Leone	1012.1	+ 0.7	95	66	86.9	73.2	80.1	- 0.6	75.3	5.6	135.12	- 22.11	173	..	..	
Lagos, Nigeria	1010.1	- 1.3	93	68	85.8	75.0	80.4	- 0.1	75.9	5.6	55.00	- 16.63	112	..	..	
Kaduna, Nigeria	..	..	99	..	88.0	..	..	..	69.3	..	55.60	+ 6.37	118	..	..	
Zomba, Nyasaland	1013.1	+ 0.8	94	..	79.0	..	..	..	..	5.9	50.48	- 3.12	121	..	..	
Salisbury, Rhodesia	1013.4	- 0.3	91	32	76.8	52.7	64.8	- 0.5	..	3.8	24.59	- 7.35	79	8.2	68	
Cape Town	1017.5	+ 0.5	101	38	73.5	54.9	64.2	+ 1.9	56.5	3.9	18.96	- 6.34	78	..	..	
Johannesburg	1016.9	+ 0.7	93	27	71.5	49.6	60.5	+ 1.0	50.9	2.5	23.44	- 9.78	81	8.5	70	
Mauritius	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Bloemfontein	..	..	102	21	76.2	48.7	62.4	+ 1.0	51.1	3.0	14.65	- 8.72	48	..	..	
Calcutta, Alipore Obsy.	1007.5	- 0.1	103	49	88.0	71.5	79.7	+ 1.0	72.2	4.7	45.82	- 16.72	69*	..	..	
Bombay	1008.7	- 0.5	94	63	85.7	74.9	80.3	- 0.2	72.4	4.3	74.38	+ 2.19	88*	..	..	
Madras	1008.6	- 0.2	109	62	92.0	75.9	83.9	+ 0.9	75.3	5.6	32.24	- 18.50	60*	..	..	
Colombo, Ceylon	1010.0	0.0	91	67	87.0	75.0	81.0	+ 0.3	77.2	7.2	91.28	+ 6.03	182	6.6	55	
Hongkong	1012.2	- 0.4	93	46	75.9	68.0	72.0	- 0.3	67.5	7.3	107.88	+ 24.06	158	5.0	41	
Sandakan	..	..	92	73	88.1	75.4	81.7	+ 0.4	77.1	..	114.91	- 4.81	174	..	..	
Sydney	1016.1	+ 0.2	101	39	70.1	55.1	62.6	- 0.6	56.8	5.1	48.56	+ 0.66	138	6.4	54	
Melbourne	1016.7	+ 0.4	106	30	67.9	49.8	58.8	+ 0.4	52.4	5.9	17.98	- 7.57	135	5.8	46	
Adelaide	1017.4	+ 0.4	110	36	73.1	53.0	63.0	0.0	53.7	5.3	16.92	- 4.28	101	7.3	60	
Perth, W. Australia	1016.0	- 0.4	106	38	73.6	55.5	64.6	+ 0.4	57.7	5.1	36.59	+ 2.56	133	7.6	62	
Coalgardie	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Brisbane	1016.0	+ 0.2	93	39	77.2	59.1	68.1	- 0.3	61.6	4.7	62.09	+ 17.43	129	7.7	64	
Hobart, Tasmania	1013.6	+ 1.0	102	32	61.5	46.4	53.9	- 0.4	47.9	6.5	20.13	- 3.61	185	6.0	50	
Wellington, N.Z.	1014.2	- 0.5	84	31	61.7	49.1	55.4	+ 0.1	52.0	6.3	43.35	- 4.69	167	5.6	46	
Suva, Fiji	1010.9	- 0.5	97	63	84.2	72.8	78.5	+ 1.5	74.3	6.9	149.17	+ 36.79	273	5.3	44	
Apia, Samoa	1010.9	+ 0.6	89	71	84.9	75.1	80.0	+ 1.5	77.1	5.5	132.35	+ 25.50	223	6.8	56	
Kingston, Jamaica	1013.7	0.0	93	62	87.2	70.8	79.0	- 0.3	69.7	3.7	25.73	- 7.86	67	8.7	72	
Grenada, W.I.	1009.3	- 2.9	92	67	85.5	74.7	80.1	+ 1.3	75.4	5.0	76.76	+ 0.68	230	..	..	
Toronto	1016.5	+ 0.1	95	- 17	54.8	38.7	46.8	+ 2.4	41.3	7.6	30.77	- 2.70	145	5.5	45	
Winnipeg	1016.8	+ 0.6	90	- 32	44.6	27.5	36.0	+ 1.7	..	4.9	21.45	- 0.38	112	5.4	44	
St. John, N.B.	1014.3	- 0.4	79	- 9	49.0	35.4	42.2	+ 1.0	38.7	6.1	54.23	+ 6.15	154	..	..	
Victoria, B.C.	1016.3	- 0.1	89	16	54.8	43.8	49.3	- 0.2	45.7	6.6	25.58	- 6.91	143	5.8	48	

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

mb. at Copenhagen. Temperature was above normal over Spitsbergen and northern Scandinavia and below normal elsewhere, while rainfall was generally below normal except for Spitsbergen and parts of Sweden (southern Norrland and southern Gothland), central Europe and eastern England.

Floods due to the formations of ice dams on the Klarälven and Dalälven rivers caused serious damage in Sweden early in the month. On the 1st a severe storm swept across Roumania and Bulgaria and 6 children were killed. Storms were also reported from Paris on the 5th and from Budapest on the 9th, and floods occurred in the valley of the Struma on the 4th, and in the Chamonix valley and the valley of the Bièvre about the 8th owing to the heavy rains. From about the 10th to 22nd cold weather prevailed generally in France, central Europe and northern Italy; snow occurred as far south as Perugia and Fabriano and the frost did much damage to the crops in all parts. On May 15th much of the crops in the fertile district of Ottaviano was destroyed by rain, which had been contaminated by falling through the vapours emitted by Vesuvius. Continuous heavy rain during Whitsuntide caused severe floods in part of lower and middle Silesia, and on the 31st thunderstorms caused serious damage to the crops in eastern Switzerland. Snow fell in large quantities in Tirol on the 28th, which is very unusual so late in the year.

Very hot weather was experienced in Lower Burma at the beginning of the month.

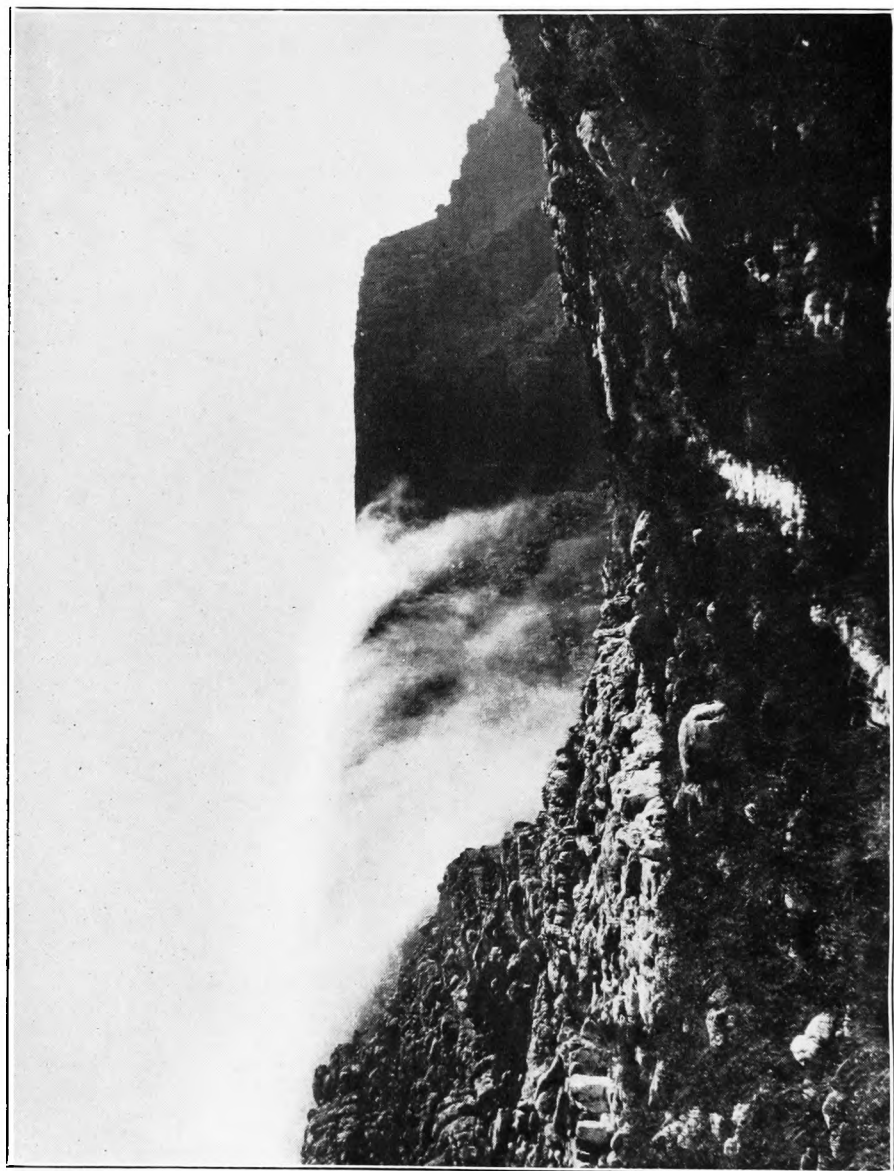
Owing to the warm weather in Ontario about the 8th the snow in the northern hinterland melted with unusual rapidity causing floods in the Ottawa valley and in northern Ontario. These continued until the 16th, when the situation began to improve. Temperature rose above 90° F. at many places in Saskatchewan and Manitoba on the 21st to 26th, reaching 98° F. at Battleford on the 21st and Medicine Hat on the 22nd. Heavy floods also occurred near Quebec about the 28th. Dense fog was prevalent over the western North Atlantic from about the 16th to 19th.

The special message from Brazil states that rain was very scarce in the north being 3.03 in. below normal, in the centre it was 1.30 in. below normal, and in the south the distribution was irregular, the average being 3.15 in. above normal. The circulation was active and seven anticyclones passed over the country; depressions over the southern part of the continent caused the temperature to fall in Argentina and southern Brazil. At Rio de Janeiro pressure was 0.2 mb. below normal and temperature 1.3° F. above normal.

#### Rainfall, May 1928—General Distribution

England and Wales	...	74	} per cent. of the average 1881-1915.
Scotland	...	66	
Ireland	...	60	
British Isles	...	69	





The "Table Cloth" on Table Mountain.  
(See p. 141)

<h1>The Meteorological Magazine</h1>	
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## **The Trans-Polar Flight of Captain Sir G. H. Wilkins on 16th April, 1928**

It has long been recognised both in this country and abroad that when flying can take place regularly across the Polar regions many of the long-distance flights envisaged would be very much shortened. To mention but one of these flights, from the British Isles to Japan, only 6,000 miles would be covered if Polar regions were traversed, while by the ordinary shipping routes or along the routes already followed by aircraft the distance approximates to 11,000 miles. However, for the safe and regular operation of such flights, whether by airship or aeroplane, it is essential to have detailed information of the average weather conditions along the selected route, while for any individual flight the existing pressure distribution and the changes to be expected during the flight are required. This involves a network of meteorological reporting stations and it is here that such flights encounter a great difficulty. At the present time little information on which to base average weather conditions is available for any points north of latitude 75°. There is only Spitsbergen in the European Section reporting regularly, although Bear Island and two Siberian Stations border on this limit. Northwards there is solely the information obtained by various Arctic explorers, and this refers to different parts of the Polar basin and is scattered irregularly over a large number of years.

It became thus essential to find whether there are possible sites in these Polar regions where meteorological stations can

be established and particularly if there are islands in the unexplored regions north of Alaska and Eastern Siberia.

With this object in view Captain Sir G. H. Wilkins, M.C., and Lieutenant C. B. Eielson undertook a detailed survey of this section of the Polar basin using Point Barrow, the most northerly point in Alaska as their base of operations. These operations extended over the years 1926-7-8, but by using aircraft it was not necessary to spend more than a short portion of the year at this base. Another advantage possessed by aircraft was the great saving of time in exploring a large area where journeys over the ice on foot are often difficult, slow and laborious. In 1926 little information was gained, but in the following year a flight 600 miles north-west of Point Barrow was undertaken, and a landing made. The sounding indicated a depth of one mile for the sea and thus the absence of any islands in this region. This year it was intended to fly 600 miles north-east from Point Barrow and if no land was observed to continue the flight around the Polar basin to Spitsbergen.

In both the latter years the actual time when the flight commenced was regulated by the existing weather conditions, and all assistance possible was obtained by employing following winds.

An investigation of the changes in the pressure distribution over the northern parts of the northern hemisphere during and just prior to the flight on 16th April has been carried out by M. Rodewald and is published in *Annalen der Hydrographie und Maritimen Meteorologie*, pp. 192-195, Vol. VI, 1928. A weather chart covering these regions for 13h. G.M.T. on 16th April accompanies the paper. The essential features of the pressure distribution are large anticyclones, one extending from northern Alaska to the Liakhof Islands, another over northern Greenland and a third extending northwards from northern Russia. There were relatively shallow depressions over Baffin Island and Siberia and an intense depression centred over Spitsbergen. During the first part of the flight where the central regions of the Alaskan anticyclone were crossed the winds were light, the sky cloudless and the visibility good. The northerly current on the eastern side of this anticyclone became gradually shallower as the flight progressed and clouds of the St. or St.-Cu. type were found at a height of 3,000 feet, these clouds being formed at the upper boundary of the surface layer of cold air. Over this first third of the flight frequent extensive snowdrifts were observed mainly in a west-east direction, and Captain Wilkins concludes that in general the prevailing winter wind direction in these regions is west-east.

As Grant Land was approached the amount of cloud again increased and extended more than 6,000 feet upwards. This was very probably formed in the warm air current moving on



the eastern side of the Baffin Island depression. The northward movement of this air was shown by observations from west Greenland. The mountains of Grant Land were seen projecting through the clouds, while a snowstorm was encountered over the Lincoln Sea. As the flight continued towards Spitsbergen the aeroplane was assisted more and more by the north-westerly wind blowing between north Greenland and Spitsbergen, but weather commenced to deteriorate. The A-St. cloud associated with the Spitsbergen depression was soon met, the temperature fell to  $-54^{\circ}$  F., and at about 250-300 miles from Spitsbergen immense Cu.-Nb. clouds were encountered extending about 6,500 feet and with an unbroken lower surface. The winds became more and more stormy with great turbulence, while the base of the cloud reached gradually lower levels. Almost continuous snow was encountered, but a landing was effected on the western side of Spitsbergen.

During the whole of the flight no land was encountered over the Polar basin, and from that point of view the results of the exploration were negative. Captain Wilkins concludes that such meteorological stations as will need to be established in these regions must thus be on the drifting ice and not on land.

R. S. READ.

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## Transport of Sea-Spray Inland by Gales

The fact that sea spray may be carried by gales for long distances inland has been recognised for many years, although the occasion mentioned in the January number of the *Meteorological Magazine* may be the first on which the presence of sea salt has been noted for its effect on electric transmission lines.

In *British Rainfall* for 1864-65 notes showed that the question was in mind; mention was made of the utility as well as interest of the detection of the amount of sea spray "10, 20, 30 or perhaps more miles inland." It had been observed that "at Cape Wrath the gauge is 355 feet above the sea, yet, when a heavy south-west gale is blowing the yard in which the gauge stands is reported to be flooded with sea spray lifted up by the wind."

In *British Rainfall* 1866 it is mentioned that "we have seen windows three miles inland frosted like ground glass, and the detection of stray crystals 20 and 30 miles from the sea is frequent"; and in a footnote it is mentioned that after the great storm of January, 1839, salt was seen deposited on the leaves of the trees at two places near Huddersfield "about 80 miles from Scarborough and 60 miles from Liverpool (the nearest ports of the opposite coasts)." In the same article it is mentioned that arrangements had been made by Mr. Symons for supplying at a

cost of £1, sets of apparatus and chemicals (silver nitrate and chromate solutions) for determination of the amount of salt in solution.

Several occasions are noted in *Symons's Meteorological Magazine*.

In 1869 salt equivalent to 11.2 grains per gallon of rain was found at Chepstow in rain which had fallen during squalls from W. and NW. Correspondence followed this report regarding the probable accuracy of the measurement; incidentally one of the writers who evaporated the whole of a year's collection from his raingauge, "932 cube inches down to about a cubic inch" seems to have been a pioneer in atmospheric pollution measurement. After a violent gale which swept the south of England in April, 1882, letters were published giving observations of salt on foliage at Tonbridge, 30 miles inland, and at Kew Observatory, over 50 miles from the sea in the direction of south-south-east from which the gale had blown. It was stated by Mr. G. M. Whipple, then Superintendent of the Observatory, that the greatest hourly run of the wind during the gale was 50 miles but several gusts of 70 to 80 m.p.h. had been timed.

References were also published to occasions when "in one great gale all the windows in Leeds which faced west were covered with a thin film of sea salt" (the sea is 54 miles to the west, over the Pennines, about 1,500 feet high); and when there had been made measurements of 5 to 7 grains of salt per gallon, carried by autumnal gales to Cirencester, where "if no rain followed for a few days after the gale, the salt sparkled on the trees even at a distance of 35 miles from the Bristol Channel."

It was stated that the phenomenon was first noted by Dalton at the beginning of the century.

In 1889 references were made to salt hail, and to salt moisture carried to a distance of about 25 miles from the Firth of Clyde.

In 1890 a salt film was observed on windows 30 miles from the Ayrshire coast. In this case the wind was from about south, and the salt may have come from Luce Bay (Solway Firth) more than twice that distance. "In either case it had to cross the range of hills dividing Ayrshire from Clydesdale, where it would be projected upwards to a considerable altitude before it found a final resting at Cambuslang, 150 feet above the sea level."

After the gale of 22nd December, 1894, reports of salt being detected inland were received from Settle (24), Sowerby Bridge (40), Bolton Abbey (42), Harrogate (50), East Ardsley, Wakefield (57), Bramhope (60), and Burton House, Masham (65 miles from the west coast). From Birmingham, 55 miles from the Bristol Channel and nearly 100 miles from Cardigan Bay, came two reports of objects being covered with salt. Near Garstang, about 10 miles inland, on the following day, "brine of nearly twice the usual specific gravity of sea water" was found dripping from trees.

There appears to be no more mention of the subject until November, 1911, when at Ilkley, 50 miles inland, after a severe westerly gale lasting more than 24 hours, a salt incrustation was observed on windows. Analysis of the water in the rain-gauge showed salt equivalent to 13 lbs. to the acre, or  $3\frac{3}{4}$  tons to the square mile.

Presumably the conditions under which the salt can be carried long distances inland and deposited in a way suitable for attracting attention are rather specialised, but in view of the contemplated large increase of power transmission lines in this country, opportunities for occurrences such as those of 28th October ought to be more frequent in future.

S. T. A. MIRRLEES.

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## OFFICIAL NOTICE

### Course of Training for Observers

It is proposed to hold a course of training for observers at climatological stations on Monday, Tuesday and Wednesday, 24th, 25th and 26th September, 1928, 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 connection 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.

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## Institution of Water Engineers

The thirty-third summer meeting of the Institution of Water Engineers was held in Torquay on the 12th to 15th June. The general meetings were held in the Reception Room at the Town Hall, where an official welcome was given by the Mayor of Torquay and Mr. S. C. Chapman, C.E., Engineer of the Torquay Waterworks, presented his presidential address. Papers on "The Torquay Corporation Waterworks" by R. V. Toms, on "Average and Extreme Seasonal Rainfall" by J. Glasspoole; and on "The Water Supply of Lourenço Marques, Portuguese East Africa" by R. H. Fox, were also read. A lecture was subsequently given on "The Geological Structure of Dartmoor" by R. G. Handsford Worth. Visits were paid to H.M. Dockyard at Devonport, to the Burrator Reservoir

(Plymouth Corporation), Venford Reservoir (Paignton U.D.C.) and to Tottiford Reservoir (Torquay Corporation). A summary of Dr. Glasspoole's paper is given below.

*Average and Extreme Seasonal Rainfall over the British Isles*

The engineer engaged in the supply of water for domestic purposes naturally considers the year divided into two parts, viz., a winter half-year, October to March, in which evaporation is small, and a summer half-year, April to September, in which the reserves of water are usually drawn upon. The meteorologist, unfortunately, usually adopts other subdivisions of the calendar year so that relatively few seasonal rainfall statistics have been published. An endeavour to meet that deficiency has been made in this paper.

The average falls of the winter and summer half-years are considered in the paper separately, and expressed as a percentage of that for the whole year. There are only three areas where the summer rainfall is the greater, viz., in the Fen District, round the mouth of the Tees and near Edinburgh. In these relatively dry areas the average summer rainfall slightly exceeds that of the winter. Conversely, the usually wet stations of the west receive much more rain in the winter than in the summer. On Dartmoor 65 per cent. of the average annual amount falls in the winter six months. In such regions complete use of the available water can only be made by extensive storage of the winter rains.

The fall in each half of the seasonal winter and summer, *i.e.*, October-December, January-March, April-June and July-September, is also defined by means of maps for all parts of the British Isles. This emphasises the wide range in the Western Highlands of Scotland, from only 15 per cent. in the three months April to June to over 30 per cent. of the annual amount in both October to December and January to March. The maintenance of the water supply in early summer is therefore dependent upon the adequate storage of the winter rains.

It is also shown that while in mountainous areas there may be considerable diversity from place to place in the annual rainfall, there is only a slight variation in the proportion falling in the different seasons. This is important to a water engineer since quite frequently, while there are long rainfall records in the drier valleys, records in the mountainous parts of the catchment area are quite short. Having determined the average annual rainfall of any given catchment area, the proportion falling in the seasons can be computed fairly accurately by using stations in the adjacent valleys. It is demonstrated that the high proportion of rain in the winter is primarily a feature of stations in the west of the country, so that Torquay, like other places in the west, offers certain advantages over the

much advertised "dry east coast" in that rain falls mainly in winter. Similarly, stations in the west also score in that there is a slight preponderance of rain at night over that during the day—the Midlands and east coasts having a greater tendency to thunderstorms in the summer afternoon.

Another interesting fact brought out by the paper is that over the British Isles generally a definite wet period set in about 1906, and while initially the excesses were contributed more especially by wet winters, of recent years the summers have been unusually wet.

Extreme values in 60 years' records are given for the winters, summers and seasonal years separately for certain representative stations. Attention is directed more particularly to the smallest falls on record as proving the severest tax on the capacity of water-supply schemes. Over the British Isles as a whole wet years have so predominated recently that in the last 22 years a rainfall appropriate to 23 years has occurred. So great an abundance of rain obviously cannot be relied upon in the future. Moreover, it is reasonable to expect that the present run of wet years will break down and the accumulated excess be wiped off in due course. This renders a consideration of the driest periods on record of some importance, especially in the case of those water-supply schemes which have only just been able to cope with increasing demands during the recent years of plenty.

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### Unusual Thunderstorm Phenomena

With regard to the "vit" or "click" sound\* accompanying lightning or preceding the thunder by a perceptible fraction of a second, the sound is familiar to any one living within the tropics. I have noticed it eight times in twelve years. I am certain that the interval does occur, or appears to occur and I have tried to get at the reason with others who have also noticed it.

The instance I gave you of thunder occurring 204 seconds after the flash is undoubtedly correct. The spacing between the individual flashes and corresponding thunder varied only 4 or 5 seconds over half a dozen flashes or more. They only occurred about every five minutes. There were no weaker flashes from any other point of the sky between them. There are no railways or towns situated in that direction, neither are there heavy guns in the neighbourhood to produce the sound. The flashes were short and sharp, and, considering the distance of the storm, extremely brilliant. The sky was clear nearly to the horizon.

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\**Meteorological Magazine*, 63 (1928), p. 113.

A Survey Department friend, who has spent long periods on the tops of mountains, assures me that he has timed thunder over 300 seconds and is equally as positive as I am about it.

There is one more point I should like to mention to you, if I am not boring you, and that is, the length of lightning flashes. Though the storms here are generally not half so severe as in other parts of the world, we frequently get good opportunities for observing flashes unobstructed in their course. There are two extremes. The first appears in "pillar" cumulus clouds which form in hot weather. Before the cloud extends and a general storm occurs, these flashes are very short and one can often detect reports of thunder not more than two seconds in length. The second results from storms which have formed among the mountains or on the farther side of them, the peaks of the clouds having caught upper currents and having drifted back in a contrary direction to the surface current. The flashes start from, say, overhead, perhaps three miles above, follow the course of the cloud and earth twelve miles away under the base of the storm. The thunder begins with an ordinary rattle, proceeds more or less drowsily until it takes its final plunge to earth with a tremendous booming about a minute after the flash has occurred.

The longest flash I think I ever saw happened one evening last year after an afternoon of many local thunderstorms. The storms were spent and the flash was the last of many, a considerable interval having intervened between it and the previous one. It started at a great height nearly overhead. One end I traced afterwards, went to earth at Roubibon about twelve miles away, the other went away at right angles for about the same distance. The thunder started from the nearest point, overhead, and rumbled away in each direction for about a minute, ending in each case with the usual distant roar marking the direction of the point of contact with the earth.

R. S. BRETON.

*The Siam Commercial Bank, Ltd., Tung Song, S. Siam. 6th June, 1928.*

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I found Mr. Breton's remarks about the "click" accompanying lightning unusually interesting, as I have heard the phenomenon on numerous occasions, but have never before seen it mentioned in meteorological literature. The sound is practically simultaneous with the flash; there is a slight but scarcely perceptible lag.

An explanation that seems to me to satisfy the conditions is that the sharp sound is due to a relatively small induced discharge occurring in the vicinity of the observer, perhaps 3 or 4 yards away, the sound being due to sparking in some imperfect conductor. I have in mind small gaps in metal pipes and

the like: this agrees with the mental impression of the sound as I remember it now.

R. M. POULTER.

28, Pinner Park Avenue, Headstone Lane, Middlesex. 21st June, 1928.

I have read with great interest Mr. R. R. Breton's account of a "vit" or "click" preceding thunder from a very close discharge of lightning.

I have on two occasions noticed it—in the storm of 9th July, 1923 (I think the date is right) lightning struck the house next but one to this. I was watching the storm from an open window and heard three distinct "vits" very close together and presumably simultaneous with three successive discharges. All these were heard before the first deafening crackle of thunder.

The other occasion was a very long time ago when a tree was struck in Broomfield Park, Palmers Green, in North London. At the time I was about 300 yards from the tree, and the sound resembled, I remember, that of a branch being cracked off.

The phenomenon is not altogether new. I have heard it discussed from time to time and have also heard the explanation given that it is entirely subjective, being produced by the induced charge in the subject's head escaping to the earth simultaneously with the flash. The momentary current stimulates the auditory nerve. It would doubtless stimulate the optic nerve also, but the simultaneous brilliance of the real flash prevents this being seen.

If the phenomenon is not subjective it cannot be a true sound because it must be carried by an ether wave, otherwise it could not precede the thunder and be simultaneous with the lightning.

RONALD L. BEST.

73, Bexley Road, Erith, Kent. 22nd June, 1928.

### Sea-spray in the Rain-gauge\*

A striking example of the effect of spray at an exposed place on the coast during the gale which swept the country on the night of 10th-11th February of this year was brought to light during a recent inspection of the telegraphic reporting station at St. Ann's Head. The gauge at this station is situated on a bleak headland about 150 feet above sea level, and just over 100 yards from cliffs to the west which slope down abruptly to an inlet known as "Cobbler's Hole." The observer on duty on the night in question says that it appeared to be raining hard whilst he was on watch at the signal station, which is close to the rain-gauge, but his relief, who walked across the headland about midnight reported that the night was fine and clear on the eastern side of the headland. In the morning it was found that

\* See page 131.

there was much brine in the gauge and the observer is almost certain that of the 8.8 mm. "rain" measured at 7h. on 11th, not more than a millimetre or so was true rain. There is little doubt but that the very high wind (WNW, force 9 at 1h.), in sweeping up and over the headland carried with it large quantities of sea water and deposited it over the area in which the rain-gauge is situated. The *Daily Weather Report* shows that the following amounts were recorded:

		Day 10th.	Night 10th-11th.
	mm.	mm.	
St. Ann's Head ...	3	9	
Scilly ...	2	1	
Aberystwyth ...	5	0.3	
Ifracombe ...	2	0.6	

The total fall for 24 hours ending 9h. on the 11th at Haverford-west, Portfield, about  $12\frac{1}{2}$  miles inland, was 4.5 mm.

C. V. OCKENDEN.

R.A.F., Worthy Down, Winchester. 15th May, 1928.

### Sea and Road Mirage

I was much interested in reading the articles on this subject in the January and February issues. I have not observed any road mirage in my time and am an octogenarian, but I have seen a sea mirage once only at Tenby although I have visited there on business as a commercial traveller for thirty-five years and looked for more when there and also during my career in England, Ireland, Scotland and Wales. It was about 1882 looking from the Castle Hotel at Tenby that I saw on the horizon what looked like a lighthouse; it did not hold very long but was clear and distinct. The day was fair and the sight I shall never forget.

Reading in the *Wonder Book of Atmosphere* by Edwin J. Hunter, Ph.D., he writes "a report was once spread at Malta (page 250) that a new island had arisen from the sea in the channel at a distance of from four to six miles. The different objects on this island were so clearly visible to the unaided eye, that several ships in the harbour thought of taking possession of the new land in the name of their respective countries. This afterwards proved to be a portion of the coast of Sicily and included Mount Etna.

HENRY A. ROGERS.

31, Fernbank Road, Redlands, Bristol. 5th April, 1928.

### Road Mirages

In the *Meteorological Magazine* for December, 1927, Mr. Vernon Jones gave an account of his observations of a road mirage.

A similar mirage was under observation during the years 1922 and 1923 on one of the tarred roads inside the aerodrome at



Biggin Hill, Kent. The road itself had a fairly level stretch of about 100 yards, but fell away gradually at either end of this stretch. It was on this higher level portion of the road that the mirage was formed and in appearance resembled a pool of water in which white posts along the side of the road were clearly reflected. The mirage was equally visible from both ends of the road.

The most curious fact about the phenomenon was that it was visible both in winter and summer (although less intense in the former season) under most conditions of wind, weather and temperature. It reached its greatest intensity during hot summer middays, but was still faintly visible as dusk approached. High winds only served to diminish the intensity. Even with a damp road and drizzle falling one was considerably surprised to find that, on approaching what appeared from a distance to be a puddle of water, the puddle vanished.

A series of readings were taken twice daily—morning and afternoon—from July 14th to August 23rd, 1923, with an Assmann psychrometer at heights of 1 inch, 3 inches, 1 foot, 3 feet and 6 feet respectively above the tarred road, and corresponding notes made of the intensity of the mirage, but these failed to give any definite relationship between the intensity of the mirage and the height distribution of temperature and humidity.

W. H. BIGG.

*R.A.E., South Farnborough, Hants. 19th May, 1928.*

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### **Parhelia observed at Hindhead**

The phenomenon described below was observed yesterday evening (23rd June). At 19h. to the west the sky was covered with thin cirrus and there were a few patches of alto-cumulus and some lumpy strato-cumulus. At 19h. 15m. a faint solar halo of  $22^\circ$  became partly visible and some faint iridescence was seen on the alto-cumulus just after. By 19h. 31m. the halo had become almost complete, and much brighter, and the left parhelia was visible. The right parhelia appeared between cloud masses at 19h. 41m. The phenomenon was visible intermittently until sunset, although after 19h. 50m. it was masked by brilliant sunset colours. The last observation of parhelia here was on 25th February, on which day the phenomenon was visible over a wide area. The unsettled weather and the appearance of last night's sky lead me to believe that yesterday's phenomenon was very local.

S. E. ASHMORE.

*Windwhistle Cottage, Grayshott, Hindhead, Surrey. 24th June.*

### Solar Halo at Heyford

Mr. Goodyear called my attention to a very fine solar halo ( $22^\circ$ ) at 13h. 40m. G.M.T. to-day (Tuesday, 8th May, 1928). Not only was the whole of the circular halo visible but also the complete ellipse through the upper and lower arcs of contact. The theodolite was erected as expeditiously as possible, but by 13h. 45m. G.M.T. the ellipse had disappeared, leaving only the circular halo with the arcs of contact. The dimensions of the ellipse with respect to the circle were so impressed on our memories, however, that an estimate of the length of the semi-major axis could be made by means of the theodolite with reasonable accuracy. This was found to be  $29^\circ$  approx. The colouring along the arcs of contact was extraordinarily brilliant, even the violet being visible through the goggles. There can be no doubt that the phenomenon was similar to that shown on Plate IV, *Observers' Handbook*, 1926, except that in this case the ellipse was absolutely complete.

N. H. SMITH.

*Upper Heyford, Oxon. 8th May, 1928.*

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## NOTES AND QUERIES

### Hurricane in Gilbert and Ellice Islands

Capt. E. W. G. Twentyman, of Suva, Fiji, has kindly forwarded an account which he has received from Capt. P. C. Spain of a hurricane which visited Butaritari and Little Makin Islands at the northern end of the Gilbert Islands, in about  $3^\circ\text{N}$ ,  $173^\circ\text{E}$ , on 5th December, 1927.

On 4th December a strong wind blew all the morning from north-east with several heavy squalls. In the afternoon the wind went round to west, but about 5 p.m. the wind again changed to north-east. The sky looked stormy, and the barometer reading (after making an approximate correction for instrumental error) was about 1006.4 mb. At 7 p.m. the wind had shifted to east and by 8.30 p.m. to south-east, and was blowing with increased violence. The barometer was then about 1005.1 mb.

About 1 a.m. on 5th December there was a lull and shortly after 2 a.m. with a roar a terrific wind struck the Government Station. Trees crashed on all sides, and in the Police lines all houses save one were down. All women and children were collected in a hastily erected shelter in the middle of the parade ground, as the safest place from flying nuts and branches. At 4.15 a.m. the barometer was about 1003.7 mb. Daylight presented a dismal scene, many houses being blown down and others damaged, and the road strewn with trees and branches. At 8.30 a.m. the barometer was about 1002.0 mb. and at 9 a.m. 1001.3

mb. The wind was terrific from south-east but fortunately moderated by the time of high tide, and as the tides were neap no great damage was done. By 3 p.m. the wind had considerably moderated but was veering to the west, and by 10 p.m. had fallen away to just an ordinary breeze, while the next morning was almost calm.

The height of the storm was about 8.45 to 9.30 a.m. on the 5th, when the wind velocity was estimated as 80 to 100 miles an hour, but Capt. Twentyman considers that the comparatively slight fall of the barometer does not bear this estimate out. At Little Makin Island the hurricane was accompanied by a violent thunderstorm, but no lives were lost at either island. This is the first hurricane from the south-east that the oldest inhabitants can remember, and owing to the damage to coconut and bread-fruit trees the natives are likely to suffer great hardships.

Hurricanes within five degrees of the equator are rare, and as this example began with the wind from north-east, and the greatest velocity was from south-east, it seems that the centre must have travelled westward south of 3°N. The subsequent change of wind to west may indicate that after passing Butaritari the hurricane recurved to the north-east. It is stated that Butaritari and Little Makin are the only units of the Gilbert Group which have ever been known to suffer from wind storms of a circular nature, or exceeding in velocity the force of a gale.

### **Birds' Atlantic Flight**

*Nature* of 30th June quotes from *British Birds*, Vol. 22, an instance of bird migration across the Atlantic from east to west.

Two flocks of lapwings arrived in Newfoundland on 20th and 21st December, 1927, and on one of the birds was found a *British Birds* ring which showed it to be a native of Cumberland. It is estimated that the migrating lapwings having their normal speed of some 45 miles an hour aided by a wind of about 55 miles an hour had completed the journey in about 22 hours.

The northern hemisphere charts for 19th and 20th December show high pressure over southern Norway and Iceland, and an elongated area of low pressure along the 50th parallel in the Atlantic. The "gradient wind" was SE or ESE to the west of Iceland, and easterly towards Newfoundland, and the velocity over part of the route nearly 60 miles an hour. Wintry conditions prevailed in both western Ireland and Newfoundland.

### **The "Table Cloth" on Table Mountain**

The photograph which forms the frontispiece of this number of the *Meteorological Magazine* appeared in a Cape Town newspaper during the visit of the British Airship Mission to South Africa last year as described in the last number. The photo-

graph shows an interesting feature of the "table cloth" on table mountain during a "south-easter." The cloud shown is descending over the edge of the mountain and was described in the original publication as resembling a waterfall. Many photographs have been published showing the "table cloth" and two good examples may be found in the *Marine Observer*, Volume I, page 8, 1924, and Volume 2, page 6, 1925, the latter being accompanied by some remarks on the phenomenon. In particular, there is a statement quoted from Findlay's "Sailing Directions for the Indian Ocean," and due to Sir Thomas Maclear, one time Astronomer Royal of the Cape Observatory, to the effect that, "Its north border hangs over the precipice—drapery fashion; but during very strong winds it pours down like a cataract to about 1,000 feet from the top." The photograph reproduced here is of special interest as illustrating this particular feature.

Permission for the reproduction of the photograph has been obtained from Blyth Clayton, Argus Building, Cape Town.

M. A. GIBLETT.

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### **Renewal of the Wick and Muslin of a Wet Bulb Thermometer**

In using an ordinary psychrometer it is customary to renew the wick and muslin of the wet bulb about once a month in country districts and more frequently in towns. It seems fairly certain, and is generally understood, that the reading of the wet bulb is affected by the state of cleanliness of the wick and muslin and will thus depend upon the time elapsed since renewing them.

The observations of the present investigation were made during the winter months in a screen on the roof of the Air Ministry (Kingsway), a "town" situation, with the object of estimating the magnitude of the effect. Side by side with the usual two thermometers was mounted a second wet bulb provided with new wick and muslin each day. In the case of the ordinary wet bulb the renewal was made in the first instance every 14 days and later every 21 days. The results are summarised in tabular form, the average depression of the special wet bulb below the ordinary wet bulb together with the number of observations being given to correspond with the number of days elapsed since the wick of the ordinary bulb was changed. The mean depression is also given for periods of seven days. (Readings were adjusted for a discrepancy between the thermometers.)

It is evident that there is a definite increase in the deficiency as the wick of the ordinary wet bulb becomes older; the irregularity during the third week is probably due to the small number of observations.

An error of  $0.1^{\circ}$  F. in any particular reading may not be of vital importance, but it is very undesirable that a *systematic* error of this order should be introduced. It would therefore appear that, under conditions such as obtained in London a muslin should not be allowed to remain in use more than a fortnight.

It is to be expected that the effect will depend upon the nature of the atmospheric pollution and ordinary dust, smoke, chemical impurities in manufacturing districts and salt sea spray at coastal stations may each affect the reading of the wet bulb differently. Some information is afforded by observations made at Tiree by D. O. Maclean in which a wet bulb was allowed to remain in use without change of muslin for a period of about three months and comparison made with a normal wet bulb with muslin renewed every 21 days. At the end of this period the large difference of  $0.6^{\circ}$  F. between the two thermometers was recorded. This difference was observed to take place not gradually but in finite stages due to circumstances in which sea spray or excessive dust affected the instrument.

Results similar to these noted here for differently exposed stations would be interesting.

TABLE

Number of days Elapsed																				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Difference: ordinary wet bulb—special bulb ( $^{\circ}$ F.)																				
·01	·00	·04	·06	·04	·05	·07	·05	·10	·07	·07	·07	·10	·13	·14	·14	·17	·09	·12	·10	·10
Number of Observations																				
11	11	11	11	11	11	10	11	11	11	11	11	11	11	7	7	6	7	7	5	6
Mean difference for periods of seven days ( $^{\circ}$ F.)																				
·04							·08							·12						

R. C. SUTCLIFFE.

### The Physical-Meteorological Observatory at Davos

Volume 36, no. 5, of the *Journal of State Medicine* contains an account by Dr. F. Lindholm of the work and equipment of the Physical-meteorological Observatory at Davos. The Observatory, of which Dr. Lindholm is now Director, was founded in 1907 by Prof. Dorno, and has recently been incorporated in the Swiss Institute for Alpine Physiology and Tuberculosis Research. The main work of the Observatory is the investigation of solar and sky radiation and the electrical phenomena of the atmosphere.

The methods in use at Davos for determining the intensity of the total radiation received from the sun are described in detail. A special design of Pyrheliograph is used to obtain a continuous record; it consists of a copper cylinder, which is made to rotate by clockwork so that the sun's radiation always falls on a blackened strip situated within the cylinder. A mirror galvanometer is used in conjunction with a thermopile placed behind the blackened strip, a photographic trace being thus obtained. The readings of the Pyrheliograph are checked by a Michelson Actinometer. This consists essentially of a blackened bimetallic strip which suffers a measured deflection when radiation falls upon it. It is not an absolute instrument, the necessary calibration being carried out by means of an Angström Compensated Pyrheliometer. In this instrument there are two blackened strips, one being heated by the sun's radiation and the other by an electric current, which is varied until the temperatures of the two strips, as recorded by two thermocouples, are equal. The energy received from the sun by one strip is then equal to the electrical energy supplied to the other strip.

Ultra-violet radiation investigations form an important part of the work of the Davos Observatory. The instrument used for wave-length determinations is a quartz spectrograph with fairly large dispersion. Interesting results have been obtained concerning the variation of the amount of radiation of the shortest wave-length which penetrates the atmosphere, according to the time of day and season of the year. For quantitative methods, the photo-electric method is largely employed. A cadmium element in a uvioglass cell is used for ultra-violet radiation, a glass filter serving to separate the longer wave-lengths from the shorter. For visible radiation a calcium cell with a blue filter is used. Recently a new form of photoelectric cell has been developed and perfected at Davos, its chief feature being the employment of a Wulf single thread recorder in conjunction with a calcium or cadmium cell. Some results obtained with this instrument are briefly mentioned.

To conclude this account, Dr. Lindholm deals with several other investigations carried out at Davos, including those of local brightness, atmospheric potential gradient and conductivity, atmospheric dust and infra-red radiation.

D. W. JOHNSTON.

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### Weather and Antiquaries

Referring to the article under the above title which was published in *Meteorological Magazine* for January, Dr. J. P. Williams Freeman has contributed some notes to *Antiquity* for June, 1928. He states that several facts in archæology leave no doubt as to the great lowering in the general level of the

water-table in the chalk from Romano-British times onwards; for example, General Pitt Rivers in excavating the well in the Romano-British village at Woodyates, Dorset, found a Roman bucket at the bottom of it, 60 feet above the level to which modern wells have to be sunk in the immediate neighbourhood. Similarly, the highest springs of our winterbournes, which run only in the wettest seasons, are frequently, perhaps usually, close to the site of some ancient villa or manor often of Saxon or Roman origin. Since we cannot suppose that such sites were chosen for the sake of springs which broke out once in several years, they must at the time have been perennial. Other evidence of the retreat of the ground water is provided by the deep conical pits or spring-ponds, sometimes found at the head of valleys now dry, which have evidently been dug and deepened in an attempt to keep pace with the water as it gradually retreated. It is also pointed out that a number of fifteenth and sixteenth century houses are built on north slopes and face north, in marked contrast to nearly all Roman sites. Contemporary writers praise the north wind and the "gentle east" wind, and decry the violent west wind and the unhealthy south wind. This may point to a warmer climate in these centuries.

In a letter to the *Meteorological Magazine* dated 13th June, Mr. G. M. Meyer has also supplied further evidence that there were geographical changes on the east coast in the thirteenth and fourteenth centuries. In a letter from Sir William Dugdale to Sir Thomas Browne, dated 1658, it is stated that the passage of the Ouse at Wisbech was silted up, and the river diverted to Lynn, in the reign of King Henry III (1216-1272). This silting up may be related to the decrease of rainfall traced by Mr. Meyer in the history of East Kent watermills. In the time of King Edward III (1327-1377) it is stated that the tides in the Humber flowed four feet higher than formerly, which agrees with the belief that the fourteenth century was exceptionally stormy in the North Sea. It was about this time that the port of Ravenser or Ravensburg on the Humber was destroyed by overwhelming inundations of the sea, especially associated with unusually high tides in 1357.

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## Reviews

*Annales de l'Observatoire National d'Athènes.* Publiées par Démétrius Eginitis, Directeur de l'Observatoire, Athènes, Imprimerie Gérard Frères. Size 12 x 9 $\frac{1}{4}$ , Tome VIII, pp. 644, pl. xiii, Tome IX, pp. 614, pl. v, Figs. 21 + 4 charts.

These two volumes contain observations made at meteorological stations in Greece during the years 1915 to 1922, as well as

several memoirs, both meteorological and astronomical. Among these we must specially mention an interesting article in Tome VIII by A. N. Livathinos on cloudiness in Greece. Observations of cloud amount at Athens for the period 1881-1920 are utilised and observations at 35 other stations are available for varying periods mostly for the 20 years, 1900-19. Charts of isonephs for January, April, July, October and for the year are given.

We welcome this evidence of the renewed activity of the Athens Observatory.

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*Science For You.* By J. G. Crowther. Science For You Series. Size  $7\frac{1}{2} \times 5$  in., pp. x + 241. London, G. Routledge and Sons Ltd., 1928. 5s. net.

This book forms the first volume of a new series of popular scientific books, the "Science for you" series, which is intended to provide short readable essays on recent work in science. The reviewer, who spends a fair proportion of his time in reading scientific papers, confesses that he opened the book with bored toleration, but this soon quickened into interest, which was maintained to the last page.

The author complains in the last chapter that a journalist who writes on scientific subjects must strip away the technical jargon and at the same time retain accuracy. Regarded as scientific journalese, this book fulfils both criteria very well, though the author perhaps stretches a point now and again, as when he describes a fog as a colloid and writes that "the stability of city fogs is deducible from their colloidal nature." One thought eddy motion had something to do with it.

The various chapters range over so wide a field, from the health of miners to super-magnetic fields, that there is not much room for meteorology, but space is found for essays on "Hurricanes" and "Thunderstorms," as well as on "Earthquakes and the earth," and there is a good deal of incidental meteorology in many other chapters, sometimes where one would least expect it, showing that our science has wide contacts with other branches of knowledge.

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## Books Received

*Royal Alfred Observatory, Mauritius.* Results of Magnetical and Meteorological Observations for January to June, 1926. Port Louis, 1926.

*Rapport de la Réunion de la Commission Internationale de Météorologie Maritime à Zurich, 14-17 Septembre, 1926.* K. Ned. Meteor Inst. De Bilt, 1926.



- Het Koninklijk Nederlandsch Meteorologisch Instituut A. Organisatie en Inrichting. De Bilt, K. Ned. Meteor. Inst. No. 102. Med. en Verh. 1a. 1927. (French translation.)*
- Anales de la Sociedad Española Meteorologia. Madrid, July-August, 1927. Vol. I., Núm. 4.*
- Der jährliche und tägliche Gang des Potentialgefälles in Davos. By F. Lindholm and M. Bider. Reprinted from Met. Zs. 44, 1927, pp. 401-6.*
- Ein kugelblitzartige Erscheinung. Reprinted from Met. Zs. 44, 1927, p. 391.*
- Meteorology. Extracts from Statistics of New Zealand for the year 1926. Wellington, 1927.*
- Sur le rôle de l'ozone dans l'atmosphère. By J. Lévine. Reprinted from Comptes Rendus, 185, 1927, p. 962.*
- Jaarboek, Koninklijk Nederlandsch Meteorologisch Instituut, 1925, A. Meteorologie, B. Aard-Magnetisme (No. 98). Utrecht, 1926.*
- Ergebnisse Aerologischer Beobachtungen, 1925. K. Ned Meteor. Inst. (No. 160A.) Utrecht, 1926.*
- Onweders, Optische Verschijnselen, enz. in Nederland. Naar Vrijwillige Waarnemingen in 1923. Deel XLIII. K. Ned. Meteor. Inst. No. 81. Amsterdam, 1926,*

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## The Weather of June, 1928

Regarded as a whole the weather in the British Isles was generally cool, wet and somewhat cloudy for the time of year but northerly winds were much less general than in May and considerable bright, warm periods were enjoyed at fairly frequent intervals during the month. At the very beginning a ridge of high pressure over Scotland gave brilliant weather in the north on the 1st and, as the anticyclone extended its influence further south, similarly good records of sunshine were obtained in most districts on the 2nd and 3rd. There was a fairly wide range of temperature at this period, ground frost occurring locally in the early morning, especially on the 3rd, when several degrees of frost were registered in London and the reading was as low as 24° F. at Birmingham and 23° F. at Rhayader. During the daytime the thermometer rose slightly above 70° F. in a few places both on the 3rd and 4th.

Meanwhile with the approach of a depression off our south-west coasts conditions began to deteriorate, and subsequently remained generally unsettled throughout the month with heavy rain at times and local thunderstorms. Nearly two inches fell at Harrogate on the 7th, at Roches Point on the 12th and at Brighton on the 13th. On the last-mentioned date 2.12 in. fell

at Caheragh (Co. Cork) and 2.47 in. at Middlesbrough. This day was also outstanding as being one of the warmest during the month in England, temperature rising to about 75° F. or slightly higher in several parts including London. (Other days with a few readings approximately as high were the 22nd and 25th.) On the other hand, in Scotland the 13th was one of the coldest days, temperature remaining below 50° F. throughout the day in some parts. In England the lowest day readings generally were experienced between the 14th and 17th during a period of northerly winds in the rear of the depression which had caused the heavy rain on the 13th. Slight ground frost occurred locally on several mornings and some fairly sharp frost was reported on the 17th.

During the last week the weather became rough and exceptionally wet in some districts, strong winds occurring daily after the 25th, with gales locally on alternate days. The 26th was generally the roughest in the south. On the 28th more than 2.5 in. of rain fell in several parts of Wales and northern England and as much as 4.03 in. at Festiniog in Merioneth and 4.34 in. at Rosthwaite, Borrowdale.

The total rainfall for the month was well above normal in most districts, though in some instances the excess was only small and in others there was even a deficit. In the region where excessive rain fell on the 28th, the total for the month amounted to about 8 in. in several cases and to as much as 10.94 in. at Oughtershaw Hall in Yorkshire, 11.31 in. at Rosthwaite and 12.26 in. at Festiniog.

The sunshine records obtained during the first few days when measurements exceeded 15 hours in many places (Tiree in the Hebrides reported 16.3 hours on the 2nd) were seldom equalled later in the month, though 13 or 14 hours were enjoyed on several occasions and over 15 hours in a few instances. The total duration for the month was much above the average at Stornoway in the Hebrides and there was a small excess in London and some other eastern districts, but in many western districts there was a deficit.

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Pressure was above normal over southern France, Italy and Spain and over a belt stretching from Spitsbergen to Iceland, the greatest excess being 5.9 mb. at Isafjord; pressure was below normal elsewhere over western Europe and Scandinavia and also over the Azores and Newfoundland, the greatest deficit being 11.8 mb. at Vardo. Temperature was generally below normal except in Spain and Portugal and northernmost Sweden; in other parts of Sweden the deficit was as much as 5 to 7° F. Rainfall was below normal in Spitsbergen and above normal in Sweden excepting parts of Gothland; in northern Lapland the rainfall was treble the normal.

Violent thunderstorms and heavy rain occurred in Switzerland during the month. On the 1st a thunderstorm did much damage to the crops in eastern Switzerland, several villages in the Canton of Aargau were flooded and the railway line was blocked by landslides near Zuzgen and Zeiningen; in the Canton of Berne lightning struck a group of tourists, killing one and injuring another. Heavy rain occurred again on the 10th and the rivers rose, the Rhine rose about 3 ft. causing damage in the district of Rinkenbergl where two persons were drowned. On the evening of the 30th, during a violent thunderstorm, a small bridge on the Interlaken-Grindewald railway was swept away by a sudden torrent; the last train from Interlaken to Zweilüt-schinen was derailed, its engine falling into the ravine. A sudden storm on the 16th swept the south coast of Algarve in Portugal, and many fishing boats were lost. Hot weather was experienced in Spain during the greater part of the month. Prolonged cold and rain in Latvia is threatening the destruction of the crops, and floods in Zemgale and Livonia have prevented the sowing of spring seed and potatoes.

The monsoon broke in Bombay on the 10th; during the 24 hours ending 8 a.m. on the 13th 10 in. of rain fell, flooding the lower parts of the town; the monsoon was strong in north-east India and Burma but weak elsewhere. Good rains are reported from the Yemen and Aden Protectorate.

A tornado which swept from north-western Kansas into Nebraska did much damage on the 11th to the town of McCook, 100 houses were wrecked and 20 persons injured. On the 18th a tornado swept over Oklahoma and southern Kansas, eight people were killed and about a hundred injured. During the first part of the month the weather was rather rainy and unsettled in the western districts of Canada, temperatures approached the freezing point in one or two places, the last week however was warm and ideal for the growth of the crops which made rapid progress.

The special message from Brazil states that rain was very scarce in the north, the total fall being 2.01 in. below normal, in the centre it was 0.70 in. below but in the south it was 2.67 in. above normal. The circulation was exceptionally active, seven anticyclones passed across the country and there was a continuance of continental depressions. The conditions were unfavourable for crops of sugar cane, tobacco and cereals. At Rio de Janeiro pressure was 2.3 mb. below normal and temperature was 3.2° F. above normal.

### Rainfall, June 1928—General Distribution

England and Wales	...	145	} per cent. of the average 1881-1915.
Scotland	...	184	
Ireland	...	196	
British Isles	...	<u>166</u>	

**Rainfall: June, 1928: England and Wales**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond.</i>	Camden Square .....	2'59	128	<i>Leics.</i>	Thornton Reservoir ...	3'52	163
<i>Sur</i>	Reigate, The Knowle...	2'66	136	"	Belvoir Castle.....	3'43	180
<i>Kent</i>	Tenterden, Ashenden...	2'34	123	<i>Rut</i>	Ridlington .....	3'36	...
"	Folkestone, Boro. San.	2'02	...	<i>Line</i>	Boston, Skirbeck .....	3'17	174
"	Margate, Cliftonville...	2'06	119	"	Lincoln, Sessions House	1'46	72
"	Sevenoaks, Speldhurst	3'07	...	"	Skegness, Marine Gdns	2'35	...
<i>Sus</i>	Patching Farm .....	2'39	118	"	Louth, Westgate .....	1'84	85
"	Brighton, Old Steyne	2'83	157	"	Brigg, Wrawby St. ....	2'67	...
"	Tottingworth Park ...	4'06	193	<i>Notts.</i>	Worksop, Hodsock ...	2'15	109
<i>Hants.</i>	Ventnor, Roy. Nat. Hos.	2'37	130	<i>Derby.</i>	Derby .....	2'76	123
"	Fordingbridge, Oaklands	2'53	137	"	Buxton, Devon Hos....	4'93	153
"	Ovington Rectory .....	2'64	114	<i>Ches.</i>	Runcorn, Western Pt.	4'95	192
"	Sherborne St. John ...	2'22	104	"	Nantwich, Dorfold Hall	4'74	...
<i>Berks.</i>	Wellington College ...	2'03	94	<i>Lancs.</i>	Manchester, Whit. Pk.	5'32	202
"	Newbury, Greenham...	2'55	118	"	Stonyhurst College ...	7'47	243
<i>Herts.</i>	Benington House .....	1'96	95	"	Southport, Hesketh Pk	4'86	224
<i>Bucks.</i>	High Wycombe .....	3'08	159	"	Lancaster, Strathspey	7'00	...
<i>Oxf.</i>	Oxford, Mag. College	1'63	77	<i>Yorks.</i>	Wath-upon-Dearne ...	3'00	135
<i>Nor</i>	Pitsford, Sedgebrook...	2'51	130	"	Bradford, Lister Pk....	6'04	257
"	Oundle .....	2'14	...	"	Oughtershaw Hall.....	10'94	...
<i>Beds.</i>	Woburn, Crawley Mill	2'39	...	"	Wetherby, Ribston H.	4'40	209
<i>Cam</i>	Cambridge, Bot. Gdns.	...	...	"	Hull, Pearson Park ...	2'33	113
<i>Essex.</i>	Chelmsford, County Lab	2'32	122	"	Holme-on-Spalding ...	3'93	...
"	Lexden, Hill House ...	2'40	...	"	West Witton, Ivy Ho.	5'42	...
<i>Suff</i>	Hawkedon Rectory ...	2'28	110	"	Felixkirk, Mt. St. John	4'06	185
"	Haughley House .....	1'51	...	"	Pickering, Hungate ...	3'94	...
<i>Norfolk</i>	Beccles, Geldeston .....	...	...	"	Scarborough .....	3'52	191
"	Norwich, Eaton.....	2'30	119	"	Middlesbrough .....	5'14	272
"	Blakeney.....	2'20	118	"	Baldersdale, Hury Res.	4'96	...
"	Little Dunham .....	3'38	151	<i>Durh.</i>	Ushaw College .....	5'10	236
<i>Wilts.</i>	Devizes, Highclere.....	2'48	110	<i>Nor</i>	Newcastle, Town Moor	4'01	185
"	Bishops Cannings .....	2'99	124	"	Bellingham, Highgreen	5'24	...
<i>Dor</i>	Evershot, Melbury Ho.	3'63	159	"	Libburn Tower Gdns....	5'94	...
"	Creech Grange .....	2'21	...	<i>Cumb.</i>	Geltsdale .....	5'56	...
"	Shaftesbury, Abbey Ho.	2'48	107	"	Carlisle, Scaleby Hall	4'93	196
<i>Devon.</i>	Plymouth, The Hoe ...	2'27	105	"	Borrowdale, Rosthwaite	11'31	...
"	Polapit Tamar .....	1'79	83	"	Keswick, High Hill ...	6'64	...
"	Ashburton, Druid Ho.	2'93	114	<i>Glam.</i>	Cardiff, Ely P. Stn. ...	2'45	98
"	Cullompton.....	2'66	125	"	Treherbert, Tynywaun	8'22	...
"	Sidmouth, Sidmount...	1'84	88	<i>Carm.</i>	Carmarthen Friary ...	6'08	212
"	Filleigh, Castle Hill ...	3'21	...	"	Llanwrda, Dolaucothy	7'77	226
"	Barnstaple, N. Dev. Ath.	3'07	137	<i>Pemb.</i>	Haverfordwest, School	5'04	187
<i>Corn</i>	Redruth, Trewirgie ...	2'61	105	<i>Card</i>	Aberystwyth .....	5'62	...
"	Penzance, Morrab Gdn.	2'23	10	"	Cardigan, County Sch.	4'26	...
"	St. Austell, Trevarna...	2'27	87	<i>Brec</i>	Crickhowell, Talymaes	4'20	...
<i>Soms.</i>	Chewton Mendip .....	2'71	92	<i>Rad</i>	Birm W. W. Tyrmynydd	6'23	190
"	Long Ashton .....	2'87	...	<i>Mont</i>	Lake Vyrnwy.....	6'36	201
"	Street, Hind Hayes ...	3'23	...	<i>Denb</i>	Llangynhafal.....	4'11	...
<i>Glos.</i>	Cirencester, Gwynfa ...	3'35	140	<i>Mer</i>	Dolgelly, Bryntirion...	7'91	228
<i>Herc</i>	Ross, Birchlea.....	2'11	97	<i>Carn</i>	Llandudno .....	3'93	194
"	Ledbury, Underdown	2'48	110	"	Snowdon, L. Llydaw 9	20'68	...
<i>Salop</i>	Church Stretton.....	3'59	148	<i>Ang</i>	Holyhead, Salt Island	4'06	189
"	Shifnal, Hatton Grange	3'35	150	"	Lligwy.....	6'20	...
<i>Worc.</i>	Ombersley, Holt Lock	2'50	111	<i>Isle of Man</i>			
"	Blockley, Upton Wold	2'84	107	"	Douglas, Boro' Cem....	6'44	...
<i>War</i>	Farnborough .....	2'47	104	<i>Guernsey</i>			
"	Birmingham, Edgbaston	3'00	129	"	St. Peter P't. Grange Rd.	3'03	164

## Rainfall: June, 1928: Scotland and Ireland

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	5.47	225	<i>Suth.</i>	Loch More, Achfary ...	5.47	148
	Pt. William, Monreith	5.31	...	<i>Cwith.</i>	Wick .....	3.19	177
<i>Kirk.</i>	Carsphairn, Shiel.	9.66	...	<i>Ork.</i>	Pomona, Deerness .....	1.90	103
	Dumfries, Cargen .....	7.36	...	<i>Shet.</i>	Lerwick .....	3.69	207
<i>Dumf.</i>	Eskdalemuir Obs.	7.87	250	<i>Cork.</i>	Caheragh Rectory .....	8.18	...
<i>Roab.</i>	Braxholm .....	5.40	240		Dunmanway Rectory...	7.57	216
<i>Selk.</i>	Etrick Manse .....	7.57	...		Ballinacurra .....	5.24	201
<i>Peeb.</i>	West Linton .....	4.88	...		Glaumire, Lota Lo. ...	5.65	209
<i>Berk.</i>	Marchmont House.....	5.39	229	<i>Kerry.</i>	Valentia Obsy. ....	5.84	183
<i>Hadd.</i>	North Berwick Res.	4.35	262		Gearahameen .....	11.80	...
<i>Midl.</i>	Edinburgh, Roy. Obs.	5.18	280		Killarney Asylum .....	...	...
<i>Ayr.</i>	Kilmarnock, Agric. C.	4.24	193		Darrynane Abbey .....	6.22	198
	Girvan, Pinmore .....	4.38	152	<i>Wat.</i>	Waterford, Brook Lo...	6.34	236
<i>Renf.</i>	Glasgow, Queen's Pk.	4.66	202	<i>Tip.</i>	Nenagh, Cas. Lough...	4.33	177
	Greenock, Prospect H.	7.01	212		Roscrea, Timoney Park	4.72	...
<i>Bute.</i>	Rothsay, Ardenraig.	6.19	202		Cashel, Ballinamona..	3.68	160
	Dougarie Lodge .....	4.26	...	<i>Lim.</i>	Foynes, Coolnaues....	4.27	166
<i>Arg.</i>	Ardgour House .....	7.46	...		Castleconnel Rec. ....	5.26	...
	Manse of Glenorchy ...	6.27	...	<i>Clare.</i>	Inagh, Mount Callan..	5.40	...
	Oban .....	5.17	...		Broadford, Hurdlest'n.	4.52	...
	Poltalloch .....	4.33	142	<i>Weaf.</i>	Newtownbarry .....	6.26	...
	Inveraray Castle....	7.14	180		Gorey, Courtown Ho ..	5.57	229
	Islay, Eallabus .....	4.46	178	<i>Kilk.</i>	Kilkenny Castle .....	3.89	160
	Mull, Benmore .....	...	...	<i>Wic.</i>	Rathnew, Clonmannon	5.09	...
	Tiree .....	2.58	...	<i>Carl.</i>	Hacketstown Rectory..	5.57	199
<i>Kinr.</i>	Loch Leven Sluice.....	4.96	226	<i>QCo.</i>	Blandsfort House .....	3.98	154
<i>Perth.</i>	Loch Dhu .....	7.50	180		Mountmellick .....	5.47	...
	Balquhider, Stronvar	5.06	...	<i>KCo.</i>	Birr Castle .....	4.35	188
	Crieff, Strathearn Hyd.	4.46	169	<i>Dubl.</i>	Dublin, FitzWm. Sq...	4.79	246
	Blair Castle Gardens ...	2.75	139		Balbriggan, Ardgillan.	4.42	220
<i>Forf.</i>	Kettins School .....	3.09	165	<i>Me'th.</i>	Beaupare, St. Cloud...	5.02	...
	Dundee, E. Necropolis	4.08	227		Kells, Headfort .....	5.50	208
	Pearsie House .....	2.65	...	<i>W.M.</i>	Moate, Coolatore .....	5.75	...
	Montrose, Sunnyside...	2.98	...		Mullingar, Belvedere..	6.15	236
<i>Aber.</i>	Braemar, Bank .....	2.96	151	<i>Long.</i>	Castle Forbes Gdns....	6.85	266
	Logie Coldstone Sch.	2.60	133	<i>Gal.</i>	Ballynahinch Castle ...	8.69	245
	Aberdeen, King's Coll.	3.28	192		Galway, Grammar Sch.	5.04	...
	Fyvie Castle .....	3.32	...	<i>Mayo.</i>	Mallaranny .....	7.07	...
<i>Mor.</i>	Gordon Castle .....	3.57	175		Westport House.....	5.53	205
	Grantown-on-Spey ...	2.98	132		Delphi Lodge .....	11.73	...
<i>Na.</i>	Nairn, Delnies .....	2.90	165	<i>Sligo.</i>	Markree Obsy .....	6.90	229
<i>Inv.</i>	Ben Alder Lodge .....	...	...	<i>Cav'n.</i>	Belturbet, Cloverhill...	4.59	188
	Kingussie, The Birches	2.82	...	<i>Ferm.</i>	Enniskillen, Portora...	7.34	...
	Loch Quoich, Loan ...	10.10	...	<i>Arm.</i>	Armagh Obsy .....	4.18	166
	Glenquoich .....	8.35	170	<i>Down.</i>	Fofanny Reservoir.....	7.21	...
	Inverness, Culduthel R.	3.42	...		Seaforde .....	4.39	159
	Arisaig, Faire-na-Squir	3.56	...		Donaghadee, C. Stn ...	3.79	163
	Fort William .....	...	...		Banbridge, Milltown...	3.00	117
	Skye, Dunvegan .....	4.98	...	<i>Antr.</i>	Belfast, Cavehill Rd ...	4.81	...
<i>R &amp; C.</i>	Alness, Ardross Cas. ...	3.29	146		Glenarm Castle .....	9.45	...
	Ullapool .....	3.45	...		Ballymena, Harryville	5.57	191
	Torridon, Bendamph...	5.58	137	<i>Lon.</i>	Londonderry, Creggan	6.09	216
	Achnashellach .....	6.01	...	<i>Tyr.</i>	Donaghmore .....	6.21	...
	Stornoway .....	3.30	142		Omagh, Edenfel .....	5.78	205
<i>Suth.</i>	Laig .....	2.70	...	<i>Don.</i>	Malin Head .....	4.47	209
	Tongue .....	3.56	174		Dunfanaghy .....	3.66	...
	Melvich .....	4.27	220		Killybegs, Rockmount.	4.92	129

## Climatological Table for the British Empire, January, 1928.

STATIONS	PRESSURE		TEMPERATURE						Relative Humidity.	Mean Cloud Am't	PRECIPITATION		BRIGHT SUNSHINE		
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values			Mean			Am't from Normal	Diff. from Normal	Days	Hours per day	Percentage of possible
			Max.	Min.	Max. 1/2	min. 1/2	Diff. from Normal								
mb.	mb.	mb.	o F.	o F.	o F.	o F.	o F.	o F.	%	0-10	in.	in.	1-7	17	
London, Kew Obsy: ..	1010.0	- 7.6	53	26	45.9	36.0	40.9	+ 2.0	89	6.1	1.91	+ 0.15	19	1.7	17
Gibraltar: .....	1024.0	+ 2.8	67	42	60.4	48.3	54.3	- 0.5	77	2.4	0.36	- 4.70	7	..	..
Malta: .....	1017.1	- 0.5	65	50	58.7	52.8	55.7	+ 0.4	83	7.5	6.83	+ 3.62	20	4.9	49
St. Helena: .....	1011.7	+ 1.9	71	57	68.3	59.2	63.7	- 0.8	93	9.1	1.80	- 1.17	17	..	..
Sierra Leone: .....	1011.0	+ 0.2	92	67	87.8	72.4	80.1	- 1.2	70	3.1	2.06	+ 1.65	3	..	..
Lagos, Nigeria: .....	1008.2	- 1.7	91	71	88.3	75.6	81.9	+ 1.0	83	6.7	1.77	+ 0.70	7	..	..
Kaduna, Nigeria: .....	1015.0	+ 3.4	93	67	90.2	69.8	80.0	+ 6.6	90	1.6	0.05	+ 0.06	2	..	..
Zomba, Nyasaland: ..	1008.5	+ 1.1	91	62	82.9	65.1	74.0	+ 1.2	79	7.0	9.49	- 1.61	22	..	..
Salisbury, Rhodesia: ..	1008.4	- 0.1	85	54	79.6	61.9	70.7	+ 1.0	73	7.5	7.34	- 0.13	21	6.5	50
Cape Town: .....	1014.6	+ 1.2	90	54	79.6	62.3	70.9	+ 1.0	72	3.2	0.54	- 0.16	6	..	..
Johannesburg: .....	1010.1	0.0	84	49	77.6	58.0	67.8	+ 1.3	74	5.4	5.90	- 0.27	15	7.2	53
Mauritius: .....	1013.1	+ 1.2	92	70	86.7	73.2	80.0	- 0.7	71	6.0	3.83	- 3.93	19	9.5	72
Bloemfontein: .....	..	..	92	49	84.1	60.3	72.2	- 1.0	66	4.0	4.15	+ 0.13	13	..	..
Calcutta, Alipore Obsy: ..	1016.0	+ 0.8	89	49	79.4	57.8	68.6	+ 2.2	82	2.5	0.17	- 0.17	1*	..	..
Bombay: .....	1013.3	- 0.3	87	65	83.6	69.4	76.5	+ 1.2	72	1.4	0.00	- 0.10	0*	..	..
Madras: .....	1013.9	- 0.2	93	69	88.6	72.9	80.7	+ 4.6	74	5.8	0.03	- 1.36	0*	..	..
Colombo, Ceylon: .....	1011.4	- 0.1	89	67	86.3	72.4	79.3	+ 0.2	75	5.2	6.27	+ 2.77	15	8.0	68
Hongkong: .....	1019.1	- 0.7	77	45	65.9	57.8	61.9	+ 1.7	82	8.0	1.88	+ 0.51	9	3.0	28
Sandakan: .....	..	..	89	73	87.6	81.5	84.5	+ 4.7	85	..	26.61	+ 8.16	22	..	..
Sydney: .....	1013.8	+ 1.3	101	60	78.5	64.7	71.6	- 0.1	66	5.2	2.58	- 1.15	14	8.3	59
Melbourne: .....	1014.5	+ 1.6	104	49	77.6	58.3	67.9	+ 0.4	60	5.5	4.04	+ 2.19	12	6.7	47
Adelaide: .....	1014.5	+ 1.5	109	51	82.8	61.4	72.1	- 1.8	38	5.0	1.01	+ 0.28	5	9.4	67
Perth, W. Australia: ..	1013.6	+ 1.1	100	52	85.1	62.6	73.9	- 0.0	50	4.3	0.85	+ 0.51	5	9.7	70
Oolgardie: .....	1013.1	+ 1.7	109	49	88.2	59.5	73.9	- 3.5	40	2.9	0.21	- 0.26	6	..	..
Brisbane: .....	1013.4	+ 2.1	92	62	83.8	67.9	75.9	- 1.3	68	6.3	6.15	- 0.12	19	8.3	61
Hobart, Tasmania: .....	1014.2	+ 3.9	101	47	72.6	54.2	63.4	+ 1.1	60	6.5	4.42	+ 2.63	14	7.4	50
Wellington, N.Z.: .....	1022.8	+ 9.5	78	45	68.2	53.4	60.8	- 1.7	73	5.5	0.19	- 3.14	5	10.1	69
Suva, Fiji: .....	1007.2	- 0.5	94	72	87.1	76.1	81.6	+ 1.7	77	6.5	9.65	- 1.07	24	6.5	50
Apia, Samoa: .....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kingston, Jamaica: .....	1015.8	+ 0.7	89	64	85.0	67.4	76.2	- 0.6	83	2.7	0.16	- 0.80	1	6.4	57
Grenada, W.I.: .....	1009.6	- 3.0	88	70	83.9	73.1	78.5	+ 1.5	79	4.6	4.12	- 0.31	25	..	..
Toronto: .....	1013.8	- 3.6	44	1	80.9	19.5	25.2	+ 3.1	76	4.8	2.30	- 0.57	14	2.6	28
Winnipeg: .....	1016.9	- 2.9	41	-25	15.7	1.3	8.5	+12.9	..	4.4	0.39	- 0.43	6	3.4	40
St. John, N.B.: .....	1011.0	- 4.7	48	-10	28.8	10.9	19.9	+ 0.7	67	7.0	4.98	+ 0.18	14	3.6	40
Victoria, B.C.: .....	1021.1	+ 5.8	51	24	44.7	38.9	41.8	+ 1.7	90	8.6	6.12	+ 1.61	17	1.7	20

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

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## The International Commission for Synoptic Weather Information

By LIEUT.-COL. E. GOLD, F.R.S.

The meeting of the International Commission for Synoptic Weather Information in London during the week 29th May to 2nd June marks another stage in the progress towards the ideal of the world weather map. The Commission used to be known as the Commission for Weather Telegraphy, but, like many children, it became dissatisfied with the name which its parents gave and adopted a new title at Utrecht in 1923, with the consent of its parents. Many people think the old and simpler title is the better, but the use of the word "synoptic" has become so extensive in meteorological circles that it was almost inevitable that the Commission should eventually become known as the Synoptic Commission.

Meetings of Commissions usually follow one another with intervals of three years, but in this case an interval of less than two years has elapsed since the previous meeting (at Zürich in September, 1926). In the interval between the two meetings the International Radio Telegraphic Conference had met at Washington in the autumn of 1927 and had been duly "seized" of the claims of synoptic meteorology in radio telegraphic matters. Meteorological reports for synoptic purposes are practically useless unless they are received very quickly—the ideal of the forecaster is a series of synoptic charts the last one giving an instantaneous view of the existing meteorological situation at the moment when he is putting the last touch on his forecast. At present the ideal is unattainable: progress

towards it was made when the International Telegraphic Conference at Paris gave international priority to meteorological messages: it has been further assisted by the grant at Washington of the same priority in respect of radio telegraphic messages.

An even more important matter, from the point of view of synoptic meteorology in Europe, was the resolution of the Washington Conference that two wave-lengths should be reserved for use, in Europe, in the distribution of collective synoptic reports. The Synoptic Commission had to decide whether each country issuing collective synoptic reports should be asked to adopt one or other of these two wave-lengths or whether the existing scheme for the exchange of reports in Europe should be replaced by a different one. The Commission took the view that the scheme of exchange of reports should be changed. At present it is necessary for each country which desires to have a complete synoptic chart for the European area to arrange for the reception of between twenty and twenty-five wireless issues made by different stations on different wave-lengths. Under the new scheme proposed by the Commission the reports from all the countries of western Europe would be issued from a wireless station on one of the reserved wave-lengths in France; those from the rest of Europe, excluding Russia and the Balkans, would be issued from a station in Germany on the other reserved wave-length. The reports from Russia and Siberia would be transmitted from an existing station whose wave-length is already fixed and is different from the wave-lengths used for the rest of Europe. The re-transmission of the reports for south-eastern Europe and Asia Minor would be either from an existing station or from a station with one of the two reserved wave-lengths, at a time when the stations in France and Germany were not transmitting on that wave-length. Details of the arrangement have been referred for elaboration to a special sub-commission. If and when the arrangement can be put into operation it will not merely make it easier for services to arrange for the reception of the necessary reports, but it will also largely remove the difficulties which arise from the non-reception of many reports from distant countries, issued from stations of comparatively low power.

The second important question considered by the Commission is comparatively new. The ocean constitutes about two-thirds of the surface of the globe and the meteorology of the ocean has been studied practically only in its statistical or climatological aspect. Efforts have been made by different countries in the last 20 years to develop the synoptic representation of the ocean but the result, though extremely useful to forecasters in Europe, has been lamentably inadequate when compared with the synoptic representation of land surfaces. International co-operation is as vital for the synoptic meteorology of the



ocean as it is for that of the land, but it is much more difficult to achieve. The co-operation has necessarily to be of a different character because the ocean cannot be parcelled off among different countries: observing stations (ships belonging to different countries, *e.g.*, France, Norway, Holland, America, Great Britain, will all be required for the representation not merely of the whole ocean but of any part of it. A special sub-commission had been appointed at Zürich to consider the method of collecting and distributing these reports. The sub-commission met in Paris in May under the chairmanship of General Delcambre, Director of the National Meteorological Office of France, and prepared a scheme for the consideration of the Commission. The Commission gave its approval to the scheme which includes the collection of reports from all ships at selected wireless stations and for the repetition of the reports received for the benefit of all countries. It is anticipated that one collecting and distributing centre will be at the Azores. The scheme further provides for the reports to be made in a universal code and for the observations to be made at standard hours of Greenwich time in all the oceans. Steps will be taken in the matter of consulting the services interested as soon as possible so that the approval of the International Meteorological Committee to a definitive plan may be obtained when the Committee meets in 1929.

At the meeting of the Commission held in London in 1920 a new International Code was adopted for use in telegraphic meteorological reports, and this was approved by the International Meteorological Committee in 1921. The code marked a great advance on the pre-war codes but at the time of its introduction neither the Norwegian ideas of the polar front nor the French ideas of the systems of cloud had been much developed: these ideas profoundly affect modern forecasting; they must therefore affect the conception of a code for telegraphic reports. Moreover as the meteorological map extends in area, the necessity of a world-wide code becomes increasingly obvious. The revision of the code prepared in 1920, which applies primarily to the temperate zone, is therefore inevitable if it is to become universal and in conformity with the recent advances in meteorological science. The first steps towards its revision were taken at the meeting at Utrecht in 1923; further advance was made at Zürich in 1926; and at the recent meeting a new code was prepared which is designed to meet requirements in all countries: polar, temperate and tropical; and to give an adequate description of those skies which are found to be characteristic of different "air." This new code also is to be communicated to meteorological services in all countries for their consideration, preliminary to a decision being taken at the meetings of the Conference and Committee next year.

Lastly, the Commission, which is composed of men who are face to face both with the practical difficulties arising from diversity of units and with the difficulties arising from a change in the unit used in their own services, resolved by 15 votes to 2 that in synoptic messages issued by wireless telegraphy for international exchange the pressure will be expressed in millibars. The dissentients were Dr. la Cour, of Denmark, and Dr. Pouichet, of Russia, who expressed himself as favourable to the proposal though he did not consider that it would be at present practicable to introduce it in the Russian Meteorological Service. The Commission did not feel able to arrive at a similar decision in regard to temperature—possibly because no Bjerknes has yet found the thermal counterpart of the millibar: but it requested one of the sub-commissions to “examine the question of the unification of the reports of temperature in international messages on the basis of the Centigrade scale.”

Nearly all the European members of the Commission were present at the meeting and for the first time since the war, representatives of the United States of America attended, *i.e.*, Dr. Marvin, Chief of the U.S. Weather Bureau, and Mr. E. B. Calvert, Head of the Forecast Service of the Bureau.

The arduous work of the business meetings of the Commission was relieved very sociably by a reception by Dr. and Mrs. Simpson at the Meteorological Office, on Tuesday, 29th May, very hospitably by a luncheon given by the Government on Thursday, 31st May, and very instructively by a visit arranged by the Royal Meteorological Society to Croydon Aerodrome on Thursday afternoon, 31st May. The week of the meetings was one of very pleasant weather—by coincidence.

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## The Seventh Cruise of the *Carnegie*

By R. E. WATSON, B.Sc., Ph.D.

On the morning of 1st May, 1928, the non-magnetic brig *Carnegie*, decked out in new white paint, new masts and sails, left Washington on a three-years' cruise over tracked and trackless seas. To the world of science, to navigation, to surveyors and explorers, this event was of extreme importance, for the *Carnegie* is one large floating laboratory, with physical, chemical and biological sections, in which, for three years, intensified scientific research will be pursued over every ocean of the world.

Up to the end of the 15th century, it was thought that the compass needle always pointed in a fixed direction towards true north. Then during the progress of his voyage across the

Atlantic, by observation of the stars, Columbus discovered a shift of the needle from true north, whereupon it is stated, he turned his compass card round to correspond to the variations of the needle in order to allay the suspicions of his crew. Now, of course, we know that the compass needle is directed towards the magnetic north pole which lies about 1,000 miles from the geographical north pole in latitude  $70^{\circ}$  N. and longitude  $96^{\circ}$  W.; approximately. It was not, however, until 200 years after Columbus's discovery that the astronomer Halley, in 1698, conducted extensive observations over the sea of the difference between the pointing of the compass needle and the geographical north, that is the magnetic declination. This led to the issue of his now famous declination charts upon which mariners depended for a long time afterwards. Similar charts at the present time are very much altered owing to the rapid changes which have taken place in the earth's magnetic state since Halley's time. To give some idea of the changes which have actually occurred, taking London as an example, if we go back to Queen Elizabeth's time (1580), the magnetic declination had its largest easterly value then, namely  $11^{\circ}$  E. It gradually diminished until about the time of Cromwell's death (1658), when the magnetic north coincided with the geographical north. From this time the declination increased in a westerly direction until about the time of the Retreat from Moscow (1812), when it had its maximum westerly value of  $24^{\circ}$  W. Since then the westerly declination has decreased at a variable rate, until at the present time it is  $12\frac{1}{2}^{\circ}$  W. In London for the past ten years the average rate of decrease of westerly declination has been one minute of arc per month, or one-fifth of a degree per year, while over the Indian Ocean the change has been more rapid, being about one-third of a degree per year. Thus it will be seen that simply for purposes of navigation and surveying by compass needle it is absolutely necessary to keep track of the magnetic changes going on over the earth.

On land continuous magnetic changes are recorded at fixed observatories, while periodic surveys serve to determine variations in the rate of change over large areas. Over the oceans, however, observational work is not so easily organised, and special voyages must be undertaken to keep information up to date.

Soon after its inception in 1904, the Department of Terrestrial Magnetism of the Carnegie Institution of Washington decided to put declination charts over the ocean on a correct footing if a suitable ship could be found. The main consideration was to have as little iron as possible in the construction of the vessel so that magnetic observations would be unaffected by local magnetic material. A sailing ship, the *Galilee*, was chartered to undertake, in the first place, a magnetic survey

of the Pacific Ocean. Between 1905 and 1908 three cruises were made, but from the experience gained, it was proved conclusively that for ocean magnetic surveys, it was necessary to have a vessel designed with the special needs in view, in fact, a true non-magnetic ship.

To meet these needs, the *Carnegie* was built, and launched in 1909, and she can truly lay claim to her description of non-magnetic. She is a brig built of white oak with her keel and hull sheathed in copper. Her rigging is of hemp, not steel, while her pure bronze anchors are carried by heavy Manilla cable, 11 in. diameter. Her galley ranges, locks, pots, pans, rails, bolts, nails, etc., are all made of copper, bronze, or gun metal, and even the buttons of the crew's uniforms are of bone or brass. Although speed is not the predominant note in her design, under full canvas in a favourable wind she can move with the speed of an ocean liner. She is not dependent, however, solely on the wind, but is fitted with a 100-h.p. bronze engine which will carry her along at six knots in a calm. The engine is an internal combustion one, which, owing to the difficulty of storing (and in some regions of procuring) petrol, is run on producer gas, and only a few essential parts of the engine are of steel. In all there is only about one ton of iron in the whole of the brig, and this is all so far removed from the magnetic instruments in the deck houses as to be quite ineffective. The vessel is constructed on the very best lines, combining the finish and workmanship of a yacht with the sturdy strength of a merchant ship.

The main purposes to be served by the *Carnegie* were the changes in the magnetic elements all over the globe; special problems concerning seasonal, annual and secular variations, magnetic storms and aurorae, the connexion between magnetic disturbances and the 11-year sunspot period and to test theoretical considerations of the origin of the earth's magnetic field. Later on with the improvement in instrument design and observational methods it was decided to make atmospheric electrical observations and regular readings of the earth's electric field, conductivity of the air, ionic content and radio-active content of the air were made.

Six cruises have already been made and all the oceans have been surveyed several times. Since the magnetic work on the present and seventh cruise is primarily to secure secular variation data in terrestrial magnetism, the route to be followed will cover as nearly as possible that of previous cruises, but the programme of work has been considerably enhanced. In addition to the magnetic and electrical investigations, it has been arranged to carry out researches in physical and biological oceanography.

For the measurement of the magnetic elements, declination, horizontal intensity and dip, instruments and methods of observing have been improved to give the best results for a minimum expenditure of labour and time, so that more time is available for other work. In the atmospheric electrical programme, besides taking records of the conductivity of the air, it is proposed to study diurnal variations of the earth's electric field at more widely distributed stations than previously, in order to test the suggestion that such variations progress according to universal time, a deduction first indicated by results obtained on the *Carnegie*. Additional measurements of the penetrating radiation, or "cosmic rays" are to be taken with a new Kohlhörster instrument, special regard being taken of the variations with time, geographical position and depth, with the corresponding salinity and temperature of the water. Nuclei in the atmosphere will be counted with an Aitken dust-counter and correlated with the ionic content and conductivity of the air. An attempt will also be made to measure marine electric currents by trailing electrodes on cables from the stern of the vessel.

Investigations in physical oceanography allow for a study of the topography and configuration of the ocean bed. Every 150 to 200 miles the ship will be kept stationary for four or five hours by sea anchors while soundings are made with a sonic depth finder, up to a maximum of 20,000ft. Temperature and pressure will be measured, and samples of water at various depths will be obtained for analysis.

The marine biology work will consist mainly of the determination of the distribution and abundance of plankton (the fundamental food supply of fish) and other small organisms down to a depth of 600ft. In shallow water dredging will be carried out to bring to the surface diatoms and foraminifera for microscopic study, while in certain isolated regions specimens of porpoises, dolphins, birds, &c., will be collected.

Marine meteorology will be studied by observations of barometric pressure, wind direction and velocity. Also, in view of the effect of ocean currents on climate, the interchange between the surface of the ocean and the air above it will be obtained by measurements of the lapse rates of temperature and humidity in the first 100ft. above the sea. Solar radiation observations will also be carried out.

The *Carnegie* carries a staff of seven scientists and a crew of seventeen men under the command of Capt. J. P. Ault, who was in command on her 3rd, 4th and 6th cruises. She will visit 26 foreign ports, in each of which she will stay for anything from 2 to 25 days free of all duty or port charges, a courtesy extended to her for her services to navigation. During re-victualling in port opportunity will be taken for a comparison

of instruments with any land stations that may be conveniently available. The *Carnegie* has already visited Plymouth, Hamburg and Reykjavik and thence is now on her way to Barbados, which should be reached by the end of September next, after 50 days at sea. She will return to Washington about September, 1931, with a cargo rich in scientific treasure, having added 105,000 miles to her previous 291,000 miles voyaging.

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## Royal Meteorological Society

By permission of the Air Ministry a special meeting of the Society was held at Croydon Aerodrome on 31st May, 1928. After a brief address of welcome by Sir Richard Gregory, President, supported by Dr. G. C. Simpson, Director of the Meteorological Office, a Lecture on the "Development of Meteorological Services for Aviation" was delivered by Capt. F. Entwistle, Superintendent Aviation Services Division, Meteorological Office. Capt. Entwistle explained the organisation by which pilots were not only informed of the weather conditions over the route they were flying at the time of the commencement of the flight, but also of the changes likely to occur and the prevailing conditions at neighbouring stations, so that an alternative route could be taken in the event of bad conditions on the normal route.

Tea was provided at the Aerodrome Hotel and afterwards guides conducted parties to the various points of interest in the Aerodrome. A popular feature of the afternoon was the opportunity provided by Imperial Airways Ltd. to make short flights at a reduced charge in commodious air liners specially detailed for this purpose. About one-third of the company took advantage of this opportunity to make an ascent.

About 200 Fellows and their friends were present, including representatives from the International Commission for Synoptic Weather Information, who were attending a Conference at the Air Ministry.

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

### *Report on the Phenological Observations in the British Isles, December, 1926, to November, 1927.*

1927 was summarised by the Meteorological Office as "A wet year with a dull and wet summer." As in many recent years, early warmth, inducing also early bloom on fruit trees, was precursor of destructive cold spells in April, May and even early June, when sunless drought prevailed as well. Then followed a wet, cool, sunless summer. But in the yearly totals tempera-

ture and rainfall make a fair showing. It is when these data are considered by the quarter, still more month by month, or week by week, that their mischievous nature is apparent. An additional table of some interest compares land and sea temperatures around the coasts of Great Britain. The average sea temperatures were  $48^{\circ}$ ,  $50.5^{\circ}$ ,  $53^{\circ}$  on the east, west and south coasts respectively for the year. For the phenological nine growing months, December to August, these values were  $47.8^{\circ}$ ,  $49.3^{\circ}$ , and  $51.3^{\circ}$ , respectively  $1^{\circ}$ ,  $2^{\circ}$  and  $1^{\circ}$  warmer than on the adjacent land. On all coasts the sea was coldest in February, warmest in August; in the west and south colder in May than November. The mean flowering date was actually early, though after May practically all were late. The early migrants, on the other hand, were retarded two days, the later were a day early. The final results for farming were bad; in many parts, especially north-east Scotland, disastrous. Only apples and raspberries gave a good fruit crop, but the exceptional wet coolness gave a wealth of herbaceous blossom. October was the only redeeming feature in the latter half of the year.

*C. K. M. Douglas.*—*On the relation between temperature changes and wind structure in the upper atmosphere.* (Memoir Vol. I., No. 7).

On the assumption that the wind velocity is "geostrophic," the horizontal gradients of temperature in the free air can be deduced from the variation of wind with height at a given time, and the temperature changes due to purely horizontal movements readily follow. (This subject has been developed chiefly by Shaw in this country and by Exner on the Continent, the latter giving a formula for the change of temperature at a given point.) This paper gives a comparison between the temperature changes calculated on the above assumptions, and the observed temperature changes based on a considerable number of observations for the years 1920 to 1925 inclusive. The results show that the correlation between the observed and theoretical changes is a little less than 0.5, both for 6-hour and 24-hour time-intervals, but is higher for large temperature changes.

*R. M. Poulter.*—*Simple formulæ for computing relative humidity.*

By means of the formulæ given in this paper relative humidity can be calculated readily from readings of dry and wet bulb thermometers without reference to tables. For air temperatures around  $60^{\circ}\text{F}$ . the "relative dryness" of the air is given by  $\frac{1000}{3} \times \frac{\text{depression of the wet bulb}}{\text{dry bulb reading}}$ . The required relative humidity is given by subtracting this "dryness" figure from 100. Slight modifications of the  $\frac{1000}{3}$  provide for a range from

below freezing point to about 120°F. Primarily intended for mental use with the Fahrenheit scale, the formulæ can be adapted to Centigrade readings simply by adding 18 (or strictly 17·8) to the dry bulb reading before making the computation.

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### Phenomena Preceding Lightning

In the *Meteorological Magazine*, June, 1928, p. 113, Mr. R. S. Breton writing from Tung Sung, S. Siam, states that on a number of occasions he has noticed a sharp "vit" or "click" accompanying lightning that has struck something in the immediate neighbourhood, preceding the thunder by a perceptible fraction of a second.

He adds that he has three times noticed that animals show alarm immediately before a flash, and that in one case a dog walking on grass turned and began to bark angrily in the direction of a very strong flash that came  $\frac{1}{4}$  second after, striking several of a group of trees 200 yards away. He mentions two occasions when fowls rushed for shelter from the open in alarm before a very near discharge actually took place. In each case the discharge was a very powerful one, taking place on dry soil before rain had fallen. He asks "if it may be that the sensitive feet of the dog could detect vibrations before the discharge took place."

The Editor of the magazine answers "that the 'vit' or 'click' accompanying lightning which has struck close by appears to be new; no reference to any similar observation can be found in the literature, and at present it is not possible to offer any explanation."

Clicks, preceding intense lightning flashes are common at Blue Hill Observatory and undoubtedly can be heard elsewhere under certain conditions, when an insulated metallic conductor is exposed in a strong electric field, and a grounded conductor is close by. At Blue Hill every intense flash within a radius of 1,000 metres gives this click preceding thunder by an interval which is a function of the distance of the flash.

Intervals as large as 6 seconds indicating a flash distant 2 kilometres or more, have been noted.

Regarding the behaviour of the dog, it would seem to be not so much a question of sensitive feet, as a matter of insulation, and increasing electrification, to a degree that the hairs for instance become discharging points. This bristling can be seen readily on animals caught in thunderstorms near the top of a



mountain. I recall being near the summit of Mt. Whitney (4,420m. above sea-level, 14,502ft.) during a thunderstorm. The hairs of the burros (pack animals) stood out straight, and a faint hissing could be heard. A metal button on my cap gave a tingling sensation. I kept wondering how long it would be before a flash of lightning would demolish the entire party of astronomers as they proceeded in close formation to the summit. I think we had a narrow escape from disaster. During a week's stay at the summit, we had several thunderstorms, when the lightning seemed to be below us.

The feeling of uneasiness preceding lightning flashes may be due, aside from effects of pressure, temperature and humidity, to the increasing electrical strain, as a charged cloud comes over the position of the observer. We know from our quadrant electrometer measurements that at such times the potential gradient increases steadily from 50 volts per metre to ten thousand or more. A jet of water from an insulated collector exhibits many interesting changes as the charged cloud approaches. In fact, we can tell just about when the flash will occur. We can also detect and record discharges which an observer fails to detect, if dependent on the eye alone. With each flash there is an instantaneous equalisation of potential and return of the index spot of light to zero.

ALEXANDER MCADIE.

*Harvard University, Blue Hill Observatory, Mass., U.S.A. 10th July, 1928.*

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### Unusual Thunderstorm Phenomena

With regard to the correspondence in the issues for June and July, 1928, I have heard on two occasions a "click," or "crack," accompanying a comparatively near discharge of lightning.

In the course of a rather severe thunderstorm during the evening of 12th July, 1924, I and two other members of the staff whilst in the main building of this Observatory heard a loud, sharp "crack," the sound appearing to come from the direction of the pressure-tube anemograph at the north-west part of the building. We were in a room to the east of that in which the recording portion of the anemograph is situated.

The second occasion was during a thunderstorm on 14th July, 1927. At 15h. 38m., G.M.T., those of us who were in the main building heard a very loud "crack" (somewhat similar in character to the sound which accompanies an electric spark discharge) which slightly preceded a particularly loud crash of thunder. Two of us who were in different rooms at the west end of the building thought that the "crack" sound came from the more easterly part of the building; while of the two people who were situated in the central room (which contains a telephone)

one thought that the sound came from a room to the east and the other that the sound came from the telephone circuit. My wife, who was in a building some forty yards to the west of the main building, heard no "crack," but was sufficiently impressed by the violence of the particular crash of thunder to look to see if the main building had been struck. Careful examination of the ordinary magnetic records reveals a perceptible faintness of the photographic trace for about a minute after 15h. 38m.; thus indicating that the recording magnets were oscillating after a sudden displacement caused by the magnetic field change associated with the lightning discharge. The magnitude of the presumed initial sudden displacement cannot be determined. A much larger effect is seen on the photographic record obtained of the indications of a galvanometer connected to a large loop of insulated cable resting on the ground to the north-west of the Observatory.

The main building is furnished with a lightning conductor.

H. W. L. ABSALOM.

*The Observatory, Eskdalemuir, Langholm. 23rd July, 1928.*

### Ancient Hindu Meteorology

Various Indian weather lores have already been recorded but perhaps it is not widely known that ancient Indian *rishis* or savants also speculated on meteorological problems with a scientific touch. Readers of the *Meteorological Magazine* may be interested to know that an antiquarian scholar and the owner of a unique private museum of curios in Bombay, Mr. Purushottam Visram, has collected a number of rare Sanskrit manuscripts. For want of facilities it has not yet been possible to study these valuable records in detail. Mr. Visram, however, has published one of his lectures on the natural philosophy of ancient India, delivered before the seventh Gujarati Literary Conference held at Bhavnagar in 1924. In this lecture he mentions a list of forty-nine different scientific treatises by different ancient *rishis* now in his possession.

Of these treatises the one by Angiras entitled *Meghautpatti* (*On the origin of rain*) is of interest to meteorologists. Angiras mentions twelve kinds of clouds and their nine forms and discusses the processes of their formation. He describes twelve different kinds of rain, sixty-four kinds of lightning, the causes of thunder, thirty-two kinds of thunder and twenty-one kinds of thunderbolts and speculates as to how and when thunderbolts occur. He also mentions eight varieties of hail and the relation between the size of raindrops and the growth of insects. In another treatise the same *rishi* discusses the physical aspects of the incidence of sun's rays on clouds, the modification of solar radiation by the intervention of clouds, and the

effect of the radiation so modified on the growth of seeds. The exact date when Angiras lived cannot unfortunately be given accurately, but he certainly was one of the celebrated *rishis* in the hoary *vedic* age. It is regretted that further details cannot be given unless and until the old manuscripts are carefully studied by a competent Sanskrit scholar.

S. N. SEN.

Poona. May, 1928.

### The Folklore of Storms

On 8th July Shanghai was visited by a severe typhoon. According to the official Chinese mythology such disturbances are caused by the flight of one of the Dragon Kings, but apparently on this occasion the natives preferred to attribute the tempest to the "spirit" of the late Marshal Chang Tso Lin.

Such a belief in regard to sudden storms is wellnigh world-wide and a few examples may be of interest.

On 27th August, 1590, Pope Sixtus V lay dying in Rome, and as he breathed his last a storm broke over the Quirinal Palace. The superstitious Roman populace fully believed that the Evil One had come to carry off the soul of the unpopular Pontiff in the storm.

In Germany when a sudden wind blew it was long said someone had hanged himself—the spirits were welcoming their comrade. In France it was the Wandering Jew passing by. In Scotland and Ireland the little dust-whirls that spring up on a hot day are due to the fairies, but the Irish also say that such a whirl is a company of souls, and if a piece of paper is caught up by the whirlwind it is the soul of an unbaptised child going to burial.

The tornado of the United States ought to have a place in the folklore of the American Indians but the writer is not aware of any myths referring to it.

Examples of similar beliefs to the above could be given from Arabia, (the "Jan"), South America, Australia and Fiji. There is a good collection in Sir James Frazer's monumental work the "Golden Bough."

This information was supplied to the writer by Miss I. Grubb, of Seskin.

CICELY M. BOTLEY.

17, Holmesdale Gardens, Hastings. 10th July, 1928.

### Screen Minimum Temperatures at Cranwell during Radiation Nights in Early Spring

In the *Meteorological Magazine* for February, 1928, p. 20, the present writers gave approximate equations for the determination at Cranwell, Lincolnshire, of screen minimum tempera-

tures during radiation nights in winter derived from a consideration of data of the preceding 15h. In view of the importance of frosts in early spring to agriculturists and others, it was thought desirable to extend the inquiry to that season, defining early spring as the months of March and April. The period examined stretched from 1st March, 1921, to 30th April, 1927, and a "radiation night" was defined as in the previous note, but the data for relative humidities and dew points employed were those of the preceding 18h. instead of the preceding 15h., as it was found that using the later hour gave much better results for the months being considered than did the earlier hour. The wind data were obtained as before.

In determining the equations representing the relationships by the usual graphical method, a two-fold differentiation with regard to wind force during the night was adopted this time in view of the smaller number of available occasions, but the same differentiation with regard to relative humidity was maintained.

As events turned out, however, there were too few cases of radiation nights with a relative humidity of 85 per cent. or more to justify any generalisations. But this is of less importance when it is remembered that, normally, the lower screen minima would be given with the relative humidities at 18h. below 85 per cent. The two equations remaining are shown in the following table,  $T$  being the expected night screen minimum and  $D$  the dew point at the preceding 18h. They fit the actual results well, there being no very marked divergencies. As in the previous note the equations only hold for values of  $D$  greater than  $32^{\circ}\text{F}$ .

Mean wind speed	Relative humidity at 18h.	Equation	No. of cases available
8 m.p.h. or over	below 85%	$T = 0.80D + 3.5$	34
less than 8 m.p.h.	below 85%	$T = 0.75D + 1.5$	14

W. H. PICK.

J. PATON.

*R.A.F. Cadet College, Cranwell, Lincolnshire. 24th February, 1928.*

### A Coloured Solar Halo

On 30th June last, at 13h. 50m. (G.M.T.) I saw a brilliantly coloured solar halo from near Banstead Downs, Surrey (midway between Belmont and Carshalton Beeches railway stations). The only part visible was a segment of about  $30^{\circ}$ , in front of a dark

cumulus cloud, which was at an angular distance of about  $20^{\circ}$  to the west of the sun. The neighbouring parts of the sky were bright, and no other part of the halo could be seen.

The brightest colours were red, yellow and blue, and the general appearance resembled that of a primary rainbow (except, of course, that the colours were in the reverse order).

I could see no signs of cirrus clouds in the sky and was, therefore, surprised to see this halo, which disappeared when the cumulus cloud had moved away from its position at about  $20^{\circ}$  from the sun.

L. G. VEDY.

8, Grosvenor Avenue, Wallington, Surrey. 5th July, 1928.

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## NOTES AND QUERIES

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### The Warm Spell of July, 1928

The warm spell over southern and south-eastern England for which July, 1928, will be meteorologically remembered may be said to have commenced on the 10th when the shade maximum temperature at Kew reached  $77^{\circ}$  and to have terminated on the 28th when the shade maximum temperature at the same place was  $72^{\circ}$  to be succeeded by  $67^{\circ}$  as the reading on each of the following two days.

The beginning of the month saw a large anticyclone situated between the Azores and eastern North America, whilst a large depression was off the Irish coast. The anticyclone slowly spread eastward from the Azores, but it was not until the morning of the 9th that it could be said to have brought southern England under its domain, depressions having dominated the situation there in the meanwhile. On that date the anticyclone practically spanned the Atlantic between the British Isles and North America and it continued to extend eastward until by the 11th it had covered France and Germany in addition. The huge anticyclone was split by a depression in mid-Atlantic on the 16th, but re-established itself in its entirety on the 21st. The end of the warm spell in England came with the appearance off the coast of Ireland on the morning of the 26th of a small secondary depression which moved eastwards carrying the usual depressional features with its passage and being but the first of a chain of similar disturbances, the anticyclone in consequence receding south-westwards from our coasts.

Some of the figures for London during the spell may not lack in interest. At Kew, the highest shade maximum temperature recorded during the period, the 10th to 27th, inclusive, under review, was  $87^{\circ}\text{F.}$  on the 15th and the lowest shade maximum temperature  $73^{\circ}\text{F.}$  on the 19th. The absolute maximum at Kew

was, however, exceeded at other London stations which reached  $90^{\circ}$  or more, Greenwich attaining  $92^{\circ}$  on the 22nd and  $91^{\circ}$  on the 15th, whilst at Camden Square  $92^{\circ}$  was recorded on the 15th and  $90^{\circ}$  on the 14th. No rain fell at Kew during the period 9th to 25th, inclusive. Towards the end of the spell there came two abnormally warm nights. The first was the night of Monday, the 23rd, during which the shade minimum temperature in St. James' Park did not fall below  $66^{\circ}$ , whilst the second was the night of the following day, Tuesday, the 24th, during which the shade minimum temperature at Camden Square was  $67^{\circ}$  and at Kensington Palace, Kew and St. James' Park  $66^{\circ}$ . The comparatively high relative humidities accompanying these high temperatures made the conditions thoroughly oppressive. The high temperatures on the two nights in question are to be ascribed to clouding over preventing the air from cooling at anything but a slow rate. Yet another outstanding episode of London's weather during the spell was the extreme dryness of the air on the 18th when, at 13h., Croydon had a relative humidity of 25 per cent. and Kew of 35 per cent., a condition of things probably due to the slow descent of air from higher levels of the atmosphere.

Outside London, the southern, south-eastern and eastern districts enjoyed during the spell similar genial conditions to the Metropolis, sunshine being abundant and maximum temperatures of  $80^{\circ}$  or more frequent.

The spell should have done something to remove one rather widespread misconception. There is a common belief that very high surface temperatures must necessarily mean thunderstorms. It is, therefore, worth while noting that, apart from local occurrences in the English Channel on the 15th, no thunderstorms occurred at all in southern England during the spell except towards its very end when they were experienced on the morning of the 27th.

W. H. PICK.

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### Hot Weather and Thunderstorms

The July of 1928, like that of 1921, was distinguished by high temperatures, but very few thunderstorms. Even when clouds formed, the temperature above them was too high to permit of thunderstorm development, a state of affairs typical of persistent anticyclones. The figures for Kew Observatory for the last twenty years show that there is no appreciable correlation between the mean temperature of any particular month and the number of thunderstorms in that month, for the months May to August taken separately. The correlation co-efficient for July is negative, but it is too small to be significant. Even if one took individual days it is doubtful if one could obtain an ap-

preciable correlation, since many thunderstorms develop in polar currents, with day temperature somewhat below normal, and with temperature in the upper air much below normal, the largest deficiency occurring in the middle and upper levels of the troposphere. There can, however, be little doubt that a relation exists between the number of peals of thunder on any day and the mean temperature of that day, since storms of outstanding violence nearly always occur in comparatively warm weather.

C. K. M. DOUGLAS.

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## Reviews

*Veröffentlichungen des Forschungs-Institutes der Rhön-Rossitten-Gesellschaft.* Nr. I, Jahrbuch, 1926-27.

Most of this publication is devoted to problems in aerodynamics, but there are several articles on meteorological subjects. The most interesting of these is by Dr. W. Georgii on eddy winds formed in air currents crossing mountains, which produce local downward currents on the windward side and upward currents on the lee side. The local pressure differences responsible for the eddy winds are attributed to the temperature anomalies produced adiabatically when an air current with a stable lapse-rate of temperature is forced across a mountain.

C. K. M. D.

*Wirbelstürme und Sonnenflecken.* By O. Myrbach. Ann. Hydr. Berlin. VI., 1928, pp. 52-58, 91-96; and *Haben die Leoniden einen Einfluss auf das Wetter?* By O. Myrbach. Informations Bull. Ukrmets, Band 4-5, 1925-6, pp. 551-561.

The first of these two papers is an attempt to show that the passage of a spot group across the sun's meridian is generally accompanied or followed by a hurricane or typhoon in the tropics or by a tornado or waterspout in temperate regions. The material included a collection of catastrophes all over the world for 1926 and the first half of 1927. The research was difficult because both sunspots and catastrophes were so frequent that without any real connection most sunspots would be attended by a catastrophe, but the author finds that the association is somewhat closer than "expectancy." Isolated spot groups are most dangerous, and tend to give a repetition on their return after a solar rotation; the author discusses whether in certain circumstances a warning would not be justified but concludes that further study is first necessary in order to determine which part of the world should be warned.

One would say that the position which comets held in mediæval meteorology was being usurped by sunspots, but the

second paper does something to restore the balance. In 1925 a heavy rainstorm occurred in Vienna on 12th November, which was quite unjustified by the general meteorological situation; there were similar catastrophes in other parts of the world and as the day happened to coincide with the earth's passage through the path of the well-known Leonid swarm of meteors, the author suspected a connexion. His investigations persuaded him that this idea was well-founded, and that the 35-year Bruckner cycle is probably due to the Leonids.

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### Obituary

*Dr. F. A. E. J. Malmgren.*—It is with deep regret that we record the death of Dr. Finn Malmgren, the meteorologist of the *Italia*, who after the wreck of the airship while it was returning from the North Pole to Spitsbergen, lost his life in a gallant attempt to cross the ice to North-East Land.

Although he was only 32 years of age, Malmgren had acquired great experience in Arctic expeditions, both by sea and air. After studying at the University of Uppsala, he assisted Professor Hamberg at the high-level observatory of Portetjåkko, afterwards serving at the Meteorological Observatory of Uppsala, and at Professor Pettersson's Hydrographic Institute at Bornö. In 1922 he joined Captain Amundsen's Arctic expedition in the *Maud*, which drifted in the polar ice for two years. Although he did not return until 1925, in the following year he joined the Amundsen-Ellsworth expedition in the airship *Norge* which crossed the North Pole in the course of a flight from Rome to Alaska. He was next appointed lecturer in meteorology at the University of Uppsala, but gave up this work to join the expedition in the *Italia*.

So full a life left small time for writing, and Dr. Malmgren's great knowledge of meteorological conditions in the Arctic has been lost almost without record. His best-known paper is his discussion of the humidity and hoar frost observations during the *Maud* expedition; he also contributed a chapter to Amundsen and Ellsworth's history of the *Norge*—"The First Flight across the Polar Sea." In this country only those who had the opportunity of meeting him at Pulham can appreciate the magnitude of the loss which science has sustained in his untimely death.

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*Flight Lieutenant Lance Harold Browning, M.C., D.F.C., R.A.F.*—We learn with regret of the death of Flight Lieutenant L. H. Browning, who was killed in a flying accident at Holbeach Ranges on 2nd August.

Flight Lieutenant Browning was one of the first officers to be appointed for meteorological duties in connection with the Royal Air Force in the Middle East. He was attached to the



Meteorological Office, Air Ministry, for instruction in 1920 and in December of that year proceeded to Iraq where he was in charge of the Royal Air Force Meteorological Section. It was largely due to his zeal and capable organisation in conjunction with Squadron-Leader Oxland that the Royal Air Force Meteorological Service in the Middle East was successfully established. During his subsequent service in Egypt he not only maintained the essential meteorological organisation for the Royal Air Force, but carried out a valuable special programme of upper wind and free air temperature observations in connection with the airship development programme.

On his return to this country in 1925, Flight Lieutenant Browning relinquished meteorological work for general flying duties, but he always maintained a keen interest in meteorology and made good use of the knowledge acquired in applying it to flying. All who knew him will deeply regret his death, not only on account of his ability as an officer but also because of his charming and likeable personality. F. E.

*Miss E. D. Anderson.*—The death occurred on 19th July, 1928, of Miss E. D. Anderson, the pioneer of women's work so far as the Meteorological Office is concerned. Miss Anderson started work on 1st January, 1883, in connection with the preparation of "Synchronous weather charts of the North Atlantic and the adjacent Continents, 1st August, 1882, to 3rd September, 1883," and retired in 1913 on account of ill-health after more than thirty years' service.

*Dr. C. Chree.*—We regret to record the death on 12th August of Dr. Charles Chree, Superintendent of Kew Observatory from 1893 to 1925.

## The Weather of July, 1928

Fine, warm, dry, sunny conditions prevailed in general during July although for the first week the unsettled and rather cool weather so prevalent in June continued. A belt of low pressure, maintained from mid-Atlantic to Scandinavia, gave rain at times but bright intervals in most districts from the 1st to 4th; among the heaviest falls were 2·15in. at Sawrey (Lancs.) and 1·30in. at Eskdalemuir on the 1st, 0·78in. at Crowborough on the 3rd and 3·19in. at Bettws Garmon (Carnarvon) on the 4th. After this there was a general improvement in the south although slight rain was experienced at times until after the 9th. A belt of high pressure with a separate centre to the south-west of England then became firmly established, but depressions moving south of Iceland caused a gale at Blacksod Point on the 11th and general rain in Scotland and northern England; 2·60in. fell at Sawrey (Lancs.) and 2·18in. at Grange (Lancs.) on the 10th. Thereafter, although rather

unsettled weather continued at times along our north-west seaboard, the high pressure system remained the dominating feature until the 25th. A period of dry, fine weather set in over nearly the whole country with brilliant weather over the southern half of the kingdom and a rapidly rising temperature. More than 15 hours of bright sunshine were enjoyed at many places on several days and temperature rose above 85°F. locally in the 12th, 13th, 14th, 15th and 22nd. 90°F. was reached at Tottenham on the 15th and 92°F. at Greenwich on the 22nd for the first time since July, 1923. On the 14th 15·5hrs. of sunshine at Ross-on-Wye constituted a record for the station for July. Jersey also had 15·5hrs. on the 12th and Harrogate 15·5hrs. on the 15th. With 15·3hrs. at Edgbaston (Birmingham), the 14th was the sunniest day there for 41 years. A depression over Iceland moving east-south-east broke the dry spell over Ireland and Scotland on the 22nd and 23rd. In England rain fell generally on the night of the 26th-27th and thunderstorms occurred at many places, 2·30in. of rain fell at Chale (Isle of Wight) on the 27th and Mr. J. E. Cowper informs us that 2·04in. fell at Ventnor and 1·83in. at Shanklin, mostly between 2 and 4 a.m. on the 28th. This brought to an end an absolute drought that had lasted for 26 days at Llanthony Lock (Glos.) and 22 days at Chatteris (Cambridge), Felsted (Essex) and Melbury House (Dorset). Cooler and less settled conditions, with rain locally, prevailed until the end of the month over the whole country. The total sunshine for the month was above normal in the south, but below normal in the north. The total of 291hrs. at Kew was 90hrs. above normal, that of 255hrs. at Falmouth 30hrs. above normal and that of 202hrs. at Dublin 52hrs. above normal. At Stornoway, however, there was a deficit of 63hrs. and at Valentia one of 11hrs.

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Pressure was above normal over western and south-western Europe, the excess reaching 5.3mb. at Scilly and 4.5mb. at Madrid. With the exception of southern Gothaland pressure was below normal over the Scandinavian peninsula, Spitsbergen and Iceland, the greatest deficit being 11.3mb. at Vardo. From Iceland a trough of pressure slightly below normal extended southwards to the Azores. Temperature was above normal and rainfall below normal except in Scandinavia; over Sweden as a whole the rainfall was normal, a deficit in south-eastern Gothaland compensating for an excess in northern Norrland.

Severe thunderstorms were experienced in Germany, Poland and Switzerland early in the month which did much damage to the crops and fruit trees, and also interrupted communications. In Italy and Majorca the weather was dry and fine with a rising temperature. Towards the middle of the month the heat

wave spread over the whole of central Europe, temperatures over 90°F. being experienced in many places. Forest fires broke out in the eastern Pyrenees about the 20th. On the 19th the village of Oberammergau was flooded owing to a violent thunderstorm accompanied by heavy rain. Much damage was also done by a thunderstorm in the Savoy mountains on the 22nd. The fine weather continued generally until about the 30th, but the drought caused serious damage to the crops in Italy and Turkey. Forest fires occurred near Golling (Austria) from the 27th-31st.

The monsoon strengthened considerably on the 5th and rains fell generally in most of the Indian provinces; 14in. were measured at Colaba Observatory from the 1st to 7th. Towards the end of the month the Punjab was suffering from abnormal heat and humidity. In Burma the monsoon was unusually heavy, and Mandalay was flooded on the 21st while gales did damage at Tavoy, Moulmein and Rangoon. Blagoveshchensk (Siberia) and fifty villages in the Amur regions were flooded on the 31st, owing to the rising of the rivers.

A heat wave prevailed in Algeria during the first week of the month and forest fires occurred.

Good general rains fell in the agricultural districts of South Australia during the middle of the month.

The weather in Canada throughout the month was favourable for the growth of crops which were doing well. A severe heat wave occurred in New York from about the 9th to 20th with an interval of somewhat cooler weather about the 13th and 14th. Owing to the drought in Mexico many cattle died and the crops were burnt. Fine cold weather was experienced in Buenos Aires on the 1st to 5th proving beneficial for the crops. Heavy rain from the 28th to 31st caused further landslips at Santos (Brazil).

The special message from Brazil states that rain was scarce in the north being 1·93in. below normal, but in the centre it was plentiful being 2·01in. above normal and in the south it was 0·67in. above normal. The circulation was less active and three anticyclones passed over the country. During the last three weeks the temperature in the south was very low. Crops were generally in good condition, cotton, sugar cane, tobacco, cocoa and coffee were reaped. At Rio de Janeiro pressure was 0·6mb. above normal and temperature was 0·5°F. above normal.

### Rainfall, July, 1928—General Distribution

England and Wales	...	71	} per cent. of the average 1881-1915.
Scotland	... ..	91	
Ireland	... ..	63	
British Isles	... ..	<u>74</u>	

## Rainfall: July, 1928: England and Wales

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond.</i>	Camden Square .....	2.12	89	<i>Leics.</i>	Thornton Reservoir ...	1.19	48
<i>Sur.</i>	Reigate, The Knowle...	1.61	77	"	Belvoir Castle.....	1.15	47
<i>Kent.</i>	Tenterden, Ashenden...	1.11	53	<i>Kut.</i>	Ridlington .....	1.52	...
"	Folkestone, Boro. San.	1.16	...	<i>Line.</i>	Boston, Skirbeck .....	1.23	56
"	Margate, Cliftonville...	.98	49	"	Lincoln, Sessions House	.90	41
"	Sevenoaks, Speldhurst	1.92	...	"	Skegness, Marine Gdns	.94	43
<i>Sus.</i>	Patching Farm .....	2.04	85	"	Louth, Westgate .....	1.05	42
"	Brighton, Old Steyne	1.95	39	"	Brigg, Wrawby St. ...	.47	...
"	Tottingworth Park ...	1.61	64	<i>Notts.</i>	Worksop, Hodsock ...	.49	22
<i>Hants.</i>	Ventnor, Roy. Nat. Hos.	3.00	149	<i>Derby.</i>	Derby .....	1.33	56
"	Fordingbridge, Oaklands	1.65	83	"	Buxton, Devon Hos. ...	2.07	53
"	Ovington Rectory .....	1.63	63	<i>Ches.</i>	Runcorn, Western Pt.	2.05	75
"	Sherborne St. John ...	1.49	67	"	Nantwich, Dorfold Hall	2.01	...
<i>Berks.</i>	Wellington College ...	1.44	70	<i>Lancs.</i>	Manchester, Whit. Pk.	1.77	54
"	Newbury, Greenham...	1.78	80	"	Stonyhurst College ...	3.41	88
<i>Herts.</i>	Benington House .....	2.19	90	"	Southport, Hesketh Pk	2.68	94
<i>Bucks.</i>	High Wycombe .....	2.69	137	"	Lancaster, Strathspey	4.97	...
<i>Oxf.</i>	Oxford, Mag. College	1.83	81	<i>Yorks.</i>	Wath-upon-Dearne ...	.43	17
<i>Nor.</i>	Pitsford, Sedgebrook...	2.47	105	"	Bradford, Lister Pk. ...	.78	28
"	Oundle .....	1.98	...	"	Oughtershaw Hall.....	4.73	...
<i>Beds.</i>	Woburn, Crawley Mill	2.57	115	"	Wetherby, Ribston H.	.90	36
<i>Cam.</i>	Cambridge, Bot. Gdns.	...	...	"	Hull, Pearson Park ...	.50	21
<i>Essex.</i>	Chelmsford, County Lab.	1.74	82	"	Holme-on-Spalding ...	.65	...
"	Lexden, Hill House ...	1.66	...	"	West Witton, Ivy Ho.	.65	...
<i>Suff.</i>	Hawkedon Rectory ...	2.63	108	"	Felixkirk, Mt. St. John	.61	22
"	Haughley House .....	2.12	...	"	Pickering, Hungate ...	.67	...
<i>Norfol.</i>	Beccles, Geldeston .....	...	...	"	Scarborough .....	1.01	42
"	Norwich, Eaton.....	1.96	76	"	Middlesbrough .....	1.17	46
"	Blakeney.....	1.62	75	"	Baldersdale, Hury Res.	1.37	...
"	Little Dunham .....	2.29	83	<i>Durh.</i>	Ushaw College .....	1.49	53
<i>Wilts.</i>	Devizes, Highclere.....	2.43	105	<i>Nor.</i>	Newcastle, Town Moor	1.58	60
"	Bishops Cannings .....	2.57	103	"	Bellingham, Highgreen	2.04	...
<i>Dor.</i>	Evershot, Melbury Ho.	2.17	86	"	Lilburn Tower Gdns. ...	1.08	...
"	Creech Grange .....	1.68	...	<i>Cumb.</i>	Geltsdale.....	5.03	...
"	Shaftesbury, Abbey Ho.	2.26	88	"	Carlisle, Scaleby Hall	3.94	121
<i>Devon.</i>	Plymouth, The Hoe ...	1.89	69	"	Borrowdale, Rosthwaite	9.49	...
"	Polapit Tamar .....	2.16	80	"	Keswick, High Hill ...	5.22	...
"	Ashburton, Druid Ho.	1.95	64	<i>Glam.</i>	Cardiff, Ely P. Stn. ...	2.10	68
"	Cullompton.....	2.06	77	"	Treherbert, Tynywaun	5.38	...
"	Sidmouth, Sidmount...	1.50	60	<i>Carm.</i>	Carmarthen Friary ...	3.27	93
"	Filleigh, Castle Hill ...	2.51	...	"	Llanwrda, Dolaucothy	3.14	72
"	Barnstaple, N. Dev. Ath.	2.29	85	<i>Pemb.</i>	Haverfordwest, School	3.28	103
<i>Corn.</i>	Redruth, Trowirgie ...	1.63	53	<i>Card.</i>	Aberystwyth .....	3.89	...
"	Penzance, Morrab Gdn.	1.65	61	"	Cardigan, County Sch.	2.55	...
"	St. Austell, Trevarna...	1.86	58	<i>Brec.</i>	Crickhowell, Talymaes	3.00	...
<i>Soms.</i>	Chewton Mendip .....	3.39	97	<i>Rad.</i>	Birn W. W. Tyrmynydd	3.62	88
"	Long Ashton .....	3.17	...	<i>Mont.</i>	Lake Vyrnwy.....	2.01	59
"	Street, Hind Hayes ...	2.36	...	<i>Denb.</i>	Llangynhafal.....	1.04	...
<i>Glos.</i>	Cirencester, Gwynfa ...	2.69	104	<i>Mer.</i>	Dolgelly, Bryntirion...	6.81	160
<i>Here.</i>	Ross, Birchlea .....	1.45	61	<i>Carn.</i>	Llandudno .....	1.08	45
"	Ledbury, Underdown	1.38	61	"	Snowdon, L. Llydaw 9	12.53	...
<i>Salop.</i>	Church Stretton.....	1.33	54	<i>Ang.</i>	Holyhead, Salt Island	1.79	69
"	Shifnal, Hatton Grange	1.04	46	"	Lligwy.....	...	...
<i>Worc.</i>	Ombersley, Holt Lock	1.14	53	<i>Isle of Man</i>			
"	Blockley, Upton Wold	1.91	79	"	Douglas, Boro' Cem. ...	3.10	101
<i>War.</i>	Farnborough .....	2.40	94	<i>Guernsey</i>			
"	Birmingham, Edgbaston	1.26	54	"	St. Peter P't. Grange Rd.	.61	30

**Rainfall : July, 1928 : Scotland and Ireland**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	1'60	55	<i>Suth.</i>	Loch More, Achfary ...	8'78	164
"	Pt. William, Monreith	...	...	<i>Caith.</i>	Wick .....	2'17	83
<i>Kirk.</i>	Carsphairn, Shiel. ....	3'40	...	<i>Ork.</i>	Pomona, Deerness .....	2'31	90
"	Dumfries, Cargen .....	3'97	123	<i>Shet.</i>	Lerwick .....	2'03	89
<i>Dumf.</i>	Eskdalemuir Obs. ....	5'24	128	<i>Cork.</i>	Caheragh Rectory .....	2'68	...
<i>Roab.</i>	Branxholm .....	2'13	71	"	Dunmanway Rectory...	2'22	57
<i>Scik.</i>	Ettrick Manse .....	3'64	...	"	Ballinacurra .....	1'18	42
<i>Peeb.</i>	West Linton .....	2'98	...	"	Glanmire, Lota Lo. ...	1'38	48
<i>Berk.</i>	Marchmont House.....	1'58	52	<i>Kerry.</i>	Valentia Obsy. ....	2'00	53
<i>Hadd.</i>	North Berwick Res. ...	1'93	75	"	Gearahameen .....	2'90	...
<i>Midl.</i>	Edinburgh, Roy. Obs.	2'11	80	"	Killarney Asylum .....	1'81	54
<i>Ayr.</i>	Kilmarnock, Agric. C.	2'52	81	"	Darrynane Abbey .....	2'16	57
"	Girvan, Pinmore .....	2'56	70	<i>Wat.</i>	Waterford, Brook Lo. ...	'93	29
<i>Renf.</i>	Glasgow, Queen's Pk. .	2'44	84	<i>Tip.</i>	Nenagh, Cas. Lough. .	2'39	76
"	Greenock, Prospect H.	4'70	120	"	Roscrea, Timoney Park	'97	...
<i>Bute.</i>	Rothsay, Ardenraig. .	4'13	104	"	Cashel, Ballinamona...	1'04	36
"	Dougarie Lodge .....	2'27	...	<i>Lim.</i>	Foynes, Coolnanes .....	2'41	78
<i>Arg.</i>	Ardgour House .....	12'20	...	"	Castleconnel Rec. ....	2'30	...
"	Manse of Glenorchy ...	7'95	...	<i>Clare.</i>	Inagh, Mount Callan...	5'42	...
"	Oban .....	4'77	...	"	Broadford, Hurdlest'n.	2'83	...
"	Poltalloch .....	3'99	97	<i>Weasf.</i>	Newtownbarry .....	1'03	...
"	Inveraray Castle .....	7'47	150	"	Gorey, Courtown Ho. .	1'29	44
"	Islay, Eallabus .....	4'09	118	<i>Kilk.</i>	Kilkenny Castle .....	'74	26
"	Mull, Benmore .....	14'10	...	<i>Wic.</i>	Rathnew, Clonmannon	'92	...
"	Tiree .....	2'36	...	<i>Carl.</i>	Hacketstown Rectory..	1'59	46
<i>Kinr.</i>	Loch Leven Sluice.....	1'69	59	<i>QCo.</i>	Blandsfort House .....	1'53	49
<i>Perth.</i>	Loch Dhu .....	5'65	117	"	Mountmellick .....	1'46	...
"	Balquhiddel, Stronvar	4'13	...	<i>KCo.</i>	Birr Castle .....	2'11	72
"	Crieff, Strathearn Hyd.	1'55	52	<i>Dubl.</i>	Dublin, FitzWm. Sq. ...	1'17	46
"	Blair Castle Gardens ...	1'16	45	"	Balbriggan, Ardgillan.	1'30	48
<i>Forf.</i>	Kettins School .....	'65	28	<i>Me'th.</i>	Beaupare, St. Cloud...	1'73	...
"	Dundee, E. Necropolis	1'09	40	"	Kells, Headfort .....	1'99	63
"	Pearsie House .....	1'85	...	<i>W.M.</i>	Moate, Coolatore .....	1'63	...
"	Montrose, Sunnyside...	2'16	82	"	Mullingar, Belvedere..	2'02	64
<i>Aber.</i>	Braemar, Bank .....	1'69	105	<i>Long.</i>	Castle Forbes Gdns .....	2'09	67
"	Logie Coldstone Sch. ...	1'93	65	<i>Gal.</i>	Ballynahinch Castle ...	3'81	92
"	Aberdeen, King's Coll.	2'09	74	"	Galway, Grammar Sch.	3'31	...
"	Fyvie Castle .....	1'37	...	<i>Mayo.</i>	Mallaranny .....	4'74	...
<i>Mor.</i>	Gordon Castle .....	2'71	85	"	Westport House .....	2'16	70
"	Grantown-on-Spey ...	2'95	96	"	Delphi Lodge .....	6'58	...
<i>Na.</i>	Nairn, Delnies .....	1'86	69	<i>Sligo.</i>	Markree Obsy .....	1'95	56
<i>Inv.</i>	Ben Alder Lodge .....	...	...	<i>Car'n.</i>	Belturbet, Cloverhill...	2'23	71
"	Kingussie, The Birches	2'02	...	<i>Fern.</i>	Enniskillen, Portora...	...	...
"	Loch Quoich, Loan ...	16'30	...	<i>Arm.</i>	Armagh Obsy .....	1'59	55
"	Glenquoich .....	12'83	200	<i>Down.</i>	Fofanny Reservoir .....	2'86	...
"	Inverness, Culduthel'R.	1'80	...	"	Seaforde .....	2'52	79
"	Arisaig, Faire-na-Squir	4'19	...	"	Donaghadee, C. Stn ...	2'62	94
"	Fort William .....	7'52	...	"	Banbridge, Milltown ...	1'54	47
"	Skye, Dunvegan .....	4'97	...	<i>An tr.</i>	Belfast, Cavehill Rd ...	2'85	...
<i>R &amp; C.</i>	Alness, Ardross Cas. ...	1'93	64	"	Glenarm Castle .....	2'31	...
"	Ullapool .....	4'19	...	"	Ballymena, Harryville	3'20	93
"	Torridon, Bendamph...	6'80	125	<i>Lon.</i>	Londonderry, Creggan	3'29	90
"	Achnashellach .....	8'19	...	<i>Tyr.</i>	Donaghmore .....	1'83	...
"	Stornoway .....	3'05	101	"	Omagh, Edenfel .....	2'50	74
<i>Suth.</i>	Lairg .....	2'47	...	<i>Don.</i>	Malin Head .....	2'47	87
"	Tongue .....	2'14	70	"	Dunfanaghy .....	2'67	...
"	Melvich .....	2'85	102	"	Killybegs, Rockmount.	3'31	75

## Climatological Table for the British Empire, February, 1928.

STATIONS	PRESSURE		TEMPERATURE						Relative Humidity.	Mean Cloud Amt	PRECIPITATION		BRIGHT SUNSHINE				
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values			Diff. from Normal			Days	Hours per day	Per-centage of possible				
			Max.	Min.	Max.	Min.	1/2 max. and min.										
									° F.	° F.				° F.	° F.	° F.	
London, Kew Obsy: ..	1019.7	+ 3.7	56	28	50.2	37.6	43.9	+ 3.8	38.5	88	7.0	1.40	—	0.14	13	3.0	30
Gibraltar.....	1025.5	+ 5.5	66	44	60.9	50.5	55.7	- 0.2	50.3	84	5.0	3.22	—	1.00	7	..	..
Malta .....	1020.5	+ 3.8	61	44	57.0	50.4	53.7	- 1.6	50.1	79	6.8	4.59	+	2.39	11	5.5	51
St. Helena .....	1012.7	+ 3.1	72	59	69.6	61.4	65.5	- 0.9	62.6	95	8.7	1.96	-	1.84	17	..	..
Sierra Leone .....	1012.0	+ 1.2	91	68	88.5	72.6	80.5	- 1.8	67.7	54	2.3	0.00	-	0.30	0	..	..
Lagos, Nigeria .....	1009.2	- 0.9	92	70	88.0	76.3	82.1	- 0.1	73.0	72	7.7	2.22	+	0.15	2	..	..
Kaduna, Nigeria .....	1015.1	+ 3.1	94	..	89.5	..	..	..	65.4	55	1.5	0.00	-	0.04	0	..	..
Zomba, Nyasaland ..	1008.8	+ 0.9	92	57	84.3	63.0	73.7	+ 1.7	..	76	5.1	3.41	-	7.24	6	..	..
Salisbury, Rhodesia ..	1009.5	+ 0.6	90	49	82.5	57.6	70.1	+ 1.3	62.2	60	3.6	3.51	-	3.89	6	9.8	77
Cape Town .....	1015.5	+ 2.1	98	47	80.7	61.8	71.3	+ 1.0	61.7	70	2.6	0.41	-	0.17	3	..	..
Johannesburg.....	1012.8	+ 1.0	82	46	75.3	55.4	65.3	- 0.1	57.9	72	4.0	5.67	+	0.45	15	7.9	61
Mauritius .....	1010.4	- 0.6	91	72	85.3	74.3	79.8	+ 0.5	77.4	78	6.3	14.41	+	6.01	22	8.2	65
Bloemfontein .....	..	..	89	44	81.8	57.9	69.9	- 2.0	59.7	64	3.8	2.12	-	1.33	9	..	..
Calcutta, Alipore Obsy ..	1013.8	+ 0.5	91	57	85.0	62.0	73.5	+ 2.5	60.8	76	2.0	0.03	-	1.07	1*	..	..
Bombay .....	1012.3	- 0.4	90	60	82.4	67.2	74.8	- 0.8	64.2	72	0.8	0.01	-	0.02	0*	..	..
Madras .....	1013.2	+ 0.3	91	65	86.8	70.1	78.5	+ 0.8	72.4	81	2.6	1.12	+	0.80	2*	..	..
Colombo, Ceylon .....	1011.6	+ 0.5	91	66	87.0	70.3	78.7	- 1.0	73.9	71	2.4	2.78	+	0.71	7	9.5	80
Hongkong .....	1020.2	+ 1.5	71	45	63.1	55.0	59.1	0.0	55.0	80	8.7	3.57	+	1.97	7	2.5	22
Sandakan .....	..	..	89	73	87.0	75.6	81.3	+ 1.2	77.1	86	..	29.50	+	19.88	21	..	..
Sydney .....	1013.4	- 0.7	85	61	78.4	67.7	73.1	+ 1.8	69.5	79	7.6	6.91	+	2.67	18	5.5	41
Melbourne .....	1014.4	- 0.1	99	50	77.7	60.4	69.1	+ 1.7	62.2	67	6.9	4.57	+	2.85	11	6.0	46
Adelaide .....	1014.5	+ 0.2	103	50	81.8	59.6	70.7	- 3.4	59.8	44	3.7	2.51	+	1.85	3	9.3	70
Perth, W. Australia ..	1014.6	+ 1.6	99	54	84.3	61.5	72.9	- 1.2	61.2	47	2.4	0.01	-	0.44	1	10.5	80
Coolgardie .....	1013.7	+ 1.2	113	52	89.1	57.9	73.5	- 2.5	58.9	43	3.1	0.78	+	0.03	4	..	..
Brisbane .....	1012.1	- 0.4	87	67	81.6	70.3	75.9	- 0.6	71.8	80	8.5	16.12	+	9.93	26	4.3	33
Hobart, Tasmania.....	1015.1	+ 1.6	86	47	70.2	61.6	65.9	+ 3.5	56.1	66	7.0	1.28	-	0.17	13	6.0	44
Wellington, N.Z. ....	1019.6	+ 3.8	79	45	71.1	56.4	63.7	+ 1.2	60.4	78	6.6	3.58	+	0.44	7	6.5	48
Suva, Fiji .....	1009.9	+ 2.2	91	71	85.7	74.8	80.3	- 0.2	76.0	83	7.6	12.87	+	2.74	22	5.1	40
Apia, Samoa .....	1011.9	+ 3.5	89	75	86.1	76.3	81.2	+ 2.2	78.2	80	5.2	21.70	+	5.99	20	7.1	57
Kingston, Jamaica.....	1015.7	+ 0.4	89	65	85.4	68.1	76.7	+ 0.2	65.8	83	2.2	0.20	-	0.40	1	5.2	45
Grenada, W.I. ....	1010.5	- 2.8	89	70	85.2	72.2	78.7	+ 1.6	72.9	77	5.0	2.12	-	0.66	18	..	..
Toronto .....	1017.2	- 0.8	43	- 4	30.8	17.4	24.1	+ 2.4	20.2	75	6.7	1.67	-	0.91	15	4.1	39
Winnipeg .....	1019.6	- 2.2	39	- 16	20.6	4.5	12.5	+ 13.1	..	..	5.0	0.18	-	0.66	5	5.2	52
St. John, N.B. ....	1015.3	+ 1.2	41	- 7	27.4	9.6	18.5	- 1.4	13.8	..	6.0	2.35	-	1.55	13	4.5	44
Victoria, B.C. ....	1023.2	+ 7.3	53	31	47.0	38.4	42.7	+ 2.4	40.5	92	7.2	0.45	-	3.08	9	3.6	36

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





CIRRO-CUMULUS CLOUD, ABERDEEN, DECEMBER 8TH, 1926.  
(See p. 190)



<h1 style="margin: 0;">The Meteorological Magazine</h1>	
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## A Note on a Remarkable Temperature Record at Aberdeen

By C. S. DURST, B.A.

During the morning of December 12th, 1913, a depression passed to the northward of the British Isles and an occlusion travelled over the Scottish stations giving a pronounced squall at Aberdeen in which the wind veered from SSW to WNW between 10h. 30m. and 11h. Unfortunately, since directions were only recorded by a Robinson anemometer it is not possible to state precisely when the change occurred. The Dines velocity recorder, however, showed an increase of wind from 2 miles per hour at 10h. 30m. to 42 miles per hour in a gust at 10h. 55m. The photographic barograph showed a rise in pressure which began at about 8h. 15m. and continued until some hours after the squall without any pronounced excursions. The photothermograph, however, gave an unusual trace. The temperature rose from about 47°F. at 10h. 30m. to 51°F. at 10h. 52m. It remained at that high figure for five minutes and then fell to 48°F. during the next hour. The relative humidity meanwhile after being between 80 and 90 per cent. up to 10h. 40m. fell to 60 to 70 per cent. between 10h. 50m. and noon. No rain fell at Aberdeen during the day of this occurrence. There are two alternative explanations of the rise in temperature as the front passed, (a) that a small portion of warm air still remained at the surface, (b) that it was a föhn effect due to the cold air passing down from the hills to westwards of Aberdeen, reinforcing the descending currents which are known often to occur in the rear of occlusions.

The objection to the first of these lies in the humidity observations which fell both absolutely and relatively when the temperature began to rise and it would seem that the second is the more likely explanation.

When a front or an occlusion passes over a mountain range there has been shown to be a tendency for a pocket of the receding air to be trapped between the mountain and the advancing air on the windward side. A corollary is therefore that on the leeward side there must be a more rapid descent of the advancing air than of the receding air and in descending this advancing air will be warmed adiabatically. This effect is probably favoured by the topography of Aberdeen, for it lies in a bay of the hills formed by the valleys of the Dee and the Don. As a consequence when a front passes from west to east, the receding air tends to flow out from the bay but can only be replaced by air descending down the sides of the hills the route for air from westward and flowing round the hills being cut off by the protruding arms of the bay. The downward currents at that point may be further reinforced possibly by the tendency for air to flow downwards in a wind which is passing from land to sea.

That some such history is true of the air which gave this remarkable rise in temperature is further supported by three pieces of evidence.

(i) The dew point of the warm air was 40°F. which would be reached adiabatically at a height of 2,400 feet, which is approximately the height of the highland over which the wind had come.

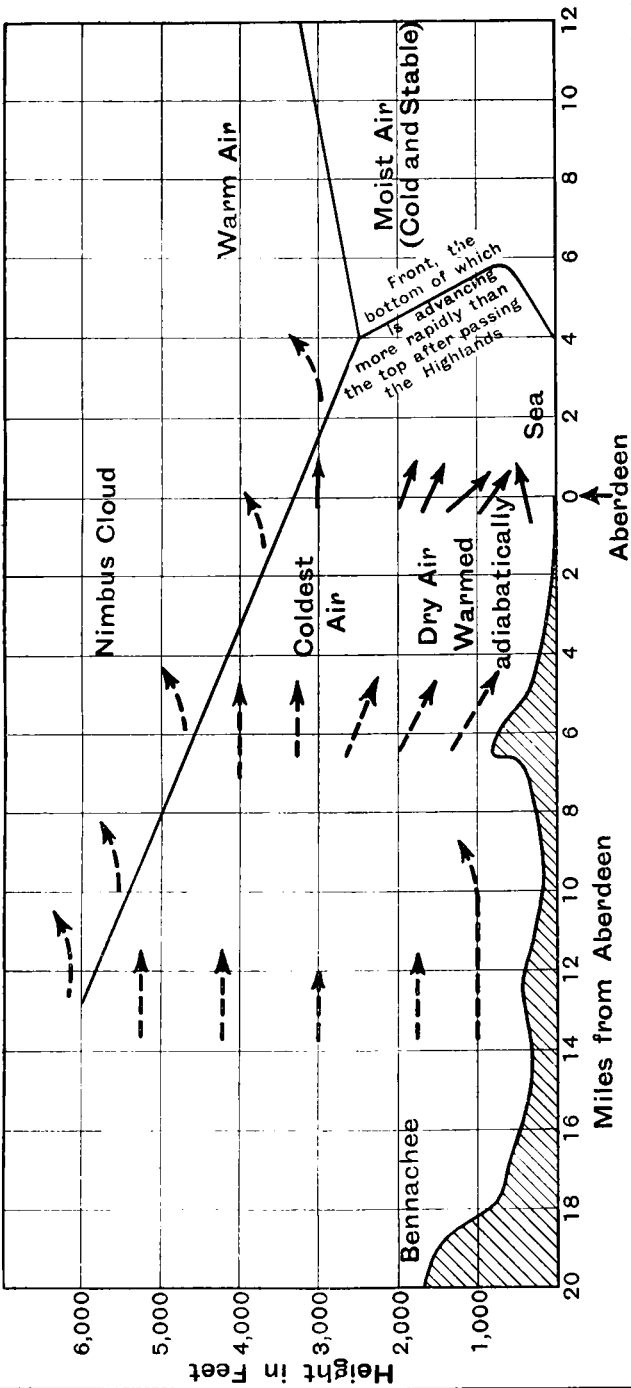
(ii) There was no rain recorded at Aberdeen, probably indicating that the descending current was evaporating any precipitation falling through it.

(iii) At 10h. 55m. on this day a pilot-balloon was released from Aberdeen just after the squall and it was the remarkable record of its ascensional velocity which first attracted the writer's attention to this occasion.

The details of the ascent are given in the *Geophysical Journal* for December, 1913, and are as follows:—

Height		Vertical Velocity of Balloon.		Horizontal.			Upward Vertical Velocity of Air.	
				Direction.	Velocity.			
m.	ft.	m/s.	ft./min.		m/s.	m.p.h.	m/s.	ft./min.
100	330	3.0	590	282°	13.5	30	+0.1	+20
250	820	1.8	350	283°	21.3	47	-1.1	-220
340	1,120	0.6	120	282°	21.3	47	-2.3	-450
500	1,640	2.0	390	286°	21.6	48	-0.9	-180
750	2,460	2.2	430	287°	22.0	49	-0.7	-140
925	3,050	2.9	570	289°	16.1	36	0.0	0

SCHEMATIC DIAGRAM OF THE SITUATION IN THE NEIGHBOURHOOD  
OF ABERDEEN AT 10.55 ON DEC. 12. 1913.

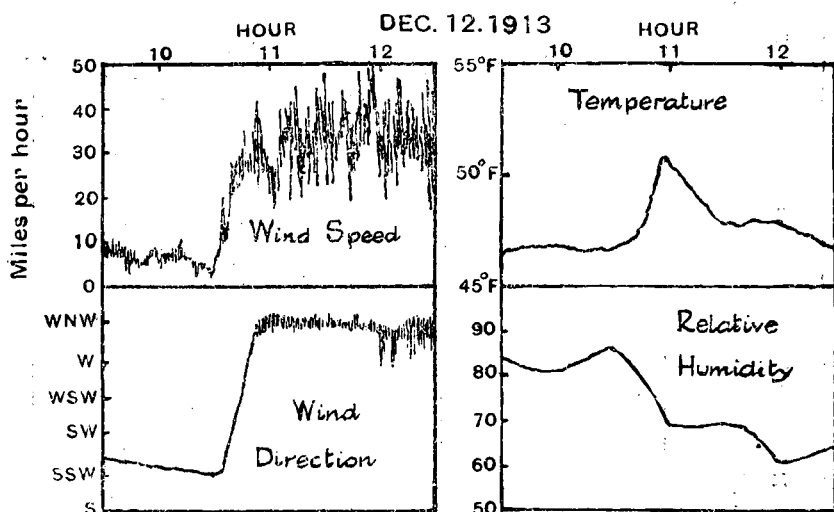


The balloon was followed with two theodolites until at 1010 metres it "entered loose nimbus base of low type of cumulo-nimbus" (the base presumably of the squall cloud), and it is recorded that at the end of the flight the balloon shot very rapidly upwards into the cloud. The wind was very constant in direction during the flight and varied little in speed.

The free lift was 48 gm.; assuming a vertical velocity of 2.9 m/s (570 ft./min.) for the balloon in still air, the vertical velocities of the air are given in the last column. Thus it is seen that there was in fact a descending current amounting to, on an average, 0.7 m/s (140 ft./min.) from the surface to the cloud base.

A schematic diagram has been constructed of a section of the surfaces of discontinuity and the profile of the country over which the air in rear of the front has passed in arriving at

#### AUTOGRAPHIC RECORDS AT ABERDEEN



Aberdeen. On it have been inserted the lines of flow of the air as recorded by the pilot-balloon ascent and arrows to indicate the presumed flow of the air above and below the surface of discontinuity. The shape of the front has been sketched in by the following line of argument:—

(i) The southerly wind in front of the occlusion has not travelled over the highlands, indeed there is some evidence to show it has flowed round rather than over hills. Hence it is probably stable air with a small lapse rate.

(ii) The west-north-westerly wind in rear of the front has flowed over the highlands and is therefore probably in neutral equilibrium with a lapse rate of the dry adiabatic.

(iii) On these two premises and since surface temperatures in the southerly current and in the main body of the west-north-

westerly current are not very dissimilar, the air at the height of 2,500 feet to 5,000 feet will be colder behind the occlusion than in front and so the occlusion will be of the cold front type.

(iv) The lowest portion of the front is bent back owing to its retarding by the highlands and it is presumed that this retarded portion will advance more rapidly than the main portion of the front as the hills are left behind, thereby generating the downward currents recorded by the pilot-balloon ascent.

The diagram is of necessity entirely speculative in regard to the slopes of the surfaces of discontinuity but still it serves as a picture of the probable deformation of a cold front or an occlusion in passing across mountainous country and of the effect that such deformation can have on the vertical wind currents.

## **The Contamination of Mercury in Barometer Cisterns**

By J. E. BELASCO, B.Sc.

The rusting which occurs in the interior of cast iron cisterns such as are to be found in Kew pattern barometers, causes the mercury surface to become contaminated. This has been avoided in recent barometers by using a cistern of stainless steel, polished inside. Even so, there remain other sources of contamination. Observations on Fortin and Newman barometers, which possess glass cisterns, reveal that after a time the mercury surface becomes tarnished. This is due to the effect of damp air, etc., and occurs in all types of barometers. Pure mercury remains unchanged in the presence of dry air at ordinary temperatures. In damp air and in contact with sulphur and carbon compounds and ozone, the surface becomes contaminated and tarnishes. When the mercury tarnishes, it leaves a deposit on the walls of the cistern of the barometer. This is probably a contributory cause of the variation in the shape of the liquid surface, so that after a time there will be a tendency for the surface to become flatter and for its lustre to disappear.

We will first examine the effect of contamination in the Kew pattern barometer. Since the mercury surface in the cistern is not visible, the loss of lustre does not matter. The change in the surface tension due to the tarnishing is, however, important, since there is no means of adjusting the zero of the scale. Experience shows that in Kew barometers with dirty mercury there is a tendency to read low. All Kew pattern barometers have cisterns sufficiently large to make capillary depression of the mercury negligible. Hence the error due to tarnishing arises from the varying conditions of the angle of contact between the mercury and the walls of the containing cistern. When the mercury in the cistern is clean, the meniscus

is convex, but if it becomes so dirty that the curvature disappears, the surface becoming plane, then the level of the mercury surface in the cistern will fall to a position defined by the condition that the volume of the mercury is constant, provided that the actual height of the barometer column has remained constant. The flatter the mercury meniscus in the cistern, the greater is the tendency of the barometer to read low. To what extent the contamination, due only to atmospheric influences, alters the shape of the mercury surface is not definitely known, though there will be a tendency for the surface to become flatter after a considerable period of time, causing the barometer to read lower by an amount which may be as much as 0.4mb. in the case of 1.3in. cisterns.

In the Fortin and Newman types of barometer, which employ glass cisterns, the effect of a contaminated surface is not to cause an error arising from the varied conditions of the angle of contact, but to give rise to an error when setting the fiducial point flush with the contaminated mercury surface, since it is difficult to see the reflected image of the knife edge or pointer in the dirty surface.

To overcome the contamination of the mercury surface due to the influence of damp air, Dr. Whipple, of Kew Observatory, suggested the fitting of a purifying apparatus to the cistern inlet of a Newman barometer. Professor J. C. Philip, F.R.S., of the Imperial College of Science, advised activated carbon granules as the most suitable material to act as a filter. Activated carbon consists of granulated charcoal specially treated. It is capable of adsorbing large quantities of all impurities likely to be present in the air of a room in which a barometer is usually installed. The more easily a gas is condensible, the more easily is it adsorbed by the carbon. The rate of adsorption of moisture is considerable. Indeed, the weight of the carbon varies with the amount of water vapour present, though it is not immediately adsorbed. Saturated air when drawn through 1cm. thickness of activated carbon will be found on the other side to have a humidity of only a few per cent. The carbon will adsorb very largely carbon and sulphur compounds; nor is ozone likely to reach the mercury surface, decomposition occurring on the surface of the activated carbon granules due to catalytic action or oxidation of the granules.

In order to test the effect of the filtration of the air in contact with a mercury surface by means of activated carbon granules, the following experiment was carried out at Kew Observatory using quality R, 2-3mm. granules kindly supplied by Ernest E. Mayer, Fawsitt and Co., Ltd., London. Approximately equal quantities of air were drawn over clean mercury surfaces, in one case the air being unfiltered, and in the other the air was filtered through activated carbon. The bottles con-

taining the mercury were about the same size as a barometer cistern. An ordinary filter pump was used to draw the air through the apparatus, which was arranged so that the flow through both bottles was about equal. The rate of flow through each bottle was approximately 40 litres per hour. After about 2,500 litres of air had been passed through each bottle the mercury in the bottle without the filter showed a very slight tarnishing over the whole surface and, in addition, there was a faint patch of dirt below the inlet tube. The mercury in the bottle with the filter remained clean until about 5,000 litres had passed, when a very faint patch of dirt appeared under the inlet tube, but the remainder of the surface was not perceptibly tarnished; the mercury in the bottle without the filter was still more tarnished than that in the other bottle. The amount of solid impurities in the quantity of air drawn through the bottles was of the order of one or two milligrams, and only a portion of this would deposit on the mercury surface.

Now the air going into the cistern space of a barometer is that necessary to keep the pressure equal to atmospheric. Over a given interval of time this will depend upon the "barometric activity." An approximate estimate of this can be obtained by dealing only with successive peaks and troughs of pressure, assuming the change linear between these peaks and troughs. During the three winter months, December, 1927, January and February, 1928, the change of pressure in London necessitated an inflow of about 36cc. of air. This represents 144cc. per annum, which is equivalent to 14.4 litres in 100 years. With such small inflows of air the service time of the activated carbon would be considerable, probably of the order of 30 to 40 years. About 1cm. is the minimum effective depth of the activated carbon granules.

In conclusion, therefore, it seems reasonable to assume that in barometers with glass cisterns in which impure air is the main source of contamination of the mercury surface, the use of an activated carbon filter would allow the mercury to remain clean for a very long period.

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## 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 1928-9. The meetings will be held on alternate Mondays at 5 p.m., beginning on Monday, October 15th, 1928, when Dr. G. C. Simpson, C.B., F.R.S., will open the discussion of a

paper by F. M. Exner, entitled "Über die Zirkulationen, kalter und warmer Luft zwischen hohen und niedrigen Breiten." (*Wien, Sitzber. Ak. Wiss. IIa*, 137, 1928, pp. 189-225.)

The dates for subsequent meetings are as follows:—

October 29th, November 12th and 26th, December 10th, 1928; January 21st, February 4th and 18th, March 4th and 18th, 1929.

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*

### Transport of Sea-Spray by Gales

The paper on this subject in the July number fails to notice the most complete examination of the occurrence of salt in rain-water, as affected by gales, carried out by a chemist and geologist. About 1890-1 the late Wm. Ackroyd, F.I.C., Public Analyst for Halifax, explored the subject from various angles and collected material from published sources as well. There are abbreviated papers by him in the *Reports of the British Association* meetings 1900-2 and elsewhere; but the most complete account of his research is to be found in Vol. XIV of the *Proc. Yorks Geol. Soc.*, pp. 401-21, under the title "On the Circulation of Salt and its bearings on Geological Problems. . . . ." Therein he quotes at some length from the original authority for the records relating to the storm of 1839, viz.: "Narrative of the Dreadful Disasters occasioned by the Hurricane which visited Liverpool, . . . . Jan. 6th and 7th, 1839." The most remarkable of these records was undoubtedly that sent from Alford, near Boston, in Lincolnshire (about 140 miles from Liverpool) where "every tree and hedge in the bleak situations were encrusted over (like a hoar frost) with a powerful alkali which an eminent chemist pronounced to be muriate of soda."

Curiously, Mr. Ackroyd was able to collect fresh direct evidence almost as remarkable of the same storm, over 60 years afterwards, for Canon Tristram, of Durham, wrote to him in 1902 of what came under his own observation in 1839. "At the castle, Castle Eden, which stands on a bluff not far from the east coast of the County of Durham, and overlooking the sea, on the morning of January 7th all the windows of the castle facing west were covered with a saline incrustation like hoar frost, while those on the east face had not a trace of salt on them."

Mr. Ackroyd's personal contribution was based upon weekly tests for salt in the water of Widdop Reservoir at 1,000ft. on the axis of the Pennines, west of Halifax, and in comparison



with it, the water collected weekly in the rain gauges at Widdop and on four other moorland gathering grounds. The tests were made for fifteen weeks through the winter of 1900-1. The records for two weeks (December 24th and January 14th) were abnormally high, the excess of salt in the gauges in December being brought by a westerly gale, with a maximum velocity of 43 miles an hour on the 20th. "During the week in January . . . strong continuous east winds blew from the North Sea, with a very light rain or snow-fall, a combination sufficient to account for the excess of salt." The last sentence is quoted from another paper by Wm. Ackroyd, "The Presence of Salt in Fresh Waters," in the *Halifax Naturalist*, VIII (1903), pp. 11-14, as the meteorological explanation appears to be omitted in his principal paper (as above). But this latter should be consulted for the details and discussion of the analyses and the problem generally.

W. B. CRUMP.

*Hawcroft, Weetwood Lane, Leeds. 8th August, 1928.*

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### Light Winds and Quick Fall of Pressure

A curiosity of synoptic charts was exhibited on the charts for 7h., 10h. and 13h. of Tuesday, August 7th, 1928. At the first of these three hours Stornoway reported a barometric fall of  $2\frac{1}{2}$ mb., at the second of  $3\frac{1}{2}$ mb., and at the third of 4mb., these big falls being associated with a vigorous secondary depression moving up from the south. In each case the pressure gradient suggested that winds should be at least moderate in force but in each case Stornoway reported "calm." It is interesting to record that Thorshavn, further north, reported similarly "calm" at the three hours mentioned though possessing a very definite gradient and continued "calm" at 16h. when falling 4mb. and on to 18h. when falling  $3\frac{1}{2}$ mb.

Within my experience I have not known calms persist so long under similar conditions, and it would be interesting to know the reasons that prevailed in this particular case.

Incidentally, the depression followed Guilbert's rule that its movement should be towards the abnormally light wind for it travelled directly towards and right across Stornoway.

W. H. PICK.

*10th August, 1928.*

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## NOTES AND QUERIES

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### Thunderstorms during August

An interesting spectacle occurred (at Cleethorpes) on the evening of August 13th about sunset, when a thunderstorm was blown across by a SSW wind. A vivid contrast was seen

between the inky black clouds and the varying depths of colour produced by the setting sun behind the falling rain. The colour was a deep purple on the fringe of the clouds, and gradually grew to a light orange towards the earth. During this time there were continual flashes of lightning and rumbles of thunder.

A. H. BLOW.

On August 20th, at 2 p.m., a detached house at High View, Pinner, was struck by lightning. The following account is sent by Miss Elsie Thorpe :—

“ The sky was lit suddenly by terrible flash and lurid flames swept over the garden. A tree appeared to be on fire ; the flames then came across garden to house and an ear-splitting crash of thunder and explosion, plunging us in immediate darkness. According to eye witness, cinders fell from sky in front. Knowing the house had been struck, we went downstairs and found the room where wireless was installed damaged. The set was not touched. The wireless was to earth. Sulphur fumes came from room. There were four holes blown in the wall over bay window—plaster all over floor and in ornaments—curtain rod scorched in two places. The lightning had gone to earth through electric light and blown four switches—two main ones and two others. The tree where wire was, was struck. Have since picked up several pieces of cinders, looks like burnt coke. One heavy piece, some metal included in it weighing 7 oz., in a bed in front garden, which had nothing of the kind in it before this happened. The electricians seem to think we’ve had a marvellous escape and that the wireless saved the house.”

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At Barnstaple we had an extraordinary storm on August 24th at 4 p.m., when for 10 minutes frozen ice of various shapes fell with great violence, breaking vegetation and cutting off the stalks of corn, &c. Two hours afterwards I found any number of pieces as large as a 6d. and  $\frac{1}{2}$  in. thick, and the drifts under the walls were still visible 4 hours afterwards. The storm was accompanied by thunder. Some of the ice fragments were elongated and faceted like cut diamonds.

Three fields away to the south-west there was no hail, but it continued here east and north-east up to Exmoor, Brayford and High Bray having much the same storm as I have to record.

H. SANDFORD CLAY.

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A violent thunderstorm occurred at Armagh on August 29th from 3.30 to 4.30 p.m. B.S.T. The rain and hail amounted to 1.66in. and the storm was followed by floods. The observer, Mr. W. F. A. Ellison, remarks that “ the phenomenal character of the hailstorm of August 29th can be realised when it is stated

that a good deal of hail was still lying on September 1st. The low grass minima on the 29th and 30th ( $34^{\circ}$  and  $31^{\circ}\text{F}$ . respectively) were due to hail lying."

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### **Opening of New Headquarters of Meteorological Department of India at Poona**

On July 20th His Excellency the Governor of Bombay performed the official opening ceremony of the new headquarters which have been built for the Meteorological Department of India at Poona, about eighty miles to the east-south-east of Bombay. The new building lies between the Colleges of Agriculture and Engineering, in an enclosure having an area of more than ten acres, which provides space for observational as well as for administrative and computing work. Although the Department has now been in existence for 53 years, it has never previously occupied a building specially designed for its needs, the previous headquarters at Simla having been only temporary. The site at Simla was especially unsuitable for upper air investigation, and that essential branch of meteorology was carried on at Agra. The work done at the latter station has shown the vital importance of upper air data for monsoon forecasting in India; the new headquarters at Poona, in the direct path of the south-west monsoon, provide an excellent site for its continuance, and a feature of the new building is a special tower for the release and observation of meteorological balloons. In his address His Excellency referred also to the advantage that in its new home the Department would be in close touch with the shipping interests of Bombay, while the near neighbourhood of the College of Agriculture is a good augury for the continuation of the efforts of the meteorologists to assist the cultivators, which have had such happy results in the past.

All meteorologists will join with His Excellency in wishing success and prosperity to Dr. Normand and his staff in their new surroundings.

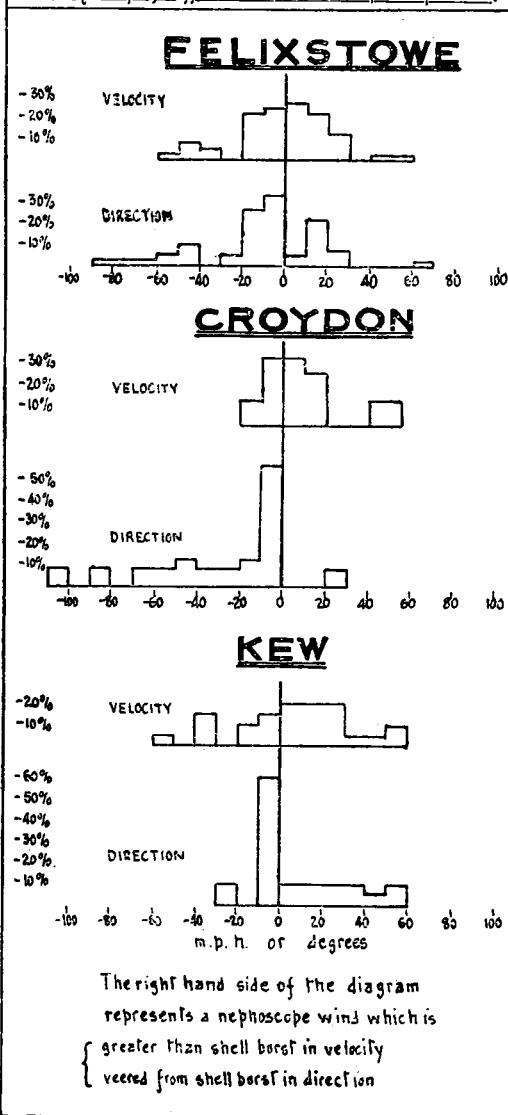
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### **A Comparison between Upper Winds deduced from observations with Nephoscopes and those obtained by the Shell-burst method**

It has been the custom at stations reporting to the Forecast Service of the Meteorological Office during recent years to deduce the velocity of the wind at high levels from determinations made by nephoscope of the apparent motion of clouds of the alto and cirrus types, the usual assumption being made that the apparent motion is due to the cloud being carried horizontally by the wind at that level. Clearly in addition to possible error caused by vertical motion, there may be error due to growth of the

cloud at one edge and dissipation at the opposite edge. An extreme case of this is the formation of a "banner" cloud near a mountain peak: such a cloud may appear to be stationary

Frequency of different "errors" in nephoscope winds.



even in a strong wind. Two further assumptions are made, in order to change the angular velocity into actual velocity in miles per hour as shown in the Upper Air Supplement to the *Daily Weather Report*, namely, that all clouds of cirrus type are at a height of 5 miles, and all alto clouds at 3 miles. These are obviously liable to cause further errors.

Determinations of upper wind made by observations of the apparent drift of the smoke due to a bursting shell are likely to be much more accurate, for in such determinations the height of the smoke puff is normally measured directly, and since the smoke puff is not likely to change its shape rapidly, its motion can be followed easily. We may therefore use measurements made

in this way as a standard of comparison for testing the accuracy of the ordinary nephoscope measurements.

Although one is not justified in regarding the shell-burst determinations as giving perfectly true values of the wind they may usefully be regarded in this way for our present purpose, which is to determine the order of magnitude of the errors made

in the nephoscope measurements. The word "error" will therefore be used to denote the quantity obtained by subtracting the shell-burst velocity from the corresponding nephoscope value; similarly with the direction expressed in degrees clockwise from north. An example will make the process clear: By shell-burst the velocity might be 90 m.p.h., and the direction  $20^{\circ}$  (*i.e.*, from about NNE), and by nephoscope 140 m.p.h. from  $315^{\circ}$  (*i.e.*, from NW). The errors would in this case be + 50 m.p.h. and  $- 65^{\circ}$ . (Positive errors in direction correspond with winds that are veered relative to the "true" wind.) The errors have been worked out in this way for three places in south-east England, for the years 1926 and 1927, using the shell-burst observations of upper wind supplied by the Meteorological Office, New Ranges, Shoeburyness, as the standard of comparison. Nephoscope observations made on clouds of cirrus type have been compared with shell-burst readings at 21,000 to 25,000 feet height and on clouds of alto type with shell-bursts at 12,000 to 18,000 feet. As complete simultaneity in time was not usually obtainable, pairs of readings were used which differed in time by amounts up to 4 hours. Shell-burst measurements are not usually taken at Shoeburyness on days when the surface wind is strong. The comparison does not therefore include such days. The highest shell-burst velocity included in the comparison was one of 82 m.p.h. while only a few exceeded 50 m.p.h. The following table indicates the results obtained, and these are also shown in the figure.

TABLE SHOWING PERCENTAGE FREQUENCY OF "ERRORS"  
BETWEEN THE LIMITS SHOWN.

*Miles per hour or degrees.*

-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
Felixstowe (48 observations)																	
Velocity																	
				2	6	4	-	17	19	21	17	10			2	2	
Direction																	
		2	2	2	4	8		4	21	28	4	17	6				2
Croydon (20 observations)																	
Velocity																	
								10	25	25	20			-	10	10	
Direction																	
5		5		5	5	10	5	5	10	45	-	-	5				
Kew (25 observations)																	
Velocity																	
				4	-	12		8	12	16	16	16	4	4	4	8	
Direction																	
							8	-	48	8	8	8	9	4	8		

From these figures it is clear that nearly two-thirds of the errors in direction do not exceed  $20^{\circ}$ ; while for velocity slightly

over two-thirds do not exceed 20 m.p.h. As might be expected large errors, due no doubt to the clouds observed being at a very different height from the assumed 3 or 5 miles, are rather frequent.

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### Notes on the Cirro-Cumulus Cloud Observed on December 8th, 1926.

The photograph which forms the frontispiece of this number of the *Meteorological Magazine* was taken at 12h. 15m. on December 8th, 1926, and shows the remarkable development that occurred in a patch of cirro-cumulus cloud during the very short period in which it was visible between the sheets of strato-cumulus and cumulus at the time present in the sky.

When first seen, a sheet of dark strato-cumulus was clearing away (it may be seen in the bottom left-hand corner of the picture) and, in doing so, it disclosed a singularly clear-cut series of waves of cirro-cumulus, whose chief feature was the extreme sharpness of their edges. These did not fade gradually into the intervals of blue sky between them, but remained very definitely sharp and clear and strongly defined. This same effect is often seen when "lanes" of blue sky traverse a sheet of upper cloud which seems to be transitional between cirro-stratus and cirro-cumulus.

It took less than a minute to make my camera ready to take the picture, but by that time, short though the interval was, the smooth uniform waves had begun to thin out and a most unusual state of turbulence had been set up in them. A series of small "holes" almost like vortices, and very suggestive of "sunspots," rapidly formed across the waves at an angle, which if allowance be made for the angular elevation of the cloud, must have been between 45 and 60 degrees. These "vortices," if the term may be employed, were remarkable for the fact that their inner edges were exceedingly clearly defined, and seemed on account of their greater brilliance to be denser, or thicker, than the surrounding parts of the cloud, as though their sunward borders were reflecting more sunlight than did the opposite ones. I am tempted to think that perhaps there may have been a series of downward "bursts" of warmer or much drier air, particularly as this development marked the commencement of a rapid disintegration and disappearance of the bulk of the cloud, which had virtually vanished in less than the five minutes during which the lower cloud had permitted a view to be obtained.

The synoptic chart for that day shows a markedly "westerly" pressure distribution, pressure being high for the time of year (1022mb. at 7h., rising to 1025mb. at 13h.). The wind was light, backing from WSW (7h.) to SSW (18h.). The

weather was fair during the forenoon, but by 18h. had become cloudy with a widespread layer of alto-stratus or fused alto-cumulus. The pilot-balloons in the forenoon showed a north-westerly wind at 6,000 ft. with a sudden rise of velocity between 6,000 ft. and 8,000 ft. of about 50 per cent. It is possible therefore that the air in the upper layers was very much stratified, and considerable further differences in velocity may have existed at the still higher levels where this cloud was formed.

I have observed quite a number—and photographed a few—of these eddy-like disturbances in the upper cloud layers, but never in the whole of my observations have I seen so remarkable an example as the one just described.

G. A. CLARKE.

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### The Expedition of the *Marion*

The valuable work which is being done by the United States Coast Guard in maintaining the Ice Patrol\* in the waters off Newfoundland, following the courses of dangerous icebergs and warning ships of their neighbourhood, is this year being extended by an expedition to the birthplace of the bergs in the fiords of western Greenland. For this purpose the *Marion* has been specially fitted out as a surveying ship, and was due to sail from Boston on July 12th, under the command of two oceanographers (Lieut.-Commander Edward H. Smith and Lieut. N. G. Rickets). In an account issued by the U.S. Coast-guard, it is stated that "the object of her quest is to learn everything possible regarding the behaviour of the icebergs from the time they break off the Greenland glaciers until they finally melt in the warm tropical waters of the North Atlantic." The investigation is especially directed towards the study of the complex currents of the region of Baffin Bay.

The programme of the *Marion* was to proceed first to Newfoundland and thence across to Greenland, a distance of 600 miles along which temperature and salinity soundings, and samples of the sea bottom, were to be taken at intervals of 25 miles. "Echo" soundings with the fathometer were also to be taken every half-hour, to order to provide detailed topography of the ocean-floor. The whole of the apparatus is electrically controlled, and a comparison of the equipment with that carried by the *Challenger* in 1872 illustrates the great changes which have taken place in the technique of oceanographical surveying in the past 56 years. Further, the *Marion* will be in touch with the world throughout by means of a short-wave radio. From the southern extremity of Greenland she will zig-zag backwards and forwards between the west coast of Greenland and

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\*See *Meteorological Magazine*, 60, 1925, p. 229.

the coast of Labrador, gradually proceeding northwards until that part of west Greenland is reached where the great bergs actually originate from the glaciers of the inland ice. Among the problems which it is hoped will be solved by these cross sections of temperature and salinity between Greenland and North America are the origin of the famous "North Water" and the extent to which a branch of the Gulf Stream influences the coast of west Greenland. It is also hoped that the echo soundings will result in the location of new fishing banks of economic value.

It is an interesting coincidence that the *Marion* was due to sail from Sydney, Nova Scotia, on July 17th, just twenty years to a day after Admiral Peary steamed from there in the *Roosevelt* on his last and successful drive for the North Pole. The cruise is expected to last about two months and to cover some 4,000 miles.

A later despatch from the United States Coast Guard reports that on August 8th the *Marion* had reached the base of the great Jakobshavn Glacier, in about 70°N, which is recognised as the birthplace of a large number of icebergs during spring and early summer.

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### Meteorological Observations in the Eastern Desert of Egypt

The *Geographical Journal* for August, 1928, contains (pp. 144-158) a paper by Mr. K. S. Sandford on "The Wadi Um Dud in the Eastern Desert of Egypt," which he visited in February, 1926. The region lies in latitude 27°N., long. 32°W., about 25 to 30 miles north-east of the Nile; the general altitude is about 1,000ft. above sea level. In view of the water-supply difficulties, the meteorological element of greatest interest is the rainfall, which is very spasmodic. "At rare intervals heavy rainstorms may be expected in this region; they flood the Wadi and a *seil* or torrent dashes down it, sweeping everything away and moving great blocks of stone. The signs of the passage of a *seil* are clear enough for years afterwards. . . . Periodically, however, lighter rain may be expected, which provides a less violent flood, often very localised . . . a few weeks later it is possible to mark the exact limits of the last rain by looking at the vegetation . . . There had been a number of local showers over the area, and our drinking-water was probably, in part at least, only a few months old."

Observations were taken with whirling thermometers on most afternoons, the highest temperature recorded being 81°F. at 2.15 p.m. on February 12th. On the 15th at 3.30 p.m. with a dry bulb of 77°F. a relative humidity of 28 per cent. was noted; but the readings were mostly between 30 and 50 per cent.

A minimum thermometer exposed each night gave an average



reading of about 32°F., with 27° on one occasion at 1,200ft. The prevailing wind in winter is from north; it commences at 9 to 9.30 a.m. and dies away about sundown; it is less marked in cloudy weather. In March this wind is replaced by a hot wind from south. Nights are still and cold with occasional gusty winds down the wadis. By day occasional gusts of wind blow up the wadis, especially in the early part of the morning.

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## Review

*Metropolitan Water Board.—Twenty-second annual report on the results of the chemical and bacteriological examination of the London waters for the twelve months ended 31st December, 1927.* By Sir Alexander Houston, Director of Water Examination, Metropolitan Water Board, Size 13 x 8in. pp. 101, illus., London. P. S. King and Son, Ltd., 1928, price 2ls.

Shrouded behind the official austerity of the above title, as Portia's portrait within its leaden casket, will be found not only the results indicated in the title, but also a further instalment of Sir Alexander Houston's characteristic and human word-paintings. This instalment describes in his own inimitable and entertaining way the gathering ground of the River Lee which supplies London with one-quarter of its water. The account, which appears under the title "The Lee as a source of water supply," extends to about one-half the volume. It does not pretend to concern itself only with water and the physical geography and geology of the area. In the author's own words:—

"Can anyone think of the lovely seas surrounding our shores, of the incomparable, although changeable skies above us, of the lovely mountains and kindly valleys, of the exquisite lakes and charming rivers of our beloved country, without passing into realms of romance? . . . If we add to the refrain of our song the historical setting of many of our water supplies, the music must surely stir the hearts and imagination of a wide circle of readers."

But, he says, in another place,

"the Philistines welcome no digressions; they see only the open road in front of them."

On the other hand

"others look to the beginning and end of things, the alluring surroundings of a subject, the association of ideas, the belief that there is nothing under the sun which is not related, in greater or less degree, to a thousand other things, which to unseeing eyes may seem to be irrelevant. These are the hill-top worshippers who regard everything in life as wonderful, and who, rightly or wrongly, fail to see why even questions of water supply should be ruthlessly shorn of all the elements of romance, and be regarded wholly and without sentiment as a matter of quantity, quality, and financial expediency. However these things may be, we have finished our meagre repast and enjoyed a friendly pipe."

And so we read about Izaak Walton and fishing, animals, birds, churches, men and things in large number. all interwoven with

a highly interesting and well-illustrated account of the River Lee from its source to Feilde's Weir, and of the country which it drains.

This kind of "report" must be of absorbing interest to readers of the "humanities" as well as to the specialists. But the author says—

"the last section, the results of analyses, should be ignored by the general reader; it is crammed with figures as dry as dust, and is meant only for the perusal of chemists, bacteriologists and technical experts who have to study these things for the good of their souls."

We think the author is here a little unkind to himself. Many who are not experts who have read the author's preliminary remarks will no doubt turn with anticipation to his tables and find points of interest in them.

We commend most warmly this further instalment of a highly successful attempt to invest with life the dry bones of official statistics, which are undoubtedly of general interest. We hope that the author and the Metropolitan Water Board will conspire to produce further similar investitures in due course and that on the next occasion they will turn their attention also to the title page, which might with advantage breathe a similar spirit and at least give a broader hint of the interesting things which lie behind its cover.

R. CORLESS.

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### Obituary

*Captain Roald Amundsen.*—With the discovery of part of the wreckage of the aeroplane in which Captain Roald Amundsen set out on June 18th in search of the wrecked *Nobile* party, it seems that all hope of finding Amundsen and his companions alive must now be abandoned. Amundsen was born at Borge, in Norway, in 1872. His interest was aroused by Nansen's successful crossing of the Greenland ice in 1888, and he attempted to join the Arctic expedition of the *Fram* in 1892. Disappointed in this, he joined the crew of a sealer in order to obtain training in Arctic work. At the age of 25 he was engaged as mate of the Belgian Antarctic expedition of 1897-9, and in 1903 he led an expedition in a small ship, the *Gjøa*, to the American Arctic Archipelago with the purpose of fixing anew the position of the north magnetic pole and re-discovering the north-west passage. The expedition lasted for three years and was successful in both its objects.

Amundsen's next ambition was to reach the North pole by drifting in the ice, but he was anticipated by Peary. He accordingly deflected the *Fram* to the Antarctic and reached the Ross Sea early in 1911. On October 20th, 1911, he set out across the ice and, favoured by fortune, reached the South pole on December 14th, five weeks before Captain Scott.

The Arctic project was not resumed until 1918, in the *Maud*, and met with great difficulties, which convinced Amundsen that Arctic exploration would be carried out most successfully by air. The first attempt, in 1922, was spoilt by stormy weather, but in 1925 he started from Spitsbergen with Lieut. Dietrichsen in two specially built flying boats, which reached  $87^{\circ}43'N$  before being forced to come down. The party experienced great difficulty in returning to Spitsbergen in one of the machines, the other being abandoned.

In May, 1926, Amundsen and Ellsworth finally reached the North pole in the airship *Norge I*, which set out from Spitsbergen and continued across the Arctic Ocean to Alaska.

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### News in Brief

A note in *Nature* for August 18th, 1928, states that during a typhoon about 400 nautical miles east of Luzon readings of a mercurial barometer gave the abnormally low figure of 886.8mb., corrected for temperature, gravity and height. This reading, which was checked by several persons, is more than 30mb. lower than the previous "record" of 918.9mb. at False Point, Orissa, India, on September 22nd, 1885.

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In a circular from the Observatoire Talence, M. Henri Mémery attributes the hot weather of July to the recrudescence of solar activity, in connexion with the sunspot maximum which appears to be located in 1928.

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### The Weather of August, 1928

Fair sunny weather prevailed generally in the south of England during August but further north, where sunshine and rainfall were both above normal in many places, the conditions were somewhat unsettled.

From the 1st to the evening of the 5th the weather over the country generally was fair and dry with the exception of south-eastern England where rain on the 1st and 3rd was associated with shallow depressions over southern England and northern France respectively. The amounts measured on the 1st were small but on the 3rd 2.08in. occurred at Blandford (Dorset) and 1.83in. at Jersey. The 5th was one of the sunniest days of the month, over 13hrs. bright sunshine being recorded at many places and 14.3hrs. at Jersey. During the night of the 5th-6th a depression off our north-west coasts caused rain in western Ireland and this spread across the whole country as the depression passed north-eastwards; 1.69in. fell at Douglas, 1.62in. at Fofanny (Co. Down), and 0.93in. at Dumfries on the 6th and 2.22in. at Borrowdale on the 7th. On the 8th the

south of England came under the influence of the anti-cyclone over France and fair sunny warm weather prevailed there generally until the 19th. Sunshine records were good on most days and temperature frequently rose above 70°F., 84°F. being recorded at Greenwich and 81°F. at Tottenham on the 11th. Over the rest of the British Isles fair weather prevailed from the 8th to 10th and again between the 15th and 18th., but from the 11th to 14th a depression passed across northern Ireland and Scotland giving rather heavy rain locally but many hours of sunshine; 1.22in. of rain fell at Eskdalemuir on the 11th. Thunderstorms occurred in many places on the 11th, 12th and 13th. From the 19th to 29th a belt of low pressure extended from the Atlantic across the British Isles to the North Sea, and was associated generally with slight rain though there were heavy falls locally, 2.59in. at Felixkirk (Yorks), 2.15in. at Geltsdale (Cumberland) on the 20th and 2.14in. at Chewton Mendip (Somerset) on the 27th. Thunderstorms occurred frequently but there were also long spells of bright sunshine. During the last two days of the month a ridge of high pressure spread across the whole country. The 30th was sunny but on the 31st there was slight rain locally in the south. Sunshine totals were generally above normal. The total of 195hrs. at Valentia was 40hrs. above normal, that of 187hrs. at Dublin, 25hrs. above normal, that of 20hrs. at Kew, 13hrs. above normal. At Stornoway the total was 2hrs. above normal, at Falmouth normal, but at Aberdeen 38hrs. below normal.

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Pressure was above normal from Spitzbergen across Iceland to Newfoundland and Bermuda, and over central Europe, Italy, south France and Spain, the greatest excess being 9.6mb. at Jan Mayen. Pressure was below normal across Scandinavia, British Isles, northern Germany, western France to Portugal and the Azores, the greatest deficit being 4.1mb. in the Atlantic at about 50°N, 30°W. Generally temperature was above normal and rainfall below normal, except in southern Scandinavia, where the reverse was the case, and in Portugal, where the temperature was below normal.

Intense heat and dry weather broken by occasional severe thunderstorms in a few districts prevailed generally in south-western and central Europe during the first part of the month. Severe thunderstorms occurred in Switzerland and the Jura on the 3rd, 4th and 5th, in Bavaria on the 4th, in Portugal and south France on the 6th, in Alsace on the 12th and in central France about the 15th. Forest fires broke out in Savoy and other districts of France and in the Trentino and the Alpine glaciers melted rapidly this year. A hailstorm caused much damage to the crops between Haby and Mjaryd, Småland, Sweden on the 15th, and in spite of the heat, the hail is reported

to have remained in drifts for 24 hours. The heat wave which had continued for a month in Majorca came to an end about the 20th. Thunderstorms were again experienced in the neighbourhood of Geneva towards the end of the month and the vines were badly damaged. On the 29th a severe storm lasting about 15 minutes swept across Milan and caused ten deaths.

Five people were killed in a severe storm which devastated the town of Jijella (Algeria) and the coast between there and Bougie between 5.15 a.m. and 5.30 a.m. on the 17th.

The Amur (Siberia) and its tributaries continued to rise during the first part of the month and several hundred yards of railroad were swept away between Blagovyeschensk and Khabarovsk. Zeya (Siberia) was devastated by a storm followed by floods about the 29th. After 29 days of drought in Delhi and the greater part of the Punjab, rain fell steadily on the 22nd. It is hoped that it has come in time to save a part of the October crop. Heavy and continuous rain fell in the Bombay Presidency between the 25th and 30th and the crops are in good condition. Floods in the south-west of Weih sien in Shantung have caused the death by drowning of 1,800 people.

Favourable weather for harvesting was experienced in most parts of Canada and the crops were mostly good except that damage from frost occurred in Saskatchewan and parts of Alberta on the nights of the 22nd, 23rd, 24th, 28th and 30th. The heat wave which was experienced in New York and the whole of the Eastern seaboard at the beginning of the month came to an end about the 11th when severe rainstorms occurred. A hurricane which swept across Florida from east to west on the 8th and 9th did much damage to the crops and communications. A hurricane also passed across the greater part of Haiti on the 10th and here about 200 people were killed. Tornadoes were experienced in Minnesota and Iowa on the 20th when six people were killed. In New York State there were floods on the 27th owing to the rainstorms, and a heat wave between the 28th and 30th.

The special message from Brazil states that the rainfall was scarce in the southern and central regions, being 34mm. and 20mm. below normal respectively, and plentiful in the northern regions with 69mm. above normal. Six anticyclones passed across the country and windstorms were experienced in the extreme south. The crops were in good condition generally, except that in the north the cotton crop had suffered from unfavourable weather.

At Rio de Janeiro pressure was 1.3mb. above normal and temperature normal.

### Rainfall, August, 1928—General Distribution

England and Wales	...	100	} per cent. of the average 1881-1915
Scotland	...	120	
Ireland	...	132	
British Isles	...	<u>112</u>	

**Rainfall: August, 1928: England and Wales**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond</i>	Camden Square .....	2·60	118	<i>Leics</i>	Thornton Reservoir ...	2·81	100
<i>Sur</i>	Reigate, The Knowle...	2·62	114	"	Belvoir Castle.....	1·95	72
<i>Kent</i>	Tenterden, Ashenden...	1·50	65	<i>Kut</i>	Ridlington .....	3·02	...
"	Folkestone, Boro. San.	1·55	...	<i>Linc</i>	Boston, Skirbeck .....	1·68	70
"	Margate, Cliftonville...	1·20	62	"	Lincoln, Sessions House	4·32	176
"	Sevenoaks, Speldhurst	3·07	...	"	Skegness, Marine Gdns	1·72	71
<i>Sus</i>	Patching Farm .....	2·08	83	"	Louth, Westgate .....	2·90	104
"	Brighton, Old Steyne	1·87	86	"	Brigg, Wrawby St. ...	4·29	...
"	Tottingworth Park ...	1·62	60	<i>Notts</i>	Worksop, Hodsock ...	2·05	84
<i>Hants</i>	Ventnor, Roy. Nat. Hos.	3·02	152	<i>Derby</i>	Derby .....	3·09	118
"	Fordingbridge, Oaklands	2·41	92	"	Buxton, Devon Hos. ...	5·31	121
"	Ovington Rectory .....	2·46	91	<i>Ches</i>	Runcorn, Western Pt.	3·73	104
"	Sherborne St. John ...	2·69	111	"	Nantwich, Dorfold Hall	3·23	...
<i>Berks</i>	Wellington College ...	2·16	93	<i>Lancs</i>	Manchester, Whit. Pk.	4·89	142
"	Newbury, Greenham...	2·15	82	"	Stonyhurst College ...	8·11	160
<i>Herts</i>	Benington House .....	2·43	100	"	Southport, Hesketh Pk	3·12	90
<i>Bucks</i>	High Wycombe .....	2·65	114	"	Lancaster, Strathspey	6·04	...
<i>Oxf</i>	Oxford, Mag. College	1·36	60	<i>Yorks</i>	Wath-upon-Deane ...	2·09	87
<i>Nor</i>	Pitsford, Sedgebrook...	1·79	74	"	Bradford, Lister Pk. ...	3·92	145
"	Oundle .....	1·47	...	"	Oughtershaw Hall.....	7·82	...
<i>Reds</i>	Woburn, Crawley Mill	2·77	120	"	Wetherby, Ribston H.	4·53	166
<i>Cam</i>	Cambridge, Bot. Gdns.	...	...	"	Hull, Pearson Park ...	3·71	128
<i>Essex</i>	Chelmsford, County Lab	2·72	125	"	Holme-on-Spalding ...	3·56	...
"	Lexden, Hill House ...	2·26	...	"	West Witton, Ivy Ho.	5·36	...
<i>Suff</i>	Hawkedon Rectory ...	1·84	71	"	Felixkirk, Mt. St. John	5·10	179
"	Haughley House .....	2·02	...	"	Pickering, Hungate ...	3·17	...
<i>Norfol</i>	Beccles, Geldeston .....	...	...	"	Scarborough .....	3·75	135
"	Norwich, Eaton.....	1·80	76	"	Middlesbrough .....	3·42	125
"	Blakeney.....	3·00	133	"	Baldersdale, Hury Res.	5·78	...
"	Little Dunham .....	2·28	84	<i>Durh</i>	Ushaw College .....	3·48	120
<i>Wilts</i>	Devizes, Highclere ...	2·43	84	<i>Nor</i>	Newcastle, Town Moor	4·35	149
"	Bishops Cannings .....	2·80	90	"	Bellingham, Highgreen	3·48	...
<i>Dor</i>	Evershot, Melbury Ho.	1·94	62	"	Lilburn Tower Gdns. ...	4·47	...
"	Creech Grange .....	2·49	...	<i>Cumb</i>	Geltsdale.....	7·81	...
"	Shaftesbury, Abbey Ho.	2·53	87	"	Carlisle, Scaleby Hall	6·52	158
<i>Devon</i>	Plymouth, The Hoe ...	2·12	69	"	Borowdale, Rosthwaite	12·59	...
"	Polapit Tamar .....	3·51	110	"	Keswick, High Hill ...	7·83	...
"	Ashburton, Druid Ho.	2·96	79	<i>Glam</i>	Cardiff, Ely P. Stn. ...	4·06	94
"	Cullompton.....	1·72	56	"	Treherbert, Tynywaun	7·98	...
"	Sidmouth, Sidmount...	2·03	72	<i>Carm</i>	Carmarthen Friary ...	4·78	103
"	Filleigh, Castle Hill ...	4·12	...	"	Llanwrda, Dolaucothy	6·64	121
"	Barnstaple, N. Dev. Ath.	2·94	89	<i>Pemb</i>	Haverfordwest, School	3·95	95
<i>Corn</i>	Redruth, Trewirgie ...	2·19	64	<i>Card</i>	Aberystwyth .....	6·73	...
"	Penzance, Morrab Gdn.	2·19	69	"	Cardigan, County Sch.	2·55	...
"	St. Austell, Trevarna...	3·17	88	<i>Brec</i>	Crickhowell, Talymaes	4·70	...
<i>Soms</i>	Chewton Mendip .....	5·41	121	<i>Rad</i>	Birm W. W. Tyrmynydd	6·57	122
"	Long Ashton .....	3·15	...	<i>Mont</i>	Lake Vyrnwy.....	7·41	143
"	Street, Hind Hayes ...	1·95	...	<i>Denb</i>	Llangynhafal .....	3·31	...
<i>Glos</i>	Cirencester, Gwynfa ...	2·05	68	<i>Mer</i>	Dolgelly, Bryntirion...	7·80	138
<i>Here</i>	Ross, Birchlea .....	2·03	79	<i>Carn</i>	Llandudno .....	2·48	82
"	Ledbury, Underdown	2·35	90	"	Snowdon, L. Llydaw 9	14·15	...
<i>Salop</i>	Church Stretton.....	3·48	107	<i>Ang</i>	Holyhead, Salt Island	2·96	93
"	Shifnal, Hatton Grange	2·94	105	"	Lligwy .....	3·83	...
<i>Worc</i>	Ombersley, Holt Lock	1·40	52	<i>Isle of Man</i>			
"	Blockley, Upton Wold	2·41	82	"	Douglas, Boro' Cem. ...	5·16	136
<i>War</i>	Farnborough .....	1·67	61	<i>Guernsey</i>			
"	Birmingham, Edgbaston	1·79	66	"	St. Peter P't. Grange Rd.	1·89	81

**Rainfall: August, 1928: Scotland and Ireland**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	3'51	67	<i>Suth.</i>	Loch More, Achfary ...	...	...
"	Pt. William, Monreith	4'41	...	<i>Caith.</i>	Wick .....	2'01	72
<i>Kirk.</i>	Carsphairn, Shiel. ....	9'13	...	<i>Ork.</i>	Pomona, Deerness .....	1'35	47
"	Dumfries, Cargen .....	6'87	156	<i>Shet.</i>	Lerwick .....	3'02	100
<i>Dumf.</i>	Eskdalemuir Obs. ....	9'48	184	<i>Ork.</i>	Caheragh Rectory .....	4'98	...
<i>Roxb.</i>	Bransholm .....	6'94	215	"	Dunmanway Rectory...	5'12	109
<i>Selk.</i>	Ettrick Manse .....	8'35	...	"	Ballinacurra .....	6'21	167
<i>Peeb.</i>	West Linton .....	5'61	...	"	Glaumire, Lota Lo. ....	6'28	172
<i>Berk.</i>	Marchmont House .....	4'40	133	<i>Kerry.</i>	Valentia Obsy. ....	8'68	181
<i>Hadd.</i>	North Berwick Res. ....	4'27	135	"	Gearahameen .....	9'80	...
<i>Midt.</i>	Edinburgh, Roy. Obs. ....	4'85	157	"	Killarney Asylum .....	4'58	104
<i>Ayr.</i>	Kilmarnock, Agric. C. ....	4'31	110	"	Darrynane Abbey .....	5'61	129
"	Girvan, Pinmore .....	5'28	119	<i>Wat.</i>	Waterford, Brook Lo. ....	4'55	119
<i>Renf.</i>	Glasgow, Queen's Pk. ....	3'20	90	<i>Tip.</i>	Nenagh, Cas. Lough... ..	4'00	101
"	Greenock, Prospect H. ....	5'38	99	"	Roscrea, Timoney Park ..	4'36	...
<i>Bute.</i>	Rothsay, Ardeneraig ..	4'98	102	"	Cashel, Ballinamona ..	5'09	143
"	Dougarie Lodge .....	4'50	...	<i>Lam.</i>	Foynes, Coolnanes .....	5'04	130
<i>Arg.</i>	Ardgour House .....	7'39	...	"	Castleconnel Rec. ....	4'30	...
"	Manse of Glenorchy ...	7'30	...	<i>Clare.</i>	Inagh, Mount Callan... ..	5'78	...
"	Oban .....	5'37	...	"	Broadford, Hurdlest'n. ....	5'64	...
"	Poltalloch .....	4'42	90	<i>Wexf.</i>	Newtownbarry .....	5'71	...
"	Inveraray Castle .....	7'79	118	"	Gorey, Courtown Ho ..	6'17	185
"	Islay, Eallabus .....	5'42	124	<i>Kilk.</i>	Kilkeny Castle .....	4'74	136
"	Mull, Benmore .....	10'20	...	<i>Wic.</i>	Rathnew, Clonmannon ..	4'95	...
"	Tiree .....	3'35	...	<i>Carl.</i>	Hacketstown Rectory... ..	5'28	130
<i>Kinnr.</i>	Loch Leven Sluice .....	5'46	143	<i>QCo.</i>	Blandsfort House .....	4'23	107
<i>Perth.</i>	Loch Dhu .....	8'75	130	"	Mountmellick .....	4'36	...
"	Balquhiddie, Stronvar ..	6'21	...	<i>KCo.</i>	Birr Castle .....	4'10	108
"	Crieff, Strathearn Hyd. ....	6'04	143	<i>Dubl.</i>	Dublin, FitzWm. Sq. ....	2'48	82
"	Blair Castle Gardens .....	5'47	162	"	Balbriggan, Ardgillan. ....	3'25	95
<i>Forf.</i>	Kettins School .....	4'01	121	<i>Me'th.</i>	Beaupare, St. Cloud... ..	3'46	...
"	Dundee, E. Necropolis ..	5'18	153	"	Kells, Headfort .....	5'71	138
"	Pearsie House .....	6'98	...	<i>W.M.</i>	Moate, Coolatore .....	4'23	...
"	Montrose, Sunnyside... ..	3'67	131	"	Mullingar, Belvedere... ..	5'24	126
<i>Aber.</i>	Braemar, Bank .....	5'64	165	<i>Long.</i>	Castle Forbes Gdns .....	5'21	127
"	Logie Coldstone Sch. ....	4'28	135	<i>Gal.</i>	Ballynahinch Castle ...	8'49	154
"	Aberdeen, King's Coll. ....	2'31	84	"	Galway, Grammar Sch. ....	5'97	...
"	Fyvie Castle .....	3'55	...	<i>Mayo.</i>	Mallaranny .....	6'56	...
<i>Mor.</i>	Gordon Castle .....	3'20	101	"	Westport House .....	5'24	129
"	Grantown-on-Spey .....	4'55	142	"	Delphi Lodge .....	9'59	...
<i>Na.</i>	Nairn, Delnies .....	3'17	132	<i>Sligo.</i>	Markree Obsy. ....	6'07	140
<i>Inv.</i>	Ben Alder Lodge .....	...	...	<i>Cuv'n.</i>	Belturbet, Cloverhill. ....	5'07	136
"	Kingussie, The Birches ..	4'20	...	<i>Ferm.</i>	Enniskillen, Portora. ....	...	...
"	Loch Quoich, Loan ...	7'00	...	<i>Arm.</i>	Armagh Obsy .....	6'86	190
"	Glenquoich .....	8'33	101	<i>Down.</i>	Fofanny Reservoir .....	6'30	...
"	Inverness, Culduthel R. ....	3'95	...	"	Seaford .....	4'28	114
"	Arisaig, Faire-na-Squir ..	3'19	...	"	Donaghadee, C. Stn ...	4'37	131
"	Fort William .....	5'71	...	"	Banbridge, Milltown... ..	4'05	116
"	Skye, Dunvegan .....	4'31	...	<i>Antr.</i>	Belfast, Cavehill Rd ...	4'27	...
<i>R &amp; C.</i>	Alness, Ardross Cas. ....	5'26	178	"	Glenarm Castle .....	5'09	...
"	Ullapool .....	3'53	...	"	Ballymena, Harryville ..	4'57	131
"	Torridon, Bendamph... ..	4'49	68	<i>Lon.</i>	Londonderry, Creggan ..	6'31	136
"	Achnashellach .....	4'67	...	<i>Tyr.</i>	Donaghmore .....	5'62	...
"	Stornoway .....	2'19	55	"	Omagh, Edenfel. ....	6'34	148
<i>Suth.</i>	Lairg .....	2'86	...	<i>Don.</i>	Malin Head .....	4'75	135
"	Tongue .....	3'28	103	"	Dunfanaghy .....	6'49	...
"	Melvich .....	2'51	84	"	Killybegs, Rockmount. ....	6'91	123

## Climatological Table for the British Empire, March, 1928.

STATIONS	PRESSURE		TEMPERATURE						Mean Cloud Am't	PRECIPITATION		BRIGHT SUNSHINE		
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values			Mean Humidity.		Am't	Diff. from Normal	Days	Hours per day	Per-cent- age of possi- ble
			Max.	Min.	Max.	Min.	1/2 max. and min.							
London, Kew Obsy.	1009.6	-3.8	64	27	50.7	39.0	44.9	+2.5	39.9	1.73	0.04	17	3.0	25
Gibraltar	1015.4	-1.6	72	47	63.1	52.5	57.8	+0.3	52.1	4.49	0.30	20	..	..
Malta	1013.5	-1.3	63	47	59.5	52.5	56.0	-1.1	53.3	4.32	2.84	18	5.3	44
St. Helena	1011.9	+2.4	73	58	68.9	60.7	64.8	-2.0	61.9	5.45	0.51	25	..	..
Sierra Leone	1011.2	+0.5	92	71	88.9	75.3	82.1	-0.3	75.6	1.68	0.52	4	..	..
Lagos, Nigeria	1008.6	-0.8	89	70	87.0	77.3	82.1	-1.2	77.3	8.20	4.46	12	..	..
Kaduna, Nigeria	1014.3	+3.2	99	..	94.5	..	..	..	74.2	1.21	0.77	3	..	..
Zomba, Nyasaland	1010.1	+0.4	86	60	80.5	64.2	72.3	+1.0	..	11.40	2.32	23	..	..
Salisbury, Rhodesia	1008.9	-0.3	84	52	80.4	58.9	69.7	+1.5	62.0	3.09	1.41	17	7.5	61
Cape Town	1014.8	+0.3	100	53	77.5	58.6	68.1	0.0	59.7	0.57	0.34	7	..	..
Johannesburg	1014.2	+0.4	83	45	75.1	54.6	64.9	+1.6	55.3	2.45	1.99	7	8.3	68
Mauritius	1011.6	-0.4	86	64	83.3	72.1	77.7	-0.3	74.8	6.46	2.91	17	8.3	68
Bloufontein	..	..	90	43	79.6	56.6	68.1	+0.7	58.6	2.27	1.70	8	..	..
Calcutta, Alipore Obsy.	1009.8	-0.1	101	60	96.1	70.5	83.3	+3.2	69.4	0.13	1.31	1*	..	..
Bombay	1010.4	-0.5	91	67	86.4	73.5	79.9	+0.4	71.1	0.00	0.02	0*	..	..
Madras	1010.7	-0.2	95	63	90.2	70.9	80.5	-0.6	73.4	1.04	0.85	3*	..	..
Colombo, Ceylon	1010.7	+0.3	92	69	89.3	73.7	81.0	-0.3	76.5	3.65	1.02	7	9.0	74
Hongkong	1014.4	-1.7	78	53	67.3	60.2	63.7	+0.4	60.7	5.19	2.40	15	2.8	23
Sandakan	..	..	91	74	87.8	75.4	81.6	+0.5	77.8	15.00	6.95	12	..	..
Sydney	1016.2	0.0	89	55	78.6	63.8	71.2	+1.9	66.4	4.46	0.33	11	7.6	62
Melbourne	1016.7	-0.3	97	48	76.4	58.7	67.5	+3.0	61.2	4.18	1.92	10	6.3	51
Adelaide	1016.2	-0.9	104	52	81.2	59.1	70.1	+0.3	59.0	1.05	0.00	4	7.7	63
Perth, W. Australia	1015.2	-0.1	99	52	79.8	59.8	69.8	-1.3	61.9	0.10	0.65	3	9.3	76
Coalgardie	1014.3	-0.5	108	46	85.4	57.9	71.7	0.0	57.5	0.78	0.04	4	..	..
Brisbane	1016.7	+2.3	87	61	82.5	66.0	74.3	0.0	68.8	2.14	3.42	14	8.6	69
Hobart, Tasmania	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wellington, N.Z.	1020.2	+3.0	75	46	68.0	55.6	61.8	+1.3	59.0	1.38	1.95	9	6.2	50
Suva, Fiji	1008.7	+0.2	92	73	86.8	76.0	81.4	+1.3	77.9	16.39	1.69	24	5.6	46
Apia, Samoa	1009.6	+0.4	89	75	85.6	76.6	81.1	+1.8	78.8	15.78	2.24	17	6.1	50
Kingston, Jamaica	1014.9	0.0	89	66	85.1	68.7	76.9	-0.2	66.8	0.11	0.91	2	8.7	73
Grenada, W.I.	1010.4	2.3	88	69	85.5	72.0	78.7	+1.0	73.0	2.17	0.57	14	..	..
Toronto	1012.4	-4.6	71	9	37.6	23.6	30.6	+1.7	25.4	2.22	0.43	18	4.9	41
Winnipeg	1017.7	-1.1	62	-14	30.5	12.4	21.5	+7.1	..	1.54	0.43	9	5.2	41
St. John, N.B.	1012.9	-1.3	..	..	34.6	22.5	28.5	+0.1	..	2.09	2.45	16	5.1	43
Victoria, B.C.	..	..	..	..	..	..	..	..	..	..	..	..	..	..

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



CRANWELL

15 DEC 1929

METEOROLOGICAL  
OFFICE



HAIL LYING A FOOT DEEP IN THE ROADWAY, THE MALL, ARMAGH,  
AUGUST 29TH, 1928. (*See p. 208.*)



THE FLOODED CRICKET FIELD IN THE MALL, ARMAGH, UNDER 2 TO 3 FT. OF  
WATER, AUGUST 29TH, 1928. THE FLOATING WHITE MASSES ARE HAIL.  
(*See p. 208.*)

(*These two photographs are reproduced by the courtesy of  
Mr. W. F. A. Ellison, of Armagh.*)

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## Dr. Charles Chree

The death of Dr. Charles Chree, which occurred at Worthing on August 12th after a few months of illness has been announced in the *Meteorological Magazine*. It is only three years ago that Dr. Chree retired from his post as Superintendent of Kew Observatory. At that time, and, indeed, until quite recently there was every reason to suppose that he had still many years of vigorous life before him.

Charles Chree was born at Lintrathen in Forfarshire on May 5th, 1860, and after passing through the Grammar School, Old Aberdeen, he graduated in 1879 at the University of that city, winning the gold medal awarded to the most distinguished graduate in arts of the year. From Aberdeen he went to Cambridge; his studies there were interrupted by severe illness, he lost a year's work and the illness left him with white hair which he carried through life. He passed the mathematical tripos however as sixth wrangler and other distinctions led to his election as a Fellow of his College, King's. In that position he had time for research work and devoted himself to the mathematical theory of elasticity. On that subject he published several important papers. In 1893 he was selected for the post of Superintendent of Kew Observatory, vacant through the death of my father, G. M. Whipple, at the beginning of the year. From 1893 to 1925 Chree was identified with the Observatory.

When Chree was first appointed to the Observatory the idea of a National Physical Laboratory had been mooted already and a strong Committee of the British Association was exploring possibilities. A considerable amount of work appropriate for

such a Laboratory was being done already at Kew, and, indeed, the income of the Observatory depended mostly on the fees for tests. The instruments submitted for verification included thermometers, barometers, sextants, telescopes, compasses, etc., as well as watches and chronometers. Chree's responsibility for much of this work continued after the National Physical Laboratory was constituted in 1901 and the new governing body took over the administration of the Observatory from the old Kew Committee. In 1910 the Observatory was transferred from the National Physical Laboratory to the Meteorological Office. Dr. Chree's last years of service were as an Assistant Director of the Office. He retired in 1925.

Soon after his appointment as Superintendent Chree began to publish papers connected with the work of the Observatory. Some of these were concerned with the standardization of instruments. To thermometry, for instance, he devoted some important papers in the *Philosophical Magazine*. He also discussed the testing of aneroid barometers, a subject which was then of interest mostly to mountaineers. Another paper he devoted to the theory of the Robinson cup anemometer.

The branches of the Observatory work which made the strongest appeal to Chree were atmospheric electricity and terrestrial magnetism. Before his time, though records of atmospheric potential were being made at various places the results were hardly comparable. Chree saw the importance of standardization and developed a method by which the photographic curves from the Kelvin electrograph could be utilised to give potential gradient in the open. Through this enterprise there is for Kew a longer series of reliable observations of potential gradient than for any other observatory. Dr. Chree devoted several papers to the discussion of the results. The latest, written with R. E. Watson, was especially concerned with the effects of atmospheric pollution on potential gradient.

As some guide to Dr. Chree's earlier work in terrestrial magnetism we have a valuable book which he published in 1912. (His activity in research continued unabated in later years, and it is to be hoped that means will be found to put the salient results on record in an equally convenient form.) His attitude to scientific investigation is well illustrated by a paragraph in the preface to this book.

"The book deals almost entirely with facts, or supposed facts. The absence of a definite theory as to the origin of the several magnetic changes is due to no lack of curiosity as to the causes of things, but to a belief that at the present stage theorising is less likely to be of substantial advantage than the extension of positive knowledge. It is sometimes claimed that a theory is essential as a guide in selecting the directions in which to prosecute research. This is a very partial

truth. When a man devotes himself to a subject, allowing free ingress to his mind to all the ideas which the results obtained by investigators naturally suggest, he must be a very unimaginative person if profitable lines of enquiry do not force themselves on his intelligence. The difficulty is not in thinking of something to do but of deciding what to do next. In making a choice some may prefer the guidance supplied by a definite theory, but others will prefer to rely on their natural instinct for detecting a weak spot in the defence offered by Nature to the discovery of her secrets."

Such doctrines Chree never tired of repeating, and he had the justification that his natural instinct had indeed detected many weak spots in Nature's defence. Although he refrained from making known speculations of his own, he insisted on the credit due to Balfour Stewart for his hypothesis that the variations of magnetic force were to be explained by the existence of a highly conducting region in the upper air. Chree wished the name of Balfour Stewart to be associated with those of Schuster, Kennelly and Heaviside in references to the conducting layer.

The first of Chree's discoveries in terrestrial magnetism was it appears the "non-cyclic change" in the magnetic elements on quiet days. Just before his time the British Association had introduced the practice of tabulating the diurnal variation on magnetically quiet days, these days being selected by the Astronomer Royal. The idea was that the effect of magnetic storms would be eliminated. In studying the tabulations Chree found that the values entered for successive midnights differed systematically. In the typical case of horizontal force, the sign of this systematic difference implied that on quiet days horizontal force was increasing. In other words the net effect of disturbed days is to reduce horizontal force and in the subsequent quiet days there is a gradual recovery. Thus a weak spot was revealed in Nature's defence, and Chree proceeded to inaugurate the study of the diurnal variation of the magnetic elements on disturbed days. Here he found an entirely new type of variation. To quote what he says in another connexion he was in the position of the doctor who had established a distinction between two types of disease such as small-pox and chicken-pox which had been confused before. He had provided a new test which a theory of terrestrial magnetism would have to satisfy. In later papers Chree devoted much attention to the recurrence of magnetic disturbances at intervals governed by the rotation of the sun. Perhaps the most notable discovery in this field was the fact that quiet conditions tended to recur with the same regularity as disturbed ones.

Chree's weighty contributions to terrestrial magnetism include the discussions of the magnetic observations brought

back by three Antarctic expeditions, Scott's two and Mawson's. The advantage is manifest of uniform treatment of these three valuable series of observations, taken in conjunction with the simultaneous observations made at observatories in other parts of the world. The whole of Chree's work on Mawson's expedition has not yet been published, he was engaged on it when his efforts were interrupted by his last illness. Another self-imposed task which he had successfully completed since his retirement was a discussion of the Kew records of magnetic declination from 1858 onwards. This discussion, which will be published in the near future, is a worthy conclusion to the fine series of papers he devoted to the observatory records.

In connexion with the organization of observations the large part which Dr. Chree took in the establishment of the Observatories at Eskdalemuir and Lerwick must be mentioned. As is well known the Observatory at Eskdalemuir was built to secure records of terrestrial magnetism at a place free from the disturbing influence of the electric currents used on tramways and railways. Dr. Chree made a careful magnetic survey round the site proposed for the Observatory and his influence was felt in many ways in the development of the Observatory. When the records from Eskdalemuir became available for study it was seen that the character of the magnetic variations there differed considerably from that found in the south of England. Dr. Chree was impressed with the importance of getting records from a station still nearer to the auroral zone, and it was largely through his advocacy that the Observatory at Lerwick was established.

Dr Chree's degrees were Sc.D. of Cambridge and LL.D. of Aberdeen. He was elected a Fellow of the Royal Society in 1897. He was awarded the James Watt medal by the Institution of Civil Engineers in 1905 and the Hughes medal of the Royal Society in 1919. He served as president of the Physical Society and of the Royal Meteorological Society. In later years his eminence as a magnetician was recognised by his election as president by both of the international bodies which deal with terrestrial magnetism and atmospheric electricity. Amongst the characteristics which made an impression on those who worked with Dr. Chree were his accuracy and speed in computation and his skill as an observer. His powers of concentration were remarkable; even the first drafts of his papers had but few corrections, and the copies which he always made with his own hand were ready for the printer and free from amendments. He was a patient teacher, as the magnetic observers who came to Kew from all parts of the world for training would testify. His sound judgment on man and affairs was tempered by kind consideration and by a sense of humour, which made him an acceptable, as well as lucid, public speaker.

Dr. Chree had won the warm affection of his colleagues and especially of those who had had the privilege of working with him at Ken; to them he was a wise counsellor and a good friend. Their keen sense of loss will be shared by his friends and fellow-workers the wide world over.

F. J. W. WHIPPLE.

## Renewal of Muslin and Wick on Wet Bulb Thermometers

In the *Meteorological Magazine* for July, 1928, Mr. R. C. Sutcliffe discusses the effect of the renewal of the muslin on the wet bulb thermometer and reaches the conclusion that under London conditions in winter a wet bulb muslin should not be allowed to remain in use for more than a fortnight.

Certain experiments were carried out here [in Heliopolis]

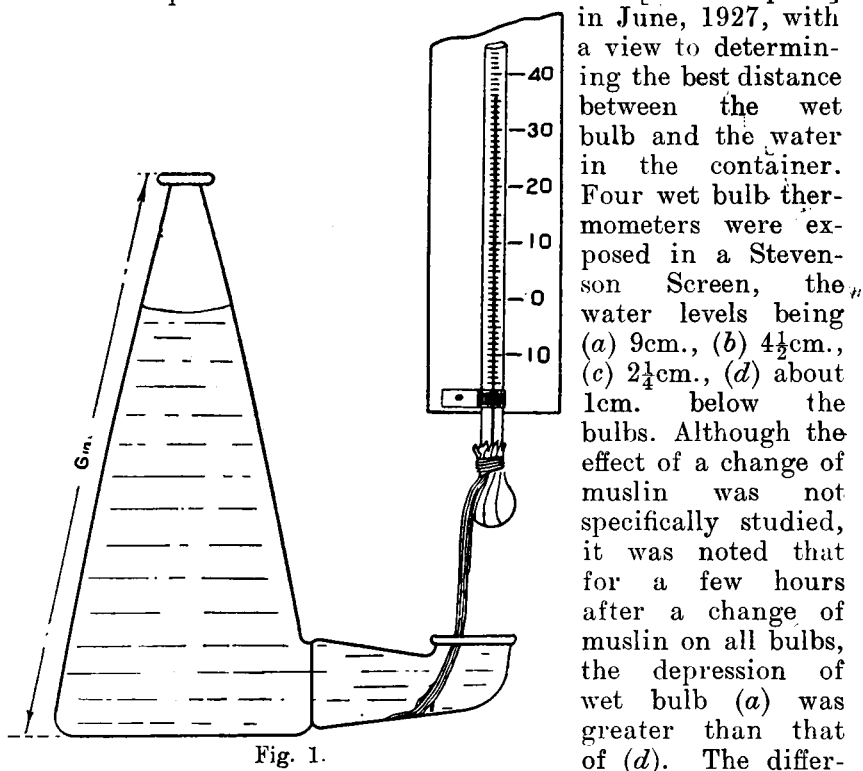


Fig. 1.

ences were not large, being generally less than  $0.5^{\circ}\text{F.}$  but reaching  $1^{\circ}\text{F.}$  occasionally. After an interval of 2-3 hours the depression of the wet bulb (d) was invariably greater than that of (a), (b), or (c), and the difference increased with time up to

about 3 days when the depression of (*d*) exceeded that of (*a*) by as much as 5-6°F.

It appears therefore that unless special precautions are taken in this country to maintain a constant water level (about 1cm. below the wet bulb) during the summer months the muslin would require to be changed about every 3 hours. Actually a simple piece of apparatus as illustrated in Fig. 1 has been brought into use at all Air Ministry meteorological stations in this area, so that a constant water level is always maintained.

There still remains the question of the frequency of change of muslin and this depends amongst other things on the nature of the water used. At meteorological stations in the vicinity of wireless stations distilled water can be obtained fairly easily but at many outlying stations distilled water or rain water is not obtainable and it seemed worth while to investigate what difference there would be in the readings of a wet bulb (*a*) covered with a clean muslin and one (*b*) covered with a muslin a few days old—muslins being kept wet from the same container. Experiments were carried out using Heliopolis drinking water which contains a good deal of lime. After an interval of three hours during which both thermometers read alike, the muslin on (*a*) was changed. With dry bulb readings of over 90° the difference in the depressions of (*a*) and (*b*) was 0.5 to 0.8°; this difference remained under 1° when the muslin on (*b*) was one day older than that on (*a*) and also when two days older but when the muslin on (*b*) was three days older than that on (*a*) differences of as much as 4.8°F. were shown. This difference is apparently due to the deposit of lime from the water and to the fine sand which collects on the muslin.

The experiments were then repeated using distilled water, the muslin on (*a*) being changed daily.

The following table shows the results obtained:—

Difference in age between muslin on ( <i>a</i> ) and ( <i>b</i> ) in days.	Average difference in depression of Wet Bulb ( <i>a-b</i> ) Dry Bulb > 90 F.			Average difference in depression of Wet Bulb ( <i>a-b</i> ) Dry Bulb < 90°F.		
0	...	...	0.0	...	...	0.0
1	...	...	0.0	...	...	0.3
2	...	...	0.8	...	...	0.8
3	...	...	1.3	...	...	1.0
5	...	...	2.4	...	...	0.8
6	...	...	2.7	...	...	1.5
7	...	...	3.0	...	...	1.5
8	...	...	3.0	...	...	1.8
9	...	...	3.1	...	...	2.9
10	...	...	3.3	...	...	2.1
20	...	...	4.5	...	...	—

To avoid systematic errors in wet bulb readings, it would therefore appear necessary even when using distilled water to



change the muslin every two days, but if an error of 5% in the relative humidity be allowed (corresponding to an error of about 2° in the wet bulb) it will be necessary to change the muslin every four days when temperatures of over 90°F. are experienced, and every six days when temperatures of under 90°F. (generally 75-89°F.) are experienced.

The above results obtained from observations at Heliopolis probably apply to other areas as well, and they show that a great deal of attention is necessary if the best results are to be obtained from the wet bulb thermometer—more especially as in areas where high average temperatures are measured, humidity is regarded as being as important a factor as the actual temperature itself.

J. DURWARD.

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## Official Publications

*Annual Report of the Director of the Meteorological Office, presented by the Meteorological Committee to the Air Council, for the Year ended 31st March, 1928.*

This report, describing the activities of the Meteorological Office during the seventy-third year of its existence and the eighth year in which its cost has been borne on Air Ministry votes, is cast in a new and more attractive form than the reports for previous years. In place of formal accounts and tables cataloguing the work of each separate division into which the Office is divided for administrative purposes, the report discusses in turn the various practical applications of meteorology—Climatology, Ocean Meteorology, Aviation, &c. The last of these sections is naturally of the greatest interest; it details the meteorological arrangements for Trans-Atlantic and other long distance flights, and gives an account of the work of the Office in connexion with airships and the British Airship Mission. Under the heading of Climatology is the story of the substitution of an annual volume for the old *Weekly Weather Report*, while a new departure in Forecasting is the undertaking of warnings when weather conditions appear likely to cause high tides in the Thames. On the other hand, the Office is no longer charged with the investigation of atmospheric pollution, this duty having been transferred to the Department of Scientific and Industrial Research.

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## Discussions at the Meteorological Office

October 29th. *The evaporation of sea water and the thermal intercourse between the sea and atmosphere.* By Was Shoulejkin (Beitr. Geophysik, Leipzig, 20, 1928, pp. 99-122). *Opener*—Mr. R. S. Read, M.A., B.Sc.

November 12th. *On the brightness of the sky.* By N. N. Kalitin (Beitr. Geophysik, Leipzig, 18, 1927, pp. 383-397) (in German). *Opener*—Mr. E. W. Barlow, B.Sc.

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### Remarkable Thunderstorm at Armagh

The thunderstorm of August 29th broke all records of the Armagh Observatory for intensity of rainfall. The locality is remarkable for its freedom from very heavy rains, and even more for the absence of severe electrical storms, which made the visitation the more unexpected. There was a good deal of distant thunder during the forenoon, and the clouds looked very threatening at times, but no rain fell, and by 13h. G.M.T., the threatening appearance of the weather had almost cleared off. It seemed as if the thunderclouds were about to disperse quietly as usual. But just before 15h., the storm broke without any warning. It did not approach, but seemed to develop right overhead out of nothing at all. A few very large drops of rain, making splashes as big as pennies, then a flash, and a crash of thunder following instantaneously, and not rain but hail, in stones as big as nuts and marbles, fell in sheets. All roof gutters and drain traps were quickly choked by the hailstones washed into them, and water poured into the houses through roofs, while the lower parts of the town were flooded to a depth of two to three feet [see the photographs which form the frontispiece of this issue]. Armagh lies in a depression, and most of the approaches to it are downhill. Each road leading into the town became in a few minutes a river discharging into the streets, bringing an amount of water which the drains could not have coped with, even had they not been obstructed by the masses of hail swept into them. The flood even lifted the manhole covers from culverts, and the water issuing therefrom added its quota to the surface deluge. The lightning and thunder were of a violent and terrifying description, such as the town had not seen for twenty years or more. According to some observers, two storms appeared to develop, one a little to the southeast and the other to the north of the town, and to converge upon it. There was little or no wind, and what there was came in uncertain puffs from different directions. The smoke from one mill chimney was seen to ascend in a corkscrew spiral towards the developing storm.

The storm lasted altogether less than an hour, but the greatest intensity lasted about 20 minutes. The rainfall, as recorded at the Observatory was 1.69in. in 50 minutes, of which one inch fell in the first 20 minutes. The trace of the Beckley recording

rain-gauge was so close that it was difficult to say whether it had emptied itself four or five times during that time. The amount collected in the Snowdon gauge close beside it however agreed with the larger amount. The greater part of the precipitation being hail, the rate of fall must have been considerably greater than the gauges indicated, as the funnels were nearly full of hail, which took some time to melt. There were two distinct forms of hailstones; small cones with hemispherical base, and spheres of clear ice. These were mixed in about equal proportions. Such was the quantity of hail that heaps of it were still lying in corners on September 1st, in spite of a maximum temperature of  $64^{\circ}$  to  $65^{\circ}$ , on each of the three following days. The storm was quite local, places only a mile or two distant from the town having no hail, and only a moderate rainfall.

What makes the rainfall the more remarkable is that it followed two other rainstorms of 1.22in., and 1.51in., respectively, on the two previous Sundays, giving a fall of 5.10in. (including minor amounts) in 10 days.

WM. F. A. ELLISON.

*The Observatory, Armagh. September 21st, 1928.*

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### **Squall at Southend-on-Sea**

A severe squall, causing loss of life at Southend, and some local damage, occurred in this district on Sunday, September 9th, at about 17h. G.M.T. The passage of the squall was very clearly shown on the recording instruments at this station. The barograph showed signs of oscillation and a sudden rise; simultaneously the wind velocity, as measured by the Dines P.T. anemometer, showed an almost instantaneous rise from calm to nearly 34m.p.h. One gust of 34m.p.h. was recorded, and the wind dropped to calm again at about 18h. 40m. G.M.T. The thermograph at this time showed a sudden drop of  $8^{\circ}\text{F.}$ , and the hygrograph a sudden drop, followed almost at once by a very rapid rise.

The weather before the storm was: overcast, strato-cumulus, with heavy showers at times; very oppressive and dark just before the wind rose. A mass of heavy cumulo-nimbus approached from the southwest, and was followed by a violent dust storm. Rain commenced about 10 minutes after the passage of the head of cloud.

O. G. SUTTON.

*Shoeburyness. September 10th, 1928.*

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### **Observations of Auroræ**

Aurora was seen by several observers in Huddersfield between 2h. and 2h. 30m. on the morning of August 27th last. A pre-

liminary rosy glow in the northern sky gave way to a series of white pillars of light which moved slowly about and were sufficiently faint to allow the stars to be seen through them.

In view of the infrequency of the observation of aurora as far south as Yorkshire, I think it would be of interest to know whether it was observed in other parts of the country on this date; up to the present I have been unable to obtain further information. The two previous records of aurora in this district were in February, 1910, and March, 1926.

S. MORRIS BOWER.

*Langley Terrace, Oakes, Huddersfield. October 3rd, 1928.*

Cromer, September 7th, 1928. The aurora was first noticed at about 10.10 p.m. British Summer Time. It was a radiation night with a very heavy dew, the sky being clear except for a small bank of cloud over the sea on the northern horizon. Above this, a pale green glow was to be seen, extending from about north by east to north by west, and  $5^{\circ}$  vertically. Four beams of the same colour, but of differing intensities, and varying in length from about  $15^{\circ}$  to  $20^{\circ}$  were seen issuing nearly vertically; and at north by east there was a single pale pink streamer. By 10.20 the streamers had disappeared, and subsequently the glow faded gradually.

G. J. W. ODDIE.

*October 3rd, 1928.*

D. W. JOHNSTON.

Mr. Wm. J. Gibson, of Waringstown, Co. Down, reports the occurrence of an unusually brilliant display of aurora at midnight (B.S.T.) on September 18th, and the following details are extracted from his description. The light was sufficient to light up the ground and to cause the styles of sundials to cast noticeable shadows. The display began at 10 p.m. in a cloudless sky, with a bank of light low in the north. "At 11 p.m. B.S.T. the lights began to stir in the form of perpendicular shafts or beams emanating from the bank . . . which by this time had resolved into a low arch." Just after midnight the northern heavens from WNW to ENE were aflame with a brilliant corona of auroral light. "Detached portions of light emanating from the horizon moved in slow uniform alignment up the sky right to the Pole Star, suggesting ripples of water on the smooth surface of a lake, whilst a thousand streamers bombarded the region of the Pole Star with such velocity as I seldom, if ever, witnessed before. The most conspicuous feature of the display was a huge stationary column or pillar of rose light extending from the horizon up to  $90^{\circ}$ , and about six times the diameter of the full moon in width." The display lasted until 1 a.m. and was associated with an outbreak of sunspots.

### Iridescence on Cirro-stratus Cloud

This morning at 10h. 16m. I observed iridescence on some thin cloud which appeared to be cirro-stratus. Only a small part of this cloud was visible, most of the sky being covered with heavy cumulus. The phenomenon appeared between two heavy masses of low strato-cumulus. The iridescence appeared on the left of the sun which was unobscured and took the form of parallel columns, perfectly straight, a complete spectrum being visible in each column. The columns, if produced, would have met the horizon at about  $45^\circ$ . As the phenomenon lasted only a matter of seconds, I had no time to get a protractor for measurements, but I should think that the length of the bands was  $4^\circ$ — $5^\circ$ . The perpendicular distance from the sun to the nearest iridescent band was about the same as the usual radius of a corona. As I have observed straight arcs of contact to solar halos on two occasions recently it occurred to me that to-day's phenomenon might be an arc of contact to a solar corona, akin to the halo phenomenon. I wonder if any of your readers can give evidence as to whether arcs of contact can really exist in connexion with coronæ.

S. E. ASHMORE.

*Windwhistle Cottage, Grayshott, Hindhead, Surrey. July 30th, 1928.*

### Minimum Temperatures on Radiation Nights

In the *Meteorological Magazine* for December, 1927, p. 260, the present writer gave, in conjunction with Mr. J. Paton, equations representing the relationships between the screen minimum and grass minimum temperatures during radiation nights at Cranwell, Lincolnshire, during winter, defined as the months October to March (inclusive) over the period October 1st, 1920, to March 31st, 1927.

That inquiry has now been rounded off by carrying out a similar investigation for summer, defined as the months April to September (inclusive) over the period April 1st, 1921, to September 30th, 1927. A radiation night was defined as in the initial note and the same three-fold differentiation with regard to wind speed employed, the anemometer and the thermometers employed being as before.

Using T as the screen minimum temperature and G as the grass minimum temperature, both read at 7h. G.M.T. on the morning following the night being considered, the three equations found were as follows:—

Mean Wind Speed m.p.h.	Equation.	No. of cases available.
0—8	$T = 0.96G \div 8.0$	113
8—15	$T = 0.97G + 6.6$	87
15 or over	$T = 1.05G + 3.2$	19

In each case the fitting of the actual points on the graphs to the lines represented by the above equations was good.

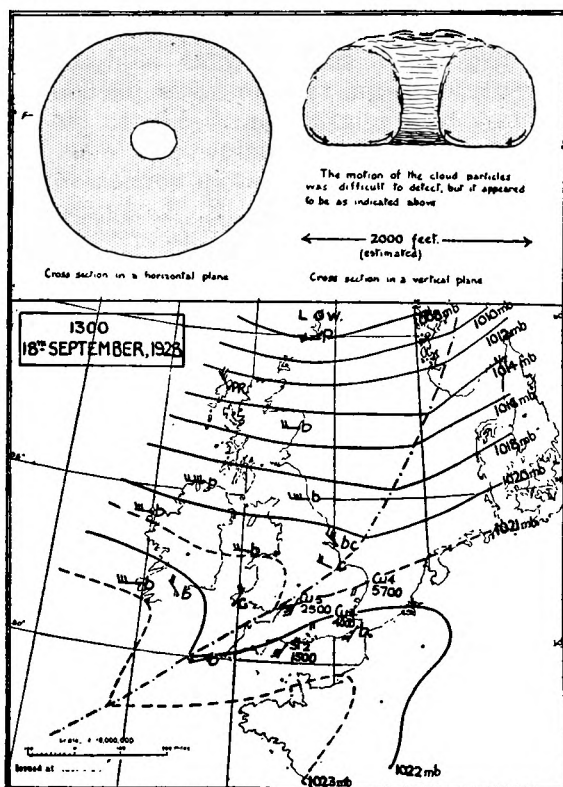
W. H. PICK.

*R.A.F. Cadet College, Cranwell, Lincolnshire, March 21st, 1928.*

## NOTES AND QUERIES

### A complete Cloud Vortex

At 3.30 p.m., G.M.T., on September 18th, 1928, I observed a complete cloud vortex passing from west to east directly over my garden at Forest Hill, London. At the time the sky was only about 3/10 covered with cloud which was neither true



strato-cumulus nor cumulus; there was also some alto-stratus near the western horizon and this had by sunset changed to alto-cumulus. The main clouds were not really isolated in the sense that each was entirely independent of the other, they appeared to be intimately connected as their pattern and texture were very similar and although I observed only one complete vortex, other clouds showed signs of having recently been of a vortical type. The sky at once brought to mind an experi-

ment shown to me three years ago by Mr. D. Brunt and described by him in the *Meteorological Magazine*.\*

The vortex cloud appeared to have a vertical axis and it was rather domed on the top and flat on its under side. The centre of the vortex ring was quite distinct, the blue sky showing up very distinctly above the centre of the ring. I estimated that

\*See Vol. 60, 1925, p. 1.

the cloud was travelling from west by north at an elevation of 2,000-3,000 feet with a velocity in the neighbourhood of 10m.p.h.

This cloud formation I have never before observed and it would be of interest to discover if it were an unusual phenomenon.

In the accompanying sketch I have endeavoured to give an idea of the size of the cumulus by means of a horizontal cross section and a vertical section; the horizontal section was not quite a regular circle but seemed very nearly so.

The following upper air temperature was taken at Duxford at 1.45 p.m. :—

Pressure	Height Above M.S.L.	Temperature		Relative Humidity
		Dry	Wet	
mb	ft.	°F.	F.	%
1,021	M.S.L.	—	—	—
1,018	100	69	60	59
980	1,140	60	55	73
950	2,000	55·5	51	75
900	3,480	49	45·5	77
850	5,060	44	40	73
800	6,690	45	33	27
750	8,430	40	29·5	31
700	10,260	35	29	56
650	12,200	30	26	69

Cloud, 3/10, broken strato-cumulus 910-860mb., alto-stratus not reached by the aeroplane.

An inversion occurred between 5,700 feet, 830mb., temp. 40°F. and 6,370 feet, 810mb., temp. 46°F.

A pilot balloon ascent at 5 p.m. at Croydon gives upper winds as follows:—

Height.		Wind.	
		Direction.	Velocity.
	Ft.	°	m.p.h.
Surface	...	260	8
1,000	...	260	10
2,000	...	260	10
3,000	...	270	9
4,000	...	270	11
5,000	...	250	27
6,000	...	225	25

From the pilot balloon ascent it is evident that there was a quite solid westerly current extending from the surface to 4,000 feet

and above this a backing and freshening of the wind, the velocity increasing from 10 to 25 m.p.h. It is also worth noting the change of temperature about the same level indicated at Duxford, the temperature decreasing from the surface (69°F.), to 5,700 feet (40°F.), where it ceases to fall and begins to increase. The inversion extends from 5,700 to 6,370 feet, above this height the temperature begins to fall again with increase of height. From 3,200 to 4,700 feet there was at Duxford a layer of broken stratocumulus clouds and at 4,700 feet the haze top was reached.

The weather map for 1 p.m. G.M.T. on the same day shows a feeble ridge of high pressure over southeast England and an advancing occlusion, the occlusion running in a northwesterly direction from the Scilly Islands to the Wash and southern Scandinavia. The passage eastwards of this occlusion caused slight rain in the London area when it passed on the following morning, this being the first rain for ten days. The map here reproduced shows the wind and weather with the clouds in the southeast mentioned in detail. At 4 p.m. G.M.T. Croydon reported cumulus clouds, 2/10 of the sky being covered. J. CRICHTON.

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### Arctic Ice and British Weather

For many years meteorologists have played with the idea that the weather secrets of temperate latitudes are to be sought in the frozen north. The theory of action centres suggested a mechanism by which polar ice may influence seasonal changes, and the development of the theory of the polar front showed how Arctic conditions could dominate day to day changes. After lying almost dormant for many years, the idea has lately begun to find expression in both practical and theoretical researches. Professor W. H. Hobbs' expedition to Greenland, which had for one of its principal objects the establishment of a station on the inland ice, is one example of the practical side, and another is the recent trans-Arctic flight of Captain Sir George Wilkins, whose programme included the search for sites on which permanent meteorological stations could be established. On the theoretical side reference has been made in a previous number of the *Meteorological Magazine*\* to the work of W. Wiese, but this is naturally concerned more with the weather of Russia than with that of western Europe.

A statistical investigation of the influence of Arctic ice on the pressure distribution over western Europe which has recently been published as a *Geophysical Memoir*† shows that the matter is sufficiently complicated, the influence varying with the season

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\*Vol. 61, 1926, p. 29.

†The influence of Arctic ice on the subsequent distribution of pressure over the eastern North Atlantic and western Europe. By C. E. P. Brooks and Winifred A. Quennell. London. Meteor. Office. *Geophys. Memoirs* No. 41.



in a way which suggests that it is due to a combination of several factors, some acting in one direction, some in another. As a result, the correlation coefficients obtained, while sometimes appreciable, are never high, though they are sufficiently confirmed by various checks to show that they are real.

The area dealt with in the Arctic is divided into four parts, the neighbourhood of Iceland and the Greenland, Barents and Kara Seas. The ice conditions in these areas in spring and summer are known mainly from the annual survey of the Danish Meteorological Institute†, and these ice figures were correlated with quarterly means of pressure at nine selected stations covering an area from Jacobshavn (Greenland) and Vardö (Norway) in the north to Ponta Delgada in the south and Berlin in the east. As a result, three relationships were found, the first two of which were suspected before, while the third appears to be not only new, but surprising:—

(1) When there is much ice in the Arctic, pressure in spring and summer tends to be above normal in the north-west (Jacobshavn, Stykkisholm and Thorshavn) and below normal in the south-west (Ponta Delgada).

(2) When there is much ice in the Arctic in the spring and summer, pressure in the following late autumn and winter (November to January) tends to be below normal over the British Isles and northern France.

(3) Similar effects tend to recur annually at northern stations for about four years following abnormal ice years. (See figure 1.)

The memoir in question is concerned more with the presentation of facts than with the discussion of their causes, but the third result was sufficiently curious to arouse speculation. It must first be remarked that there are two chief ways in which Arctic ice may affect the distribution of pressure. In the first place ice and ice-cold water cool the air above, and since cold air is heavy, the presence of a large cold area tends to raise the barometric pressure in its neighbourhood. On the other hand, the Icelandic low is generally regarded as intimately related to the general circulation of the atmosphere, so that when this circulation is vigorous, pressure at Stykkisholm is below normal. The atmospheric circulation is in turn related to the temperature difference between poles and equator, so that much ice in the Arctic, by increasing this temperature difference, should lower the pressure at Stykkisholm. Thus there are two opposing tendencies, one towards a higher pressure and the other towards a lower pressure at Stykkisholm in years of much Arctic ice, and it may well be that the first tendency prevails at one season, the second at another. Let us see how they may operate.

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†Isforholdene i de Arktiske Have. *Copenhagen, Dansk Meteor. Institut.*

Dealing first with the tendency for much ice to raise pressure, it appears that the relatively small amounts of ice which appear off Iceland in spring and early summer are not likely themselves to have a great effect. It is when they begin to melt and to cover the surface of the northernmost Atlantic with a thin sheet of cold thaw water, that we should expect the effect to be most noticeable. The greater part of the break up of ice from the East Greenland Current takes place in summer, and it is in this season that we should look for the greatest tendency for much Arctic ice to raise pressure near Stykkisholm. On the other hand, we should expect the effect on the general atmospheric circulation to be greatest in January to March, when the ice in the Arctic basin itself is most solid and extensive. Moreover

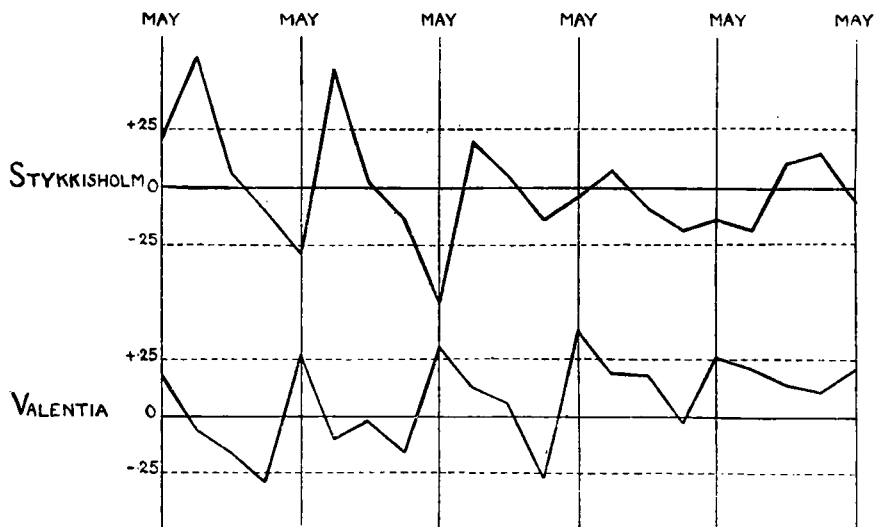


Fig. 1.—CORRELATION COEFFICIENTS; ICE INDEX FIGURES AND THE QUARTERLY PRESSURE DURING THE FOLLOWING FIVE YEARS.

the Icelandic low is intense in winter, feeble in summer, and for both these reasons we may anticipate that the tendency for much Arctic ice to lower pressure over Iceland will be greatest in winter.

We come next to the recurrence of similar tendencies at the same season in several successive years. That this is real is shown by figure 1, reproduced from the original memoir, showing the correlation coefficients between an "ice index" figure obtained by combining the ice data from the Greenland, Barents and Kara Seas, and the quarterly pressures at Stykkisholm and Valentia during the following five years. It is not until the fourth or fifth year that the regular recurrence of positive and negative coefficients breaks down. There can be little doubt that this recurrence is due to the persistence of the main mass

of Palæocrystic ice, of which the variable ice areas in the out-lying seas are merely the fringes. The Palæocrystic ice is believed to form mainly to the north of Siberia, whence it drifts slowly across the Arctic Ocean, part of it finally reaching the East Greenland Current. The passage across the Arctic takes about four years, so that if a large amount of ice is formed north of Siberia in any one year, we may look for its effects during the following four years. Each summer it sheds some ice from its fringes, and the thaw water brings high pressure to Iceland, while each winter it strengthens the atmospheric circulation and deepens the Icelandic low.

The tendency to low pressure at Valentia which recurs each autumn after much Arctic ice may be tentatively attributed to storminess resulting from the introduction of streams and patches of cold thaw water into the warm Gulf Stream Drift of the North Atlantic. The same phenomenon is observed, though less definitely, in the winter following a year with much ice off Newfoundland, an effect which is also investigated in the memoir, but with the Newfoundland ice there is very little if any recurrence in the second year.

C. E. P. BROOKS.

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### **Expedition of the *Marion***

The United States Coast Guard ship *Marion*, which sailed from Boston on July 12th, on an oceanographical expedition to Baffin Bay and the west coast of Greenland, as described in the *Meteorological Magazine* for September (p. 191), returned to harbour in New London, Conn., on September 18th after a very successful voyage. The full scientific results are naturally not yet available, but such great progress has been made that it is already possible to indicate the main conclusions. The first is the discovery of a surface layer of abnormally warm sea water—five degrees warmer than normal—100 metres thick covering an area of 100,000 square miles. This great heat reservoir must have far-reaching climatic effects, and supports the assertion frequently made that the Arctic climate has recently undergone a great temporary amelioration. Another interesting discovery is that the temperature and salinity of the bottom water in the trough between Greenland and Labrador—2.6°C. and 34.90 parts per 1,000—shows that this water cannot be derived from ice melting on the surface, but suggests that it is derived by creeping along the bottom of the Antarctic.\* No fewer than 2,100 “echo” soundings were made, and have resulted in greatly improved knowledge of the bathymetry of the region, while about 2,000 measurements of temperature and salinity were taken. Meteorological observations were carried on hourly throughout the cruise.

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\*See *Meteorological Magazine*, 62, 1927, p. 173.

### **Course of Training for Observers**

The unusually large number of 24 people attended this course at Kew Observatory on September 24th, 25th and 26th. Monday and the morning of Tuesday were spent in discussing meteorological instruments, the taking of observations, and filling-up of returns. Tuesday afternoon was occupied with a demonstration of the adjustment of a sunshine recorder (including concentricity of the sphere and bowl). On Wednesday morning Mr. Corless explained the new tables for computing accumulated temperature to the fourteen crop-weather observers, while the eight observers from health resorts each constructed a synoptic chart on form 2204 from British data telephoned from Kingsway. Later in the morning Dr. Whipple conducted the whole party round the Observatory. The course ended at noon on that day.

E. V. NEWNHAM.

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### **Agricultural Meteorological Conference**

The conference of agriculturists and "crop-weather" observers for the purpose of reading and discussing papers on agricultural meteorology, which is held annually under the auspices of the Ministry of Agriculture and the Meteorological Office, took place on September 27th and 28th at South Kensington.

Sir Napier Shaw, whose comments from the Chair have added greatly to the instructiveness of previous conferences, was unfortunately prevented by illness from being present, and Sir Thomas Middleton presided. The opening paper by Dr. C. E. P. Brooks dealt with the "Historical Climatology of England and Wales," and discussed the variations in the climate of Great Britain from the close of the Ice Age to the present day. The remainder of Thursday was devoted to the relations between weather conditions and crops, papers being read by Mr. T. W. Fagan of Aberystwyth, Mr. J. H. Blackaby, Oxford, Mr. M. C. Vyvyan, East Malling, Mr. L. N. Staniland, Long Ashton, and Mr. A. H. Lees.

The papers on Friday dealt with the relations between weather and soils, and opened with a valuable symposium on "Meteorological Conditions and Drainage from the Soil," by Dr. B. A. Keen, Rothamsted, Mr. H. D. Welsh, Craibstone, and Prof. G. W. Robinson, Bangor. Papers followed by Mr. F. Tutin, Long Ashton, Dr. E. McKenzie Taylor, Cambridge (on "Soil Temperatures in Egypt"), Prof. R. T. Leiper, of the Institute of Agricultural Parasitology ("The Influence of Meteorological Conditions on the spread of Parasitic Worms"), Prof. Dr. E. Handchin (late of Rothamsted), and Dr. W. F. Bewley, Cheshunt. The conference was well attended and many speakers took part in the discussions.

### Errata

We regret that the words "Reproduced by the courtesy of Mr. G. A. Clarke" were omitted beneath the photograph of Cirro-cumulus cloud at Aberdeen, published in the September number of the magazine. \_\_\_\_\_

September 1927, page 186, line 29 *for* "At Barnstaple we had an extraordinary storm on August 24th at 4 pm." *read* "At Gunn, Goodleigh, North Devon on August 28th there was an extraordinary storm at 4 p.m. (summer time)." Major H. Sandford Claye informs us that there was no hail at Barnstaple some five miles *away*. Line 40 *for* "H. Sandford Clay" *read* "H. Sandford Claye." \_\_\_\_\_

### The Weather of September, 1928

The most notable feature of the weather of the month was the excess of sunshine experienced over the whole country. In England and eastern Ireland the deficiency in the rainfall was also very marked. The month opened with calm anticyclonic weather over the whole country and these conditions were maintained over east and southeast England until the 9th. During this time the highest temperatures of the month were recorded (85°F. at Camden Square on the 8th, 83°F. at Greenwich on the 4th, 5th and 8th and at Tottenham on the 8th, and 82°F. at Hull on the 5th), and many hours of bright sunshine were experienced, over 12hrs. per day being recorded on several days at many places, while Hastings and Bath had 12.6hrs. each on the 4th. Meanwhile further north secondaries to a main depression over Iceland caused rain on the 3rd, 4th and 5th in the north and west; 1.95in. fell at Delphi (Mayo) on the 4th, 1.89in. at Borrowdale on the 3rd and 1.09 at Inverness on the 5th. An interval of fair weather followed, but low pressure westward of Ireland caused a renewal of unsettled weather with local gales on the 7th. This spread over the whole country on the 9th, thus temporarily interrupting the fine weather of the south. Thunderstorms accompanied by moderately heavy rain were experienced at many places on this day; 2.35in. fell at L.Llydaw (Snowdon), 1.22in. at Mallaranny, and 0.58in. at Kew. Subsequently pressure became high and another period of anticyclonic weather with much sunshine and high day temperatures was enjoyed over practically the whole country. These settled conditions persisted in the south and east with little change until the 19th, when the anticyclone began to move further north and temperature fell though the weather continued generally fair and sunny until the 27th. There was slight local rain at times, however, during this period, with a heavy fall in the north on the 16th and 17th (2.00in. at Borrowdale on the 17th) and another smaller one in the south on the 24th. From the evening of the 27th until the

29th rain was experienced in most parts of England and Ireland, but in Scotland the rain only lasted one night and fair weather occurred on the 28th, 29th and 30th. On this last day conditions were also fair but with cold northerly winds over the whole country. During the latter part of the month much mist and fog was experienced in the early mornings and several ground frosts were recorded. The lowest grass minimum temperature for the month was 22°F. at Dumfries on the 29th, and the lowest screen minimum 29°F. at Fort Augustus and Dundee on the 29th and at Markree Castle (Sligo) on the 23rd and 26th. The sunshine total for the month at Kew, 200hrs., which was 55hrs. in excess of the normal, was the highest September total there since 1911. The total of 197hrs. at Falmouth was 34hrs. above normal, that of 157hrs. at Liverpool 29hrs. above normal, that of 147hrs. at Aberdeen 23hrs. above normal. Totals in Ireland and at Stornoway were also above normal, but not to such a marked degree.

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Pressure was above normal over Spain and from the Baltic, Germany and north Italy across the North Atlantic and Iceland to Newfoundland and Bermuda, the greatest excess being about 7mb. in Jämtland (Sweden). Pressure was below normal in a narrow belt extending from south Italy across the Pyrenees to Portugal and the Azores, and also at Spitsbergen and Jan Mayen. Temperature and rainfall were both above normal at Spitsbergen, northern Norway and Portugal, and deficient in central and western Europe. At Zürich the rainfall was as much as 1.75in. below normal. In Sweden, temperature was normal and rainfall deficient in the north, while in the south temperature was below normal and rainfall generally near the average.

A thunderstorm accompanied by waterspouts caused much damage in northern Jutland and the western coast of Sweden on the 11th. In Switzerland the spell of fine weather which had lasted since about the 3rd was abruptly ended on the 16th, when snow fell on the Alps down to 6,000ft., and on the 22nd a thunderstorm which caused much damage to the crops in Canton Ticino was followed by a considerable drop in the temperature. After a long hot summer, unseasonable cold occurred about the 25th in northern and central Italy and round Trieste, and snow fell abundantly on the central Appennines. Heavy rain occurred in central and western Spain on the 27th, and at the end of the month snow fell heavily in the Rhineland and destructive storms occurred in Portugal. On the 30th a gale on the Belgian coasts was followed by floods.

A severe storm on the 2nd wrought havoc in Lahore, and on the 4th, owing to the heavy rains in Kashmir, the banks of the

Jhelum River burst at several points between Srinagar and Jhelum. Floods resulted and most of the crowded roads were blocked. In a severe blizzard which followed the continuous rain 66 of the pilgrims to the Amaranth Sacred Caves were killed. In the Bombay Presidency the heavy rain between the 14th and 20th was very favourable to the cultivators, but in Allahabad, Agra, Jhansi and Meerut districts the agricultural outlook on the 21st was grave owing to the failure of the rains. Abnormal rains in Japan at the beginning of the month have caused fears for the rice crop. On the 14th and 15th, a typhoon which passed close by Hangchow, Chinkiang and Nanking caused much damage along the coast near Shanghai. It was followed by heavy rain, as a result of which Shanghai was badly flooded.

A hurricane swept across the West Indies and Florida from the 13th to 18th causing much loss of life and great material damage. It passed across the Leeward Islands from Dominica to Porto Rico on the 13th. At San Juan (Porto Rico) the anemometer at the Weather Bureau registered 132m.p.h. before it was blown away. From here the hurricane, which was travelling about 300 miles per day, passed westnorthwestwards across the Bahamas to Florida, where it struck the coast from Miami to Jupiter Inlet on the 16th. Thence it passed to Tampa and turned northeast across southeast Georgia, where, however, its force was greatly diminished. The heavy rain in Vera Cruz, Mexico, during the last week of the month caused serious flooding and the gales damaged the crops. Two typhoons swept across Porto Alegre, Brazil, during the month, one about the 6th and the other about the 20th.

Heavy rain at the beginning and end of the month considerably improved the wheat crop in Victoria, Australia. The total rainfall for the month was, however, below normal in nearly all parts of Australia except Tasmania.

The special message from Brazil states that the rainfall distribution was irregular in the northern and southern regions with 0.35in. and 0.43in. of rain above normal respectively, but that the rainfall was scarce in the central regions, being 1.73in. below normal. Six anticyclones passed across the country, and in the south rainstorms produced floods. The crops generally were in good condition except that they were suffering, in the north-east from lack of rain, and in Rio Grande do Sul from the rainstorms. Pressure at Rio de Janeiro was 1.4mb. above normal and temperature 1.3°F. above normal.

### Rainfall, September, 1928—General Distribution

England and Wales	...	47	} per cent. of the average 1881-1915.
Scotland	...	110	
Ireland	...	92	
British Isles	...	<u>73</u>	

## Rainfall: September, 1928: England and Wales

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond.</i>	Camden Square .....	·69	38	<i>Leics.</i>	Thornton Reservoir ...	·82	45
<i>Sur.</i>	Reigate, The Knowle...	·74	38	„	Belvoir Castle.....	·46	25
<i>Kent</i>	Tenterden, Ashenden...	·60	28	<i>Rut.</i>	Bidlington .....	·87	...
„	Folkestone, Boro. San.	·62	...	<i>Linc.</i>	Boston, Skirbeck .....	·24	14
„	Margate, Cliftonville...	·66	33	„	Lincoln, Sessions House	·19	12
„	Sevenoaks, Speldhurst	·75	...	„	Skegness, Marine Gdns	·62	34
<i>Sus.</i>	Patching Farm .....	·61	25	„	Louth, Westgate .....	·43	21
„	Brighton, Old Steyne	·93	45	„	Brigg, Wrawby St. ...	·28	...
„	Tottingworth Park ...	·48	20	<i>Notts.</i>	Worksop, Hodsock ...	·21	14
<i>Hants.</i>	Ventnor, Roy. Nat. Hos.	1·03	42	<i>Derby.</i>	Derby .....	·82	50
„	Fordingbridge, Oaklands	2·15	100	„	Buxton, Devon Hos....	·79	24
„	Ovington Rectory .....	·41	62	<i>Ches.</i>	Runcorn, Weston Pt.	1·23	46
„	Sherborne St. John ...	1·74	85	„	Nantwich, Dorfold Hall	·90	...
<i>Berks.</i>	Wellington College ...	1·03	56	<i>Lancs.</i>	Manchester, Whit. Pk.	1·01	42
„	Newbury, Greenham...	1·66	82	„	Stonyhurst College ...	1·65	43
<i>Herts.</i>	Benington House .....	·83	46	„	Southport, Hesketh Pk	1·31	48
<i>Bucks.</i>	High Wycombe .....	1·10	58	„	Lancaster, Strathspey	2·44	...
<i>Oxf.</i>	Oxford, Mag. College	·70	42	<i>Yorks.</i>	Wath-upon-Dearne ...	·30	19
<i>Nor.</i>	Pitsford, Sedgebrook...	·69	38	„	Bradford, Lister Pk....	·48	23
„	Oundle .....	·62	...	„	Oughtershaw Hall .....	2·15	...
<i> Beds.</i>	Woburn, Crawley Mill	·70	39	„	Wetherby, Ribston H.	·64	36
<i>Cam.</i>	Cambridge, Bot. Gdns.	·60	37	„	Hull, Pearson Park ...	·27	16
<i>Essex.</i>	Chelmsford, County Lab	·75	44	„	Holme-on-Spalding ...	·24	...
„	Lexden, Hill House ...	·65	...	„	West Witton, Ivy Ho.	·31	...
<i>Suff.</i>	Hawkedon Rectory ...	·81	42	„	Felixkirk, Mt. St. John	·46	25
„	Haughley House .....	·35	...	„	Pickering, Hungate ...	·35	...
<i>Norfol.</i>	Beccles, Galdston .....	...	...	„	Scarborough .....	·38	49
„	Norwich, Eaton.....	1·05	49	„	Middlesbrough .....	·53	32
„	Blakeney .....	·74	40	„	Baldersdale, Hury Res.	·73	...
„	Little Dunham .....	·56	24	<i>Durh.</i>	Ushaw College .....	1·00	50
<i>Wilts.</i>	Devizes, Highclere.....	1·60	78	<i>Nor.</i>	Newcastle, Town Moor	·93	46
„	Bishops Cannings .....	1·49	68	„	Bellingham, Highgreen	1·60	...
<i>Dor.</i>	Evershot, Melbury Ho.	2·15	81	„	Lilburn Tower Gdns....	1·15	...
„	Creech Grange .....	2·43	...	<i>Cumb.</i>	Geltsdale .....	2·29	...
„	Shaftesbury, Abbey Ho.	2·15	38	„	Carlisle, Scaleby Hall	1·85	69
<i>Devon.</i>	Plymouth, The Hoe ...	2·00	78	„	Borrowdale, Rosthwaite	6·69	...
„	Polapit Tamar .....	2·10	75	„	Keswick, High Hill ...	3·56	...
„	Ashburton, Druid Ho.	2·07	67	<i>Glam.</i>	Cardiff, Ely P. Stn. ...	·89	29
„	Cullompton .....	1·20	53	„	Treherbert, Tynywaun	2·33	...
„	Sidmouth, Sidmount...	1·37	60	<i>Carm.</i>	Carmarthen Friary ...	1·59	46
„	Filleigh, Castle Hill ...	1·42	...	„	Llanwrda, Dolaucothy	1·96	48
„	Barnstaple, N. Dev. Ath.	1·40	52	<i>Pemb.</i>	Haverfordwest, School	1·90	53
<i>Corn.</i>	Redruth, Trewirgie ...	1·74	56	<i>Card.</i>	Aberystwyth .....	2·15	...
„	Penzance, Morrab Gdn.	1·72	59	„	Cardigan, County Sch.	1·34	...
„	St. Austell, Trevarna...	2·50	78	<i>Brec.</i>	Crickhowell, Tylmaes	2·00	...
<i>Soms.</i>	Chewton Mendip .....	1·73	56	<i>Rad.</i>	Birm W. W. Tyrmynydd	1·80	47
„	Long Ashton .....	1·18	...	<i>Mont.</i>	Lake Vyrnwy .....	1·98	56
„	Street, Hind Hayes ...	1·29	...	<i>Denb.</i>	Llangynhafal .....	3·25	...
<i>Glos.</i>	Cirencester, Gwynfa ...	·83	38	<i>Mer.</i>	Dolgelly, Bryntirion...	1·81	42
<i>Here.</i>	Ross, Birchlea .....	1·05	55	<i>Carn.</i>	Llandudno .....	1·28	56
„	Ledbury, Underdown	·92	48	„	Snowdon, L. Llydaw 9	5·69	...
<i>Salop.</i>	Church Stretton .....	1·49	73	<i>Ang.</i>	Holyhead, Salt Island	1·51	56
„	Shifnal, Hatton Grange	1·16	60	„	Lligwy .....	1·55	...
<i>Worc.</i>	Ombersley, Holt Lock	·79	45	<i>Isle of Man</i>	Douglas, Boro' Cem....	2·63	80
„	Blockley, Upton Wold	·81	39	„	St. Peter P't. Grange Rd.	1·56	60
<i>War.</i>	Farnborough .....	·96	45	<i>Guernsey</i>			
„	Birmingham, Edgbaston	·65	36				



**Rainfall: September, 1928: Scotland and Ireland**


Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	2'12	76	<i>Suth.</i>	Loch More, Achfary ...	4'69	82
	Pt. William, Monreith	1'89	...	<i>Caith.</i>	Wick .....	2'39	96
<i>Kirk.</i>	Carsphairn, Shiel. ....	4'21	...	<i>Ork.</i>	Pomona, Deerness .....	2'22	77
	Dumfries, Cargen .....	2'84	97	<i>Shet.</i>	Lerwick .....	2'52	84
<i>Dumf.</i>	Eskdalemuir Obs. ....	4'37	118	<i>Cork.</i>	Caheragh Rectory .....	2'73	...
<i>Rozb.</i>	Braxholm .....	2'04	91		Dunmanway Rectory...	3'69	90
<i>Selk.</i>	Etrick Manse .....	3'76	...		Ballinacurra .....	2'17	86
<i>Peeb.</i>	West Linton .....	3'22	...		Glaumire, Lota Lo. ...	2'45	87
<i>Berk.</i>	Marchmont House.....	1'51	63	<i>Kerry.</i>	Valentia Obsy. ....	4'70	114
<i>Hadd.</i>	North Berwick Res. ....	2'25	108		Gearahameen .....	5'90	...
<i>Midl.</i>	Edinburgh, Roy. Obs.	2'17	115		Killarney Asylum .....	3'53	99
<i>Ayr.</i>	Kilmarnock, Agric. C.	4'00	131		Darrynane Abbey .....	2'98	84
	Girvan, Pinmore .....	3'15	82	<i>Wat.</i>	Waterford, Brook Lo...	1'49	54
<i>Renf.</i>	Glasgow, Queen's Pk. ...	2'81	101	<i>Tip.</i>	Nenagh, Cas. Lough...	1'83	65
	Greenock, Prospect H.	5'79	122		Roscrea, Timoney Park	1'55	...
<i>Butc.</i>	Rothsay, Ardenraig.	4'79	118		Cashel, Ballinamona...	2'06	84
	Dougarie Lodge .....	3'64	...	<i>Lim.</i>	Foynes, Coolnanes.....	2'13	74
<i>Arg.</i>	Ardgour House .....	7'55	...		Castleconnel Rec. ....	1'83	...
	Manse of Glenorchy ...	6'88	...	<i>Clare.</i>	Inagh, Mount Callan...	5'37	...
	Oban .....	5'11	...		Broadford, Hurdlest'n.	2'81	...
	Poltalloch .....	4'12	90	<i>Weaf.</i>	Newtownbarry .....	1'16	...
	Inveraray Castle.....	7'34	114		Gorey, Courtown Ho ..	7'5	30
	Islay, Eallabus .....	5'05	121	<i>Kilk.</i>	Kilkenny Castle.....	1'52	66
	Mull, Benmore .....	...	...	<i>Wic.</i>	Rathnew, Clonmannon	99	...
	Tiree .....	3'52	...	<i>Carl.</i>	Hacketstown Rectory..	1'30	46
<i>Kinr.</i>	Loch Leven Sluice.....	3'80	148	<i>QCo.</i>	Rlandsfort House .....	1'86	68
<i>Perth.</i>	Loch Dhu .....	6'20	108		Mountmellick .....	2'04	...
	Balquhiddel, Stronvar	4'84	...	<i>KCo.</i>	Birr Castle .....	1'55	68
	Crieff, Strathearn Hyd.	3'67	128	<i>Dubl.</i>	Dublin, FitzWm. Sq...	94	49
	Blair Castle Gardens ...	3'75	158		Balbriggan, Ardgillan.	1'21	59
	Dalnaspidal Lodge .....	4'54	97	<i>Me'th.</i>	Beauparc, St. Cloud...	1'89	...
<i>Forf.</i>	Kettins School .....	2'61	131		Kells, Headfort .....	2'79	105
	Dundee, E. Necropolis	2'52	121	<i>W. M.</i>	Moate, Coolatore .....	2'15	...
	Pearsie House.....	2'97	...		Mullingar, Belvedere..	2'26	85
	Montrose, Sunnyside...	2'67	134	<i>Long.</i>	Castle Forbes Gdns.....	2'96	103
<i>Aber.</i>	Braemar, Bank .....	3'82	152	<i>Gal.</i>	Ballynahinch Castle ...	6'73	141
	Logie Coldstone Sch. ....	3'30	142		Galway, Grammar Sch.	5'27	...
	Aberdeen, King's Coll.	2'66	120	<i>Mayo.</i>	Mallaranny .....	7'73	...
	Fyvie Castle .....	3'19	...		Westport House.....	4'37	123
<i>Mor.</i>	Gordon Castle .....	3'55	142		Delphi Lodge .....	10'78	...
	Grantown-on-Spey .....	3'99	161	<i>Sligo.</i>	Markree Obsy .....	3'82	114
<i>Na.</i>	Nairn, Delnies .....	2'98	135	<i>Cav'n.</i>	Belturbet, Cloverhill...	2'16	87
<i>Inv.</i>	Kingussie, The Birches	3'28	...	<i>Ferm.</i>	Enniskillen, Portora...	4'38	...
	Loch Quoich, Loan .....	8'10	...	<i>Arm.</i>	Armagh Obsy .....	2'11	86
	Glenquoich .....	9'13	106	<i>Down.</i>	Fofanny Reservoir.....	2'87	...
	Inverness, Culduthel R.	3'07	...		Seaford .....	2'43	88
	Arisaig, Faire-na-Squir	3'50	...		Donaghadee, C. Stn ...	2'42	101
	Fort William .....	6'28	...		Banbridge, Milltown...	2'42	98
	Skye, Dunvegan .....	4'99	...	<i>Antr.</i>	Belfast, Cavehill Rd ...	2'41	...
<i>R &amp; C.</i>	Alness, Ardross Cas. ...	2'71	93		Glenarm Castle .....	3'33	...
	Ullapool .....	3'07	...		Ballymena, Harryville	3'21	103
	Torridon, Bendamph...	5'79	83	<i>Lon.</i>	Londonderry, Creggan	5'27	160
	Achnashellach .....	6'12	...	<i>Tyr.</i>	Donaghmore .....	2'93	...
	Stornoway .....	3'03	77		Omagh, Edenfel.....	5'13	168
<i>Suth.</i>	Lairg .....	1'57	...	<i>Don.</i>	Malin Head.....	3'97	151
	Tongue .....	2'57	81		Dunfanaghy .....	4'62	...
	Melvich .....	2'32	101		Killybegs, Rockmount.	5'23	114

## Climatological Table for the British Empire, March, 1928.

STATIONS	PRESSURE		TEMPERATURE							PRECIPITATION		BRIGHT SUNSHINE			
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values					Mean Cloud Am't	Am't in.	Diff. from Normal	Days	Hours per day	Per- cent- age of possi- ble
			Max.	Min.	Max.	Min.	1/2 max. and min.	Diff. from Normal	Mean						
	mb.	mb.	o F.	o F.	o F.	o F.	o F.	o F.	o F.	o/o	in.	in.			
London, Kew Obsy.	1009.2	- 5.2	74	32	55.2	40.5	48.0	+ 0.7	42.1	84	1.41	-	11	4.4	32
Gibraltar	1014.1	- 2.4	71	51	66.4	54.1	60.3	- 0.7	53.0	80	1.71	0.97	12	..	..
Malta	1012.2	- 1.8	80	50	67.8	56.0	61.9	+ 1.0	56.8	80	2.61	1.75	7	8.4	64
St. Helena	1011.6	+ 1.4	70	58	67.0	60.2	63.6	- 2.2	60.7	93	2.60	1.27	20	..	..
Sierra Leone	1011.3	+ 0.5	93	71	88.2	75.2	81.7	- 0.7	76.4	75	2.65	1.41	8	..	..
Lagos, Nigeria	1008.5	- 1.3	89	70	87.6	76.9	82.3	- 0.2	77.8	79	6.96	1.21	14	..	..
Kaduna, Nigeria	1014.3	+ 3.6	99	..	94.3	..	..	..	74.1	85	2.08	1.21	5	..	..
Zomba, Nyasaland	1012.9	+ 0.4	84	56	78.1	61.7	69.9	+ 0.6	..	76	4.70	1.04	10	..	..
Salisbury, Rhodesia	1012.7	- 0.1	83	44	77.3	53.3	65.3	- 0.4	57.9	61	0.52	0.47	6	8.8	75
Cape Town	1018.6	+ 2.3	95	43	74.3	54.6	64.5	+ 1.3	56.0	84	0.69	1.23	4	..	..
Johannesburg	1017.9	+ 1.4	79	43	72.0	51.5	61.7	+ 1.9	52.4	62	2.4	1.93	6	8.8	77
Mauritius	1013.8	- 0.2	84	66	81.5	71.4	76.5	+ 0.7	73.6	77	6.2	0.87	23	7.8	67
Bloemfontein	..	..	82	41	74.0	49.0	61.5	+ 0.7	53.0	70	2.8	1.11	5	..	..
Calcutta, Alipore Obsy	1006.6	- 0.3	105	67	95.9	75.7	85.8	+ 0.1	76.1	80	3.6	3.20	1	6*	..
Bombay	1008.0	- 0.8	94	75	90.8	77.7	84.3	+ 1.2	76.7	75	2.7	0.00	0*	..	..
Madras	1007.3	- 1.1	106	74	94.0	78.2	86.1	+ 0.8	78.5	74	4.6	0.06	1	..	..
Colombo, Ceylon	1008.8	- 0.3	89	72	87.2	76.1	81.7	- 0.9	78.2	77	7.8	8.99	19	6.5	53
Hongkong	1012.4	- 0.3	86	60	75.5	67.8	71.7	+ 0.9	67.2	78	7.7	4.11	10	4.3	34
Sandakan	..	..	90	72	88.8	75.4	82.1	- 0.2	77.5	82	..	7.94	11	..	..
Sydney	1017.1	- 1.4	85	54	74.7	60.9	67.8	+ 3.1	62.3	77	5.3	4.86	16	6.4	57
Melbourne	1018.2	- 1.2	84	41	71.5	52.4	61.9	+ 2.4	56.5	70	5.5	0.87	9	6.7	60
Adelaide	1018.3	- 1.7	90	47	76.7	57.7	67.2	+ 3.3	57.8	54	4.8	1.07	8	7.3	66
Perth, W. Australia	1017.0	- 1.5	96	48	76.9	57.4	67.1	+ 0.5	60.2	61	5.4	0.89	8	7.2	64
Coolgardie	1016.1	- 2.4	96	43	80.8	53.1	66.9	+ 1.8	57.3	54	2.5	0.36	2	..	..
Brisbane	1016.3	- 1.3	88	56	79.5	63.7	71.6	+ 1.3	65.8	75	5.2	14.89	16	6.2	54
Hobart, Tasmania	1015.3	+ 0.8	78	43	65.6	52.0	58.8	+ 3.7	51.9	67	6.6	4.27	13	5.4	50
Wellington, N.Z.	1019.4	+ 1.3	73	43	64.9	54.1	59.5	- 2.6	56.1	75	6.6	5.82	10	4.5	41
Suva, Fiji	1011.6	+ 1.0	86	72	82.7	74.2	78.5	- 0.2	76.0	88	8.2	17.10	27	3.5	30
Apia, Samoa	1010.4	+ 0.5	88	72	86.1	75.5	80.8	+ 1.9	78.6	82	5.5	11.29	21	5.9	50
Kingston, Jamaica	1013.9	- 0.2	90	67	85.6	70.3	77.9	- 0.5	69.8	80	2.3	0.88	4	7.3	58
Grenada, W.I.	1010.0	- 2.4	90	72	86.0	74.3	80.1	+ 1.2	73.8	72	4.6	1.65	10	..	..
Toronto	1012.7	- 2.8	71	23	49.9	33.4	41.7	+ 0.3	36.1	70	4.9	2.58	12	6.5	49
Winnipeg	1015.0	- 2.0	76	6	43.6	24.5	34.1	- 3.7	..	..	4.9	1.20	9	7.4	54
St. John, N.B.	1012.5	- 1.1	54	21	45.7	31.7	38.7	- 0.3	34.4	68	5.8	3.38	13	5.5	41
Victoria, B.C.	1015.2	- 2.1	64	35	54.8	42.3	48.5	+ 0.8	44.2	72	6.0	1.36	18	6.1	45

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

CORRIGENDA.—June 1928, pages 126 and 127. Malta, precipitation, amount and diff. from normal, December 1927, for "5.69in., +1.98in. read 6.69, +2.98in." and Year 1927, for "14.93in.—4.93in. read 15.93in. — 3.93in."

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## **British Association for the Advancement of Science. Meeting at Glasgow, September 5th to 12th, 1928**

A feature of the Glasgow meeting of the British Association was the number of papers in meteorology and allied subjects which were read in Section A. The meetings of that section began on Thursday morning, September 6th, with a discussion on "The Mechanism of Thunderstorms," opened by Dr. G. C. Simpson, Director of the Meteorological Office.

Dr. Simpson commenced with a reference to the breaking-drop theory which ascribes the origin of electricity in a thunderstorm to the breaking of the rain-drops held up within the cloud by ascending currents having a vertical velocity of more than 8 metres per second. The water after breaking has a positive charge, while the corresponding negative charge is given to the air. During steady rain there is a frequent collision of the rain-drops as they fall through the cloud, resulting in a separation of electricity, the rain becoming positively charged and the negative electricity going to the air in the cloud. The negative potential gradient in such conditions is explained by the rain falling to the ground and carrying its positive charge with it while the cloud remains with a negative volume charge. In a thunderstorm, however, there must be some other factor present to account for the large electrical forces produced. This, Dr. Simpson suggested, was the vertical component of the air currents. The main scheme of air currents in a thunderstorm was

illustrated diagrammatically in a lantern slide. The air was shown as flowing towards the thundercloud near the ground and then rising vertically to fill the ever-expanding volume of the cloud. In the cloud, where the ascending currents are the greatest, the small drops are prevented from falling, causing an accumulation of water above the ascending current. Only the large drops can penetrate to the lower part of the region of maximum vertical velocity, where they are broken up into small drops, the water becoming positively charged and the cloud negatively charged. The cloud particles, however, moving with the full velocity of the air stream are rapidly separated from the water. There is, thus, an accumulation of positive electricity in the region of separation from which heavy rain carrying a positive charge falls, while the remainder of the cloud has a volume charge of negative electricity.

Turning to the form of lightning discharges, Dr. Simpson illustrated from photographs that the flashes start in the region of separation and are branched upwards towards the negative charge in the main cloud or downwards towards the ground. Occasionally discharges take place from the ground to the negatively charged cloud; such discharges are violent and are branched upwards. In tropical storms where the region of separation is higher, the main discharges take place within the cloud, conveying positive electricity downwards; others take place between the ground and the cloud, conveying positive electricity upwards. These results have been confirmed by observations by Watson Watt in Khartoum and by Schonland in South Africa. In conclusion, Dr. Simpson referred to the electrical field associated with a thunderstorm. The accumulated positive charge in the region of separation is dissipated constantly by lightning discharges, the cloud remaining negatively charged. The potential gradient is, thus, predominantly negative and the current from the ground is mainly positive. These results have also been confirmed by observations.

Professor C. T. R. Wilson, who followed Dr. Simpson, considered that the facts relating to the potential gradients associated with thunderclouds are interpreted most naturally on the view that the rain-drops in the cloud are negatively charged and the smaller particles positively charged, the clouds being thus of positive polarity. The fall of the negative drops relative to the small particles causes the accumulation of a positive charge above and a negative charge below. The fact that the upper atmosphere is highly ionised and that point discharges from the ground occur when the potential gradient is strong would generally result in unequal dissipation of the two originally equal charges. To explain the origin of the negative charge on the rain-drops Professor Wilson suggested a process which, like that of Elster and Geitel, would require the pre-existence of an

electric field. A drop suspended by a vertical current of ionised air in a field of positive potential gradient will acquire a negative charge if the upward velocity of the air stream relative to the drop exceeds the downward velocity of the positive ions relative to the air.

Dr. B. F. J. Schonland, continuing the discussion, referred briefly to his observations upon the electric fields of South African thunderstorms, which, he suggested, did not lend support to the type of cloud required by Dr. Simpson's theory. The two main objections to the latter were that one would expect upward discharges of positive electricity to occur owing to the strong field between the negatively charged cloud and the lower positive charge; and, secondly, that the uppermost negative charge fails to show itself when the "steady" field due to a thundercloud is observed. Dr. Schonland suggested that the positive charge observed on the rain from the centre of the storm is acquired by the drops in falling through a space charge of positive electricity liberated by point discharge from conductors and from vegetation on the ground.

Mr. R. A. Watson Watt suggested that the principal difficulty in discussing the mechanism of thunderstorms was the gross inadequacy of the experimental data available. He called attention to the importance of the direction of the current to earth immediately before a discharge as a criterion of the predominant moment. In a tropical storm the upper air discharges in which a positive charge moved downwards were of brief duration, low intrinsic brilliance, and were displaced in azimuth in the earth's magnetic field in a direction which indicated the sense of the current. In the discharges in which a negative charge passed from cloud to earth the intrinsic brilliance was relatively great, the duration of visible discharge was of the order of some seconds, and the azimuthal displacement was reversed. Recent photographs by Parkinson in Peru appeared to offer confirmation of these observations and to fit with Dr. Simpson's views as to the form of the discharge.

Professor J. J. Nolan, who concluded the discussion, said that the operation of the Lenard effect in the manner proposed by Dr. Simpson appeared to supply the only mechanism, so far put forward, which was competent to account for the separation of electricity occurring in a thunderstorm. It was possible, however, that other agencies played a subordinate part. Thus a rain-drop suspended in an intense electric field would begin to discharge from the end which carried the negative induced charge. Negative ions would be carried upwards by a vertical air current. In this way a pre-existing electric field due to a bipolar cloud with negative charge above would be rapidly increased, while a field of the opposite polarity would be decreased. This effect would work in the same direction as the

Simpson effect and would be, indeed, ancillary to it or to some other method of supplying the original field.

The Section A Presidential Address on Monday was followed by a paper by Mr. R. A. Watson Watt on "The Present State of our Knowledge of Atmospherics." The author described his paper as "a summary report of progress in a study of the morphology and etiology of atmospherics in themselves rather than a study in the pathology of radio communications." The paper, which reviewed in a series of illustrative diagrams the available evidence as to the origin and properties of naturally occurring electro-magnetic waves of radio-telegraphic frequency, covered considerable ground. The subjects discussed included the relative frequency of occurrence of atmospherics of different wave-forms, the mean directions of arrival of the predominant streams of atmospherics at various stations and their diurnal and seasonal variations, and the location of thunderstorms by radio-telegraphic direction-finding on atmospherics.

During the second half of the meeting Major A. H. R. Goldie communicated a paper on "Magnetic Storms," which was based on magnetic records from the Meteorological Office Observatories at Lerwick and Eskdalemuir, and in certain cases also from Abinger (Surrey). A comparison of records during magnetic storms showed that, in certain cases, the displacements in the vertical components of force at Lerwick were in the direction opposite to those recorded at more southerly observatories. This phenomenon was explained as due to a linear electric current system in the high atmosphere. It was estimated that the heights of the systems varied from about 100 to over 800 kilometres, and that the strengths of the currents rose to the order of half-a-million amperes. A feature common to most storms was that in the afternoon and early evening the current was directed from west south west to east north east, while after midnight its direction was almost exactly reversed. Reference was made to the relationship of the current positions to those of the auroral arcs and to the great cyclone track of the northern hemisphere. Finally, the possibilities were discussed of the induction of such currents by horizontal drift of a conducting atmosphere across the earth's magnetic field or by temporary increase of the conductivity of an atmosphere which was already subject to more or less regular diurnal movement.

On the last day of the meetings of Section A, Mr. M. A. Giblett, Superintendent of the Airship Services Division of the Meteorological Office, read a paper on "Wind Structure Research at the Royal Airship Works, Cardington," which gave an account of an investigation, now in progress, into the detailed gustiness and rapid changes of the wind as affecting the mooring of large rigid airships. The apparatus in use consists of four Dines Pressure Tube Anemometers for wind speed, with masts

50 feet high, the recorders being installed in four huts, three of which are at the corners of an equilateral triangle with sides 700 feet long (approximately the length of a large airship), while the fourth is at the middle point of one of the sides. The instruments are specially adapted so that the records on the charts show on a very open time-scale the individual gusts, even those which take only a few seconds to pass any one of the huts. Wind direction is registered on Baxendell direction recorders with similarly open time-scales. The huts are connected by an electrical timing system which enables any fluctuation in the wind at any hut to be timed to a second and so permits of accurate comparison between the records obtained in the different huts. A fifth anemometer with vane 150 feet above ground is also in operation and can be adapted as required for open scale work.

The basis of the analysis of the records is the tabulation of the wind speed and direction at each hut at intervals of only 5 seconds. Eddies of different magnitudes are then sorted out by an analytical process and their horizontal extent in different directions, rate of movement and degree of persistence studied. A second part of the research is devoted to a similar detailed examination of the rapid and almost instantaneous change from one general wind to another from a totally different direction, such as takes place when a line squall passes.

The fluctuations in the wind which the installation is specially suitable to study are those which take from 5 seconds to one minute to pass a given point. The results so far obtained are only provisional since, although much material has been collected for discussion, the examination of it has not yet proceeded very far. So far as this examination goes, however, it points to the fact that the fluctuations of period lying within the range mentioned are effects which travel down wind with the speed of the mean wind taken over an interval of 10 minutes, and that they have no appreciable speed relative to this mean wind, as might conceivably be the case. Further, even the longer period fluctuations, which may extend at any instant over a distance of the order of half a mile down wind, have a relatively narrow front across the wind. When the wind is blowing along the side of the triangle containing three anemometers, these may experience a similar régime, while that at the fourth anemometer, some 600 feet off this line, may be quite different.

A paper on "The Propagation of Air Waves to Great Distances in relation to the constitution of the upper atmosphere" was read by Dr. W. S. Tucker in the absence of the author, Dr. F. J. W. Whipple. After reference to experiments which took place after the war, when explosions of munitions were arranged in Holland, France and Germany, systematic observations of audibility being made by observers in different countries, a

description was given of a method of investigation developed recently in this country. Hot-wire microphones, similar to those used for sound-ranging during the war, had been installed at Birmingham, Bristol and Sheffield, and the waves produced by firing a 16in. gun on the Shoeburyness Range could be recorded regularly, even when the sound was not perceptible by ear. The average times taken by the air waves to reach Birmingham, Bristol and Sheffield were 12 min. 5 sec., 12 min. 52 sec. and 14 min. 33 sec., respectively. Observations giving the angle of descent of the air waves at the first two stations showed that the waves reaching Birmingham had the flatter trajectories. The analysis of the observations indicated that the heights reached by the waves are usually between 40km. and 50km., and that the velocity of sound at such heights is greater than near the ground. The observations thus confirm the theory of Lindemann and Dobson, according to which there is a region of warm air above the stratosphere.

The third paper, which was read by Mr. G. A. Clarke, was entitled "The Association of Cloud with Weather." It was illustrated by a series of beautiful lantern slides showing the more commonly experienced cloud forms. The types of weather associated with the different cloud formations were discussed and emphasis was laid on the importance of a detailed picture of the sky at different observing stations to those engaged in weather-forecasting from synoptic charts.

As in past years, the Meteorological Office, Air Ministry, with the collaboration of the Signals Branch, gave a demonstration of weather-forecasting based on broadcast synoptic data received locally by wireless. The demonstration was given in the Randolph Hall adjoining the Reception Room. A local *Daily Weather Report* was published and circulated to the various sectional meeting rooms, while the morning and afternoon synoptic charts were reproduced on a large-scale map in the Reception Room. In addition to the demonstration of forecasting an exhibit of instruments, diagrams and meteorological publications was arranged. The main feature of the exhibit was a display of instruments of the latest type in use at a distributive station of the Meteorological Office, the whole demonstration and exhibit thus illustrating the work of such a station. The diagrams included a series of photographs and "quick-run" anemograph records illustrating Mr. Giblett's paper on "Wind Structure Research," a large-scale map of average rainfall in the Glasgow area and a series of cloud photographs by Mr. G. A. Clarke.

The Meteorological Luncheon was held in the University and, as in past years, proved a very successful function. Those present included:—

Dr. G. C. Simpson, C.B., F.R.S. (in the chair); Sir Oliver



Lodge, O.M., F.R.S., and Miss Lodge; Lady Lockyer; Lady Bragg; Sir Richard Gregory; Professor H. H. Turner, F.R.S., and Mrs. and Miss Turner; Professor A. C. Seward and Mrs. Seward; Dr. H. Spencer Jones; Professor A. M. Tyndall; Recorder of Section A; Professor G. W. O. Howe and Mrs. Howe; Sir John Samuel, K.B.E., F.R.S.E.; Professor J. J. Nolan; Dr. Vaughan Cornish; Dr. W. S. Tucker; Dr. L. F. Richardson, F.R.S.; The Rev. E. D. O'Connor, S.J.; Dr. H. Borno; Dr. J. S. Owens and Mrs. Owens; Major A. H. R. Goldie; Mr. W. M. H. Greaves and Mr. F. Entwistle, Secretaries of Section A, and Mrs. Greaves; Mr. M. A. Giblett; Dr. H. Jefferies; Mr. R. S. Whipple; Mr. G. A. Whipple; The Rev. J. P. Rowland, S.J.; Dr. G. Merton and Mrs. Merton; Mr. F. A. Barton and Mrs. Barton; Mr. M. G. Bennett and Mrs. Bennett; Mr. T. W. Wormell; Mr. Trevor Dillon and Mr. H. B. Booth.

Dr. Simpson, in welcoming the guests, referred to the loss which meteorology had sustained during the past year in the deaths of Mr. W. H. Dines and Dr. Charles Chree. Sir Oliver Lodge proposed the toast of "Meteorology." After referring to the historical development of the science of meteorology in association with the names of its pioneers, he called attention to the weather chart of the day which had been reproduced on the back of the menu, and which showed a well-marked occlusion over the North Sea. The present day, he said, was one of discontinuities in scientific phenomena; there were discontinuities in electronics and discontinuities in meteorology. The Glasgow weather was a striking example of the result of the latter. Speaking of weather forecasts, Sir Oliver remarked on the accuracy of the Meteorological Office forecasts which were broadcast daily by the B.B.C. Finally, he congratulated the Chairman on his researches into the mechanism of thunderstorms, which had formed the subject of a discussion during the meeting. Major A. H. R. Goldie, replying to the toast, referred to the ever-widening sphere of application of the results of meteorological science. Sir Richard Gregory then proposed the toast of "The Allied Sciences (Terrestrial Magnetism, Seismology and Astronomy)," to which Professor H. H. Turner replied.

The excellent programme of local arrangements drawn up by the local Committee for the entertainment of the guests during the British Association Meeting calls for special mention. Unfortunately the unsettled weather during the early part of the meeting deterred several members from participating fully in the numerous excursions which had been arranged for the Saturday, and which included visits to many places of beauty and of historical interest for which the surroundings of Glasgow are justly famed. Numerous visits to Clyde shipbuilding and engineering works also figured in the programme, while other arrangements included a reception and dance in the City

Chambers, given by the Lord Provost and Corporation of Glasgow, and a reception and conversazione in the Kelvingrove Art Galleries, given by the Lord Provost and members of the Local Committee.

F. ENTWISTLE.

### Official Publications Required

Copies of the following Geophysical Memoirs are out of print. As requests for these are sometimes received from important scientific libraries and institutions, the Director will be greatly obliged if any readers who possess copies which they no longer require will forward them to the Meteorological Office, Air Ministry, Kingsway, London, W.C.2.

#### GEOPHYSICAL MEMOIRS.

- Vol. I. No. 1. The Effect of the Labrador Current upon the Surface Temperature of the North Atlantic, and of the latter upon Air Temperature and Pressure over the British Isles. By M. W. Campbell Hepworth, C.B., R.D.
2. Free Atmosphere in the Region of the British Isles. Second Report by W. H. Dines, F.R.S., with a Preface by W. N. Shaw, Sc.D., F.R.S.
3. Graphical Construction for the Epicentre of an Earthquake, by G. W. Walker, M.A.
5. International Kite and Balloon Ascents. By Ernest Gold, M.A.
6. Free Atmosphere in the Region of the British Isles. Third Report. The Calibration of the Balloon Meteorograph and the Reading of the Traces. By W. H. Dines, F.R.S.
- Vol. II. No. 13. Characteristics of the Free Atmosphere. By W. H. Dines, F.R.S.
16. Aids to Forecasting. Types of Pressure Distribution, with Notes and Tables for the Fourteen Years 1905-18. By E. Gold, F.R.S.

### Discussions at the Meteorological Office

October 29th. *The evaporation of sea water and the thermal intercourse between the sea and atmosphere.* By Was Shoulejkin (Beitr. Geophysik, Leipzig, 20, 1928, pp. 99-122). *Opener*—Mr. R. S. Read, M.A., B.Sc., F.Inst.P.

During a voyage from the Black Sea to Vladivostok via the Mediterranean, Red Sea, Indian Ocean, China Seas and Japan Sea, measurements were made of the rate of evaporation of suc-

cessive samples of sea water when placed in a special type of evaporimeter. Simultaneous observations were made of air and water temperatures, vapour pressure, and wind velocity. From the rate of cooling of the known quantity of sea water in the evaporimeter, values were obtained for the rate of loss of heat. From the whole of the results obtained on the voyage, it was found that the ratio of the rate of evaporation to the water vapour deficit in the air was directly proportional to the wind speed. Curves were next constructed to connect the rate of loss of heat with the difference of the air and water temperatures. It was found that (i) for water temperature greater than air temperature, the rate of loss of heat from the water to the air was directly proportional to the temperature difference; and (ii) for water temperature less than air temperature, no definite law could be established from the available observations.

In order to extrapolate from the results obtained on board ship to determine the rate of evaporation at the sea surface, a further series of observations was performed over the Black Sea, and during the voyage, to determine the rate of change of wind velocity, temperature and vapour pressure with height above the sea surface. These extrapolated results were then compared with direct measurements at the surface of the sea, when differences not exceeding 6 per cent. were obtained for the ratio of the rate of evaporation to the vapour pressure deficit.

The author hopes by these measurements to be able to calculate the amount of water evaporating in different zones of the seas by making use of observations of prevailing winds, air and water temperatures and vapour pressure.

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

November 26th.—*Twelve years of long-range forecasts of precipitation and water level.* By A. Wallén (Ann. Hydrogr. 54, 1926, Köppen-Heft, pp. 89-99) (in German), and other papers. *Opener*—Sir Gilbert Walker, C.S.I., F.R.S.

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 will speak on "Recent research work on the Dines anemometer at the National Physical Laboratory."

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### Meteor seen from Horndon-on-the-Hill

While proceeding home at about 20h. 35m. B.S.T., on Sunday, September 30th, my mother, brother and I observed a brilliant

pyriform green meteor appear in the north about  $15^{\circ}$  above the horizon, and speed with a very slight inclination to the earth due east, turning a dull red, and vanishing with a suggestion of smokiness before reaching the horizon. The sky was clear with only an isolated piece of cumulus in the south, and exceptionally bright moonlight.

F. CLAUDE BANKS.

*Market Gardens, Horndon-on-the-Hill, Essex. October 1st, 1928.*

### Ball Lightning

To-day at 1.20 p.m. I was looking out of a window facing due east, when I saw, about 8 feet above the ground, a ball of fire about 3 feet in diameter, which exploded with a terrific crash into forked flames. There was no warning, no vibration, no sign of anything on the ground afterwards, and the atmosphere was dull but quite normal. About  $\frac{1}{4}$  hour after we heard a distant rumble like thunder, and at the moment of the explosion we all felt a shock.

F. E. CRAWFORD.

*Dowlands, Smallfield, Horley, Surrey. October 25th, 1928.*

[It is possible that this may have been a case of ball lightning. The *Daily Weather Reports* show that southwesterly winds and showery weather prevailed over the British Isles on the 25th. During the afternoon and evening heavy showers of rain fell at several places in southern England, a thunderstorm was reported at Kew Observatory and thunder was heard also at Ross-on-Wye and Southampton.—Ed. M.M.]

### A Pink Rainbow; Solar and Lunar Halo

On October 8th an unusually red sunrise developed at 6 a.m., the entire eastern sky becoming a sheet of pink and crimson by 6.5 a.m. At 6.6 a rainbow formed to the westward, pink in colour, this being the sole colour visible, it was bright throughout its entire circumference, but extremely bright in the southern segment, where a portion of a secondary bow was visible, showing the same single colour, pink. The rainbow disappeared at 6.11. The sky was almost wholly covered with cirro-stratus and alto-stratus, isolated large raindrops falling from the alto-stratus. The redness in the eastern sky was maintained to 6.15, two minutes after the actual time of sunrise.

The unusual combination of a solar and lunar halo visible at the same time was seen on the morning of April 7th last at 5.30 a.m. The sun rose at 5.24 a.m. and moonset was at 6.45 a.m. Both halos showed prismatic coloration.

SPENCER RUSSELL.

*Hurlingham, S.W.6. October 10th, 1928.*

### Mock-suns

While at South Stoneham, near Southampton, yesterday, I observed both parhelia of the halo of  $22^\circ$  in conjunction with that halo. A degree or two above the left parhelion was a patch of light nearly as big as the parhelion, which was probably due to reflection from a particularly dense patch of cirrus of cirro-stratus. The time was 15h. 25m.

S. E. ASHMORE.

*Windwhistle Cottage, Grayshott, Hindhead, Surrey. October 21st, 1928.*

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Mock-suns are interesting and beautiful phenomena, but as usually seen, the observer is not likely to be deceived in the manner implied by their name. In my experience, the sun itself is usually seen shining fairly brightly through the cirrus or cirro-stratus cloud responsible for the mock-sun, and the latter is seen as a comparatively feeble luminous patch. On Sunday afternoon, October 21st last, I was fortunate enough, however, to see a mock-sun that really lived up to its name. At about 16h. wisps of so-called "false cirrus" above a cumulus head appeared very brightly illuminated. There was a strong reddish coloration on the western edge and a suggestion of bluish purple on the eastern edge, but otherwise the appearance was exactly what one would expect to see had the sun been behind the cumulus head. Both my wife and myself were intrigued by the colouring and thought we were looking at an unusual type of "iridescence," and we were both surprised when the sun itself suddenly appeared from behind another cumulus head about the right angular distance further west. We concluded, therefore, that we were looking at a mock-sun of quite unusual brilliance. The phenomenon was seen near Wimbledon.

E. G. BILHAM.

*Richmond. October 25th, 1928.*

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To-day (Oct. 22nd) at 4.5 p.m. (G.M.T.) a rather unusual parhelion, or "mock-sun," was observed by me. The weather was squally and showery, and during a break in the heavy shower cumuli the mock-sun shone sufficiently brilliantly to throw a distinct shadow into my study window, as the real sun would do when shining through cirro-stratus. The real sun to-day being hidden at 4.5 p.m. behind heavy clouds, the mock-sun shone with a brilliance that seemed almost "uncanny." By 4.8 p.m. both real and mock-sun became visible, and on measuring the angular distance between the two objects I found it to be exactly  $45^\circ$ , the mock-sun being that distance to the north.

Although this parhelion was at first a brilliant white, it afterwards assumed prismatic colours. This phenomenon is known to seamen as a "wind-dog," and certainly on this occasion it

was a "true prophet," for high winds and rain followed within a very few hours!

The barometer at the time was 29.71 in. falling slowly; temperature 51°F, and wind SW, gusty.

DONALD W. HORNER.

63, Canute Road, Clive Vale, Hastings. October 22nd, 1928.

### Vertical Visibility and Convection

An examination has been made of the records furnished during 1926 by the Meteorological Flight of the Royal Air Force, stationed at Duxford, Cambridgeshire, in order to determine whether any relationship was apparent between the degree of vertical visibility, estimated looking downwards, and convection currents in the air.

The observations of visibility considered were those taken, when possible, from a height of 6,500 feet, approximately, and the presence or absence of clouds of cumulus or cumulo-nimbus type at the time of observation was taken to denote the presence or absence of convection currents. The time of the flights was in every case about 14h. or 15h. G.M.T., and the flights considered, 65 in number, were spread, more or less evenly, over the whole year.

The results are shown in the following table:—

	No. of flights.	Percentage No. of flights when vertical visibility was			
		Very Good.	Good.	Indifferent.	Poor.
Convection present...	22	82	9	4.5	4.5
Convection absent...	43	47	16	28	9

The table suggests that with convection present the vertical visibility is distinctly better than with convection absent, a result paralleled by that obtained by one of the present writers with regard to horizontal visibility at Cranwell, Lincolnshire.\*

W. H. PICK.

J. PATON.

August 18th, 1928.

### Waterspout seen near Cattewater

Flight Lieutenant Rankin reports that while flying on October 6th, 1928, about eight miles southwest of this station he observed a waterspout at about three miles distant on his port side. He first saw the spout descending from an enormous cumulo-nimbus cloud at 9h. G.M.T. Meanwhile the sea to the

\*See *Meteorological Magazine*, 62 (1927), p. 289.

right of it became much disturbed, a column rose up quickly towards the spout and the two portions became connected by a misty veil. This state lasted for about a minute, but the sea was disturbed for some considerable time comparatively—roughly five minutes—afterwards.

The wind at the time was between southwest and west, 20 m.p.h. up to 3,000ft., the height of the cloud was 1,500ft. in the vicinity of the waterspout and the weather fair or fine.

Flying Officer Cracroft, who was a passenger in the machine and who also observed the waterspout, adds (i) that rain was not falling from the cumulo-nimbus cloud and no rain was observed to fall afterwards, and (ii) that as they were proceeding towards the waterspout they were unable to see whether it was displaced towards or away from them.

T. H. APPLGATE.

R.A.F. Station, Cattewater, Plymouth. October 12th, 1928.

## NOTES AND QUERIES

### Waterspouts off the Isle of Wight

On June 11th, about 10.30 a.m., no fewer than five waterspouts were seen between the eastern point of the Isle of Wight and the coast of Hayling Island. They formed near the Nab and drifted south-south-west until opposite Bembridge Ledge, where they dissipated. A detailed description of one of them has been furnished by an eye-witness, Captain R. C. Lloyd Owen, R.N., who writes as follows:—

“The cloud was a very heavy dark cloud and a spout fell from it from a height of about 1,000 to 1,500 ft.; on the surface of the water the spout sent up what looked like steam splashes about 200 ft. high. It fell at about 10 a.m. and continued to fall on the sea for about 3 to 4 minutes. It fell as far as I could estimate about 2 minutes of arc south-east of the Nab Lighthouse Beacon and at the time there was only one vessel in sight. This vessel was a steamer and about one to two miles away from the waterspout. I have seen several waterspouts in eastern waters but never one so pronounced and so near at hand. My wife also saw this with me as did several other persons on Hayling Island sea front.”

Mr. H. Herrod, of 26, Worthing Road, Southsea, stated in the *Portsmouth Evening News and Southern Daily Mail* for June 11th, that “At 10 o'clock . . . a fairly heavy dark cloud overlay the water at a considerable height. From the cloud to the surface of the sea there extended a vertical column of water, extremely dark, almost black in colour. At the distance it was difficult to gauge accurately the diameter of the column, but I should say it was from 60 to 80 feet. Where it met the water, an extremely large amount of spray was visible

after a time. As the cloud moved over, the head of the column followed it, giving a somewhat sinuous effect. After several minutes the column dissolved at the junction with the cloud and disappeared slowly along its length, and the spray subsided; and then nothing was visible. At 10.40 a much lighter water-spout appeared, extremely sinuous in fall, extending from the cloud at an angle of  $45^{\circ}$  and joining on the near side of the Nab lighthouse, but slightly to the west of it, travelling past the Nab fairly rapidly. This was of about two or three minutes' duration."

On the morning of the 11th, southern England was covered by a westerly air current of "Polar" origin behind a rather intense depression which crossed from western Ireland over southern Scotland during the 9th and 10th.

During the 11th showers, accompanied in some cases by hail and thunder, occurred at several stations in the southern half of England, 6 mm. of rain being recorded at Falmouth, 2 mm. at Cattewater and 1 mm. at Calshot.

While surface temperatures were about normal, or only slightly below, upper air temperatures, as shown by an aeroplane ascent at Duxford at 9h., were considerably below the June normal and, at heights of from 6,000 to 11,000 ft., some 5 degrees below the usual temperature of "Polar" air in June. There was considerable instability in the lower layers over Duxford, and, much the same conditions probably prevailing in the south, there was every opportunity for the vigorous convection necessary for the formation of the water-spouts.

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### The London "Tornado"

During the evening of October 22nd a small secondary depression moved across southern England, giving rise to heavy rain and, locally, to destructive squalls of wind in its passage. The *Daily Weather Reports* show that the secondary had appeared southward of Ireland by 7h. G.M.T. on the 22nd, and then moved first almost eastward to the Scillies, and later more nearly north-eastward at an average speed of about 25 miles an hour across the London district to the southern North Sea. At 18h. G.M.T. the centre was situated near the Dorset coast and the area of strong winds appeared to be about 150 miles in diameter, while force 7 on the Beaufort scale was recorded at Southampton and Guernsey; force 6 at Portland Bill and force 5 at Plymouth; by 1h. G.M.T. on the 23rd the centre had moved across London to Essex, the winds at Portland Bill and Southampton had dropped to force 5 and at Guernsey to force 4, having veered from S. or S.W. towards N.W. Upper air temperature observations made at Duxford (Cambs.) on the afternoon of the 22nd



showed an unusually high lapse rate of temperature, averaging about  $4.0^{\circ}$  per 1,000 feet up to 17,760 feet, and exceeding in parts of the ascent the "dry adiabatic" rate. Conditions were favourable for the development of strong convectional movements.

According to newspaper reports a strong wind struck Hythe (Hants) about 6 p.m., trees being blown down, and some damage caused to buildings, while Mr. H. F. Jackson, Meteorological Officer at the Calshot seaplane station, had a narrow escape from injury when a falling tree struck his motor-car.

Between 6 p.m. and 9 p.m. rain fell heavily in the London area, about an inch being the general fall, while locally in the west-end the wind attained destructive force, a sudden squall, said to have lasted no longer than thirty seconds, causing structural damage estimated at upwards of £15,000. Fortunately no loss of life was caused in spite of the quantities of masonry blown into the streets, the heavy rain having driven people to shelter. Owing to the unusual occurrence, considerable Press comment was excited, the wind phenomenon being variously described as a gale, cyclone, tornado, whirlwind, or wind vortex.

An appeal to the public for information, which was issued by the Director of the Meteorological Office, met with a gratifying response, 266 communications being received, 219 of which were accompanied by barograms.

A preliminary notice issued to the Press states that "From the records received it appears that the disturbance moved northwards along a straight track of small width from near Victoria Station to Euston, passing near Piccadilly Circus and Oxford Circus. It then continued in the same line with diminished intensity. Barograms on the track differ from those off it in showing an additional very sudden fall and recovery of the barometer as the disturbance passed. They tend to confirm that the phenomenon had many of the characteristics of an American tornado." It was also stated that a similar kind of disturbance occurred at Bromley, Kent.

The occurrence of tornadoes is not unprecedented in this country. The South Wales tornado of October 27th, 1913, of which an investigation was published as *Geophysical Memoirs*, No. 11, was shown to have been a genuine tornado of the American type.

Under the heading "whirlwinds" the index volume to *Symon's Meteorological Magazine*, 1866-1895, gives about 40 references to occurrences in the British Isles. These vary considerably in intensity, a "whirlwind" at Hampstead on August 14th, 1887, raised a column of dust about 9 feet in diameter to a height of 30 feet. Another "whirlwind" which passed over Cowes on September 28th, 1876, caused much damage in the town and neighbourhood, the loss to property being estimated at

upwards of £10,000. This storm struck the town soon after 7h., lasting about two minutes, then seems to have crossed the Solent and passed up country between Portsmouth and Titchfield, causing further damage in its progress inland. It is of interest to note that the *Daily Weather Report* for this day shows that at 8h. a small depression was centred over the Bristol Channel, the circular isobar for 29.4 in. enclosing an area about 200 miles in diameter. The depression appears to have moved eastward across England, the centre passing northward of the Isle of Wight, and rainfall was less in amount, places near the track recording about half an inch. At Oxford, however, 0.87 inch was measured.

The tornado of October 22nd, 1928, is being made the subject of a special inquiry, and any relevant information will be welcomed by the Director of the Meteorological Office.

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### West Indian Hurricane

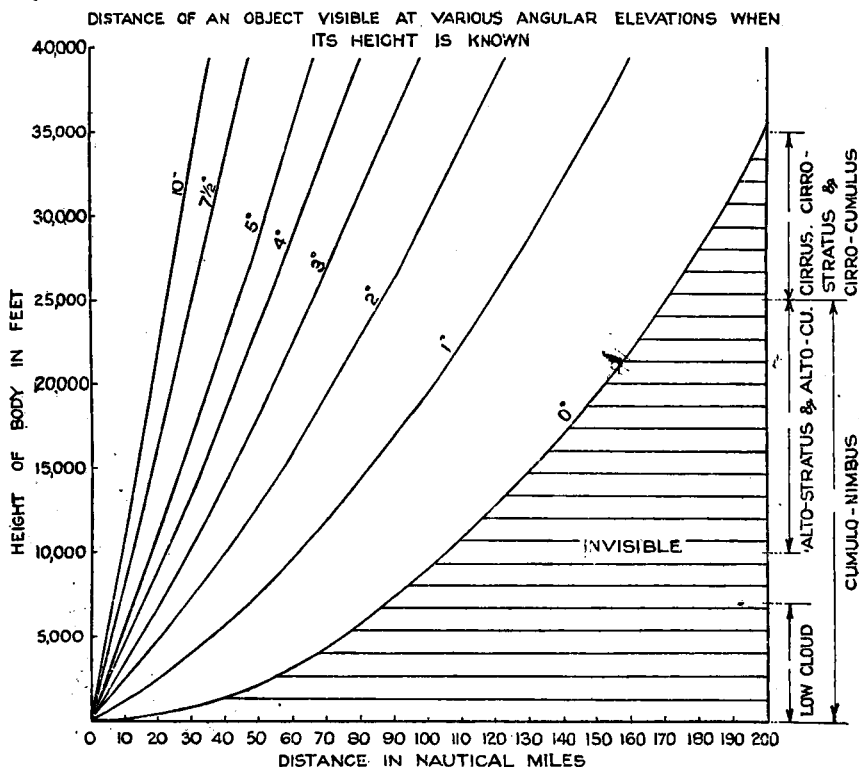
Two interesting accounts of the exceptionally violent West Indian hurricane of last September have been received from the observers for the Réseau Mondial stations at Montserrat (Leeward Islands) and Nassau (Bahamas). At the former place the observer, Mr. C. H. Gomez, maintained hourly readings of the barometer up to 6 p.m. on September 12th, when a reading of 28.38 inches was made. His enthusiasm as a meteorological observer is evidently very great, for one hour earlier the porch of the house had blown away in the northerly wind, which was estimated to have reached 120 m.p.h. at that time. Soon after 6 p.m. the roof began to move and the observer took himself and the barometer to a place of greater safety. The next hourly reading showed a rise of pressure: the minimum was estimated to have been 28.1 inches. The wind veered to southeast very quickly without falling below a severe hurricane, and the centre was believed to have passed very close to the northwest of Montserrat. The rain gauge had overflowed next morning, after recording 9 inches. Nassau did not experience the full fury of the storm until the early hours of the 16th, when a northeasterly hurricane set in. The minimum of pressure, 28.08 inches, occurred at 5 a.m., with a southwesterly wind estimated at 110-120 m.p.h. The anemometer cups had blown away an hour and a half earlier in a wind of 96 m.p.h. At this station nine inches of rain were recorded during the storm.

Mr. Talman, of the Washington Weather Bureau, states in one of his *Science Service* articles, that at Porto Rico this storm was apparently more severe even than that of August 8th, 1899, when over 3,000 lives were lost, and in the course of which one place recorded 23 inches of rain in 24 hours.

E. V. NEWNHAM.

### The Visible Distances of Clouds

One evening when the sky was covered with a uniform layer of alto-stratus cloud emanating from a depression over France, the colouring of the sunset at Bedford was most magnificent when for a few minutes the sun burst through between the edge of the layer and the horizon. Rain had been falling during the afternoon and beneath the cloud layer there was a great amount of moisture in the atmosphere giving a blood red colouration to the sunset. From the weather chart it appeared that the cloud layer extended all over the Midlands, and the writer was some-



what surprised that the sun's rays should have been able to pierce between the cloud and the horizon. A simple calculation, however, showed that if the layer was at a height of 20,000 feet the edge could still be seen at a distance of 150 miles (*i.e.*, near the Welsh Coast).

That clouds could be seen so far away was new to the writer, and the calculation was extended to other heights resulting in the figure attached, which gives for various heights the distances at which objects in the air subtend various angles. One or two facts drawn from this figure are perhaps worth noting.

(i) Cirrus plumes rising on the horizon may be as much as

200 miles away, but a cloud that has ascended to  $5^{\circ}$  above the horizon cannot be more than 60 miles from the observer.

(ii) A towering cumulo-nimbus cloud observed in London may lie over the Bristol Channel.

(iii) The base of a line squall cloud (at, say, 2,000 feet) may be seen on the horizon 50 miles from the observer.

To an aeroplane at a height of 10,000 feet these distances are extended by more than 100 miles, and the maximum visible distance of cirrus cloud becomes 300 miles, *i.e.*, an aeroplane flying 10,000 feet above London could see cirrus cloud that lay above Dublin.

A very similar diagram is published in the *Meteorological Glossary* under the heading "Horizontal." The diagram given there, however, extends only to 10,000 feet and is only applicable to clouds on the horizon, whereas to an observer who is confronted with the question of the distance of a visible cloud it is of great importance that the diagram should include the distances at which different angular elevations are subtended.

C. S. DURST.

### **Pilot Balloon Reports from Ships at Sea**

Measurements of upper winds by means of pilot balloons have been made occasionally on board ship for many years past, but the results have not usually been available to meteorologists until publication of the readings a considerable time after the date to which they refer. It would clearly increase the value of the results if they could be transmitted by wireless for the use of forecast services in the same way that ordinary surface observations at sea are now sent.

A proposal for the development of this work was brought before the meeting of the International Commission for Synoptic Weather Information, held in London last May, by Vice-Admiral Dominik of the Deutsche Seewarte. Acting on this proposal the Commission recommended that a joint sub-commission should be appointed for the investigation of the upper air over the ocean in order that the matter might receive detailed consideration.

Vice-Admiral Dominik was able to report that some preliminary steps had already been taken in Germany, the ships which had participated in recent research voyages to study the higher strata of the air over the Atlantic having communicated their wind measurements whenever possible by wireless to Norddeich. It is interesting to record that during September some reports, taken on the *Monte Olivia* of the Hamburg-South American Line as she proceeded down the English Channel, were broadcast from Lindenberg. Similar reports were also made by a German Fishery cruiser in the North Sea, one of these reaching the unusual height of 36,000 feet.

J. S. DINES.

### Books Received

- Nautisk-Meteorologisk Aarbog*, 1927. The Danish Meteorological Institute, Copenhagen, 1928.
- Apia Observatory, Samoa*. Report for 1925, Wellington, 1927.
- Meteorology in Mysore for 1926* being the results of observations at Bangalore, Mysore, Hassan and Chitaldrug. Thirty-fourth annual report. By C. Seshachar, M.A., Bangalore, 1927.
- Report on Rainfall Registration in Mysore for 1926*. By C. Seshachar, M.A., Bangalore, Govt. Press, 1927.
- Royal Alfred Observatory, Mauritius*; Annual Report, 1926, and Results of magnetical and meteorological observations for July to December, 1926, and January to June, 1927, Port Louis, 1926 and 1927.
- Falmouth Observatory*. Meteorological notes and tables for the year 1927. By J. B. Phillips, Falmouth, 1928.
- Deutsches Meteorologisches Jahrbuch*, 1926, Freie Hansestadt Bremen. Edited by Dr. A. Mey, Bremen, 1928.
- Rapporto de la Aerologia Observatorio de Tatenno*. No. 2. Tatenno, Japan, 1928.
- Catalogue Alphabétique des Livres, Brochures et Cartes de la Bibliothèque de l'Observatoire Royal et de l'Institut Royal Météorologique de Belgique préparé et mis en ordre par A. Collard*. Tome III. Accroissements de 1913-22.

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### News in Brief

*Weather Lore*. By R. Inwards. Any reader, prepared to dispose of a copy of the 1898 or 1900 edition of this book, is requested to communicate with "Weather Lore" through the Royal Meteorological Society, 49, Cromwell Road, South Kensington, S.W.7.

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## The Weather of October, 1928

Westerly winds and mild, unsettled weather prevailed generally throughout October. During the first few days, however, an anticyclone passed across the country giving generally fair weather with brilliant sunshine on the 1st and 4th, *e.g.*, 10.5hrs. at Oxford on the 1st, 9.9hrs. at Ventnor and Littlehampton on the 4th, and much frost at night. On the 1st, 25°F was registered in the screen at Marlborough and Rhayader, and on the grass 14°F, the lowest grass minimum temperature of the month, at Rhayader, and 19°F at Ford (Argyll) and Dumfries. On the 4th a deep depression over the Atlantic was spreading east, so that for the next week westerly winds and unsettled weather with bright intervals prevailed. Rainfall was heaviest in the west and north, and slight in the southeast. Among the heaviest

falls were 3.30in. at Fofanny (Down) on the 10th, 2.50in. at Rosthwaite (Cumberland) on the 7th, and 1.73in. at Eskdalemuir on the 7th. Temperature rose considerably during this period, 65°F and above being recorded in many places, with 68°F at Collumpton, Greenwich and Hull on the 8th. On the 11th and 12th a depression crossed the southern districts of the British Isles giving moderate rain generally in the south, while in the north the conditions were mainly fine. Inverness had as much as 9.3 hrs. bright sunshine on the 12th. Thunderstorms occurred locally in the south from the 9th to 12th. A short period of fair cold sunny weather ensued on the 13th and 14th during the passage across the country of a belt of high pressure, but by the 15th the winds were again becoming westerly and the weather unsettled. These westerly winds continued to prevail until the 26th, often becoming strong in places with gales at times. On the night of the 19th to 20th a gust of 84 m.p.h. was recorded at Valentia and one of 81 m.p.h. at Holyhead, while Beaufort force 9 (50 m.p.h.) was reported from one or two stations on the 18th, 19th, 20th, 24th and 26th. On the 22nd a destructive wind storm of short duration passed across London.\* Rain fell on most days over the country generally, although there were many bright intervals; the heaviest falls occurred on the 26th, 2.19in. at Guernsey, 2.14in. at Selbourne, and 2.02in. at Aasleagh (Mayo). After this, on the 28th came the third and shortest period of anticyclonic weather with bright sunshine; both Torquay and Weymouth had 8.7hrs. on this day. This ended on the 29th, when the country again came under the influence of a depression approaching from the Atlantic, and showers and bright intervals prevailed until the end of the month with strong northerly winds during the latter part of the 31st. During the month rainfall totals were generally above normal, but sunshine totals were variable. The total of 111hrs. at Kew was 19hrs. above normal, that of 100hrs. at Liverpool 14hrs. above normal, that of 124hrs. at Falmouth 8hrs. above normal. Stornoway and Dublin had also 7hrs. and 5hrs. excess sunshine respectively, but Aberdeen, Valentia and Birr Castle had all less than normal; the deficit at Birr Castle being as much as 16hrs.

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Pressure was below normal over northern and western Europe, Iceland and the North Atlantic to Newfoundland, the greatest deficit being 7.8mb. in the Atlantic at about 50°N, 30°W. Pressure was above normal over Spitsbergen, southern and central Europe, the Azores and Bermuda, the greatest excess being 5.3mb. at Horta. Temperature was below normal at Spitsbergen, northern Scandinavia, and central Europe, and above normal in southern Scandinavia, British Isles and Portugal.

\* See p. 238.

Rainfall was generally in excess in Scandinavia (about 80 per cent. above normal in eastern Svealand) and the British Isles and deficient in central Europe and at Spitsbergen.

The floods near Nieuport (Belgium) caused by the gale on the night of September 30th to October 1st resulted in no serious damage and the water receded after two days. Abundant rain in the Canton of Ticino (Switzerland) about the 5th accelerated the landslips at Motto Arbino and also raised the level of the Ticino river thus helping to cause more damage in the Arbedo Valley. Snow fell near Dijon on the 15th and a sudden drop in temperature accompanied by snowfall occurred in the Black Forest, the lower Alps and on the Saxon frontier between the 13th and 15th. Heavy rain in Switzerland, southern France and northern Italy about the 23rd caused serious floods in many parts, the railway between Geneva and Lyons being cut in five places. For a few days the weather improved, but from the 25th to the end of the month there was torrential rain in some part or other of these regions with renewed flooding. Floods were also experienced along the Tiber and in Rome owing to the heavy rain about the 29th to 31st.

Heavy rain was experienced in the Deccan between the 1st and 3rd and in Madras about the 22nd. Rainstorms were also recorded in Honshiu (Japan) about the 17th.

A northwesterly gale did much damage in New South Wales on the 7th, and bush fires were experienced in many parts of that State about the same time. Owing to the late rains which prevented spraying the peach orchards in Victoria (Australia) have been ravaged by a plague of green aphids.

The total rainfall for the month in Australia was generally above normal except in Victoria and Tasmania.

Storms on the North Atlantic between the 12th and 15th, and again between the 29th and 31st, caused the airship *Graf Zeppelin* to take a southerly course both when crossing to America and on the return voyage.

The special message from Brazil states that the rainfall in the northern and southern regions was plentiful with 0.43in. and 1.65in. above normal respectively, while in the central regions it was scanty with 2.64 in. below normal. Six anticyclones passed across the country and strong winds prevailed in the extreme south during the first part of the month. The crops generally were in good condition except in the northeastern districts, where they had suffered from lack of rain. At Rio de Janeiro pressure was 0.7mb. above normal and temperature 0.2°F. below normal.

### Rainfall, October, 1928—General Distribution

England and Wales	...	147	} per cent. of the average 1881-1915.
Scotland	... ..	145	
Ireland	... ..	165	
British Isles	... ..	<u>150</u>	

**Rainfall: October, 1928: England and Wales**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond.</i>	Camden Square .....	3.41	130	<i>Leics.</i>	Thornton Reservoir ...	4.23	151
<i>Sur.</i>	Reigate, The Knowle...	5.81	185	„	Belvoir Castle.....	3.60	133
<i>Kent.</i>	Tenterden, Ashenden...	6.48	186	<i>Rut.</i>	Ridlington .....	3.56	...
„	Folkestone, Boro. San.	5.94	...	<i>Linc.</i>	Boston, Skirbeck .....	3.95	144
„	Margate, Cliftonville...	3.28	112	„	Lincoln, Sessions House	3.51	138
„	Sevenoaks, Speldhurst	5.68	...	„	Skegness, Marine Gdns	3.33	122
<i>Sus.</i>	Patching Farm .....	7.99	222	„	Louth, Westgate .....	4.31	133
„	Brighton, Old Steyne	7.46	193	„	Brigg, Wrawby St. ...	4.20	...
„	Tottingworth Park ...	9.15	220	<i>Notts.</i>	Worksop, Hodsock ...	4.79	192
<i>Hants.</i>	Ventnor, Roy. Nat. Hos.	8.96	228	<i>Derby.</i>	Derby .....	3.92	150
„	Fordingbridge, Oaklands	7.11	172	„	Buxton, Devon Hos....	6.42	131
„	Ovington Rectory .....	8.43	208	<i>Ches.</i>	Runcorn, Weston Pt.	3.45	100
„	Sherborne St. John ...	5.26	150	„	Nantwich, Dorfold Hall	3.97	...
<i>Berks.</i>	Wellington College ...	3.31	101	<i>Lancs.</i>	Manchester, Whit. Pk.	3.94	119
„	Newbury, Greenham...	5.30	151	„	Stonyhurst College ...	6.12	136
<i>Herts.</i>	Benington House .....	...	...	„	Southport, Hesketh Pk	5.57	157
<i>Bucks.</i>	High Wycombe .....	4.70	150	„	Lancaster, Strathspey	5.75	...
<i>Oxf.</i>	Oxford, Mag. College	3.21	115	<i>Yorks.</i>	Wath-upon-Dearne ...	4.79	173
<i>Nor.</i>	Pitsford, Sedgebrook...	4.11	153	„	Bradford, Lister Pk....	5.04	145
„	Oundle .....	2.81	...	„	Oughtershaw Hall.....	10.57	...
<i>Reds.</i>	Woburn, Crawley Mill	3.63	136	„	Wetherby, Ribston H.	4.69	156
<i>Cam.</i>	Cambridge, Bot. Gdns.	2.49	105	„	Hull, Pearson Park ...	4.58	154
<i>Essex.</i>	Chelmsford, County Lab	3.34	136	„	Holme-on-Spalding ...	3.09	...
„	Lexden, Hill House ...	2.03	...	„	West Witton, Ivy Ho.	6.13	...
<i>Suff.</i>	Hawkedon Rectory ...	3.23	120	„	Felixkirk, Mt. St. John	3.63	126
„	Haughley House .....	1.92	...	„	Pickering, Hungate ...	3.90	...
<i>Norfol.</i>	Beceles, Geldeston.....	...	...	„	Scarborough .....	3.16	101
„	Norwich, Eaton.....	2.74	88	„	Middlesbrough .....	2.56	85
„	Blakeney .....	2.88	110	„	Baldersdale, Hury Res.	3.65	...
„	Little Dunham .....	3.45	111	<i>Durh.</i>	Ushaw College .....	3.20	93
<i>Wilts.</i>	Devizes, Highclere.....	4.44	143	<i>Nor.</i>	Newcastle, Town Moor	2.85	89
„	Bishops Cannings .....	4.77	144	„	Bellingham, Highgreen	4.08	...
<i>Dor.</i>	Evershot, Melbury Ho.	9.37	203	„	Lilburn Tower Gdns....	3.37	...
„	Creech Grange .....	8.52	...	<i>Cumb.</i>	Geltsdale.....	5.85	...
„	Shaftesbury, Abbey Ho.	5.12	131	„	Carlisle, Scaleby Hall	4.45	133
<i>Devon.</i>	Plymouth, The Hoe ...	5.87	148	„	Borrowdale, Rosthwaite	16.34	...
„	Polapit Tamar .....	6.49	135	„	Keswick, High Hill ...	9.16	...
„	Ashburton, Druid Ho.	11.03	182	<i>Glam.</i>	Cardiff, Ely P. Stn. ...	7.22	150
„	Cullompton.....	4.74	115	„	Treherbert, Tynywaun	18.42	...
„	Sidmouth, Sidmount...	5.74	154	<i>Carm.</i>	Carmarthen Friary ...	8.58	150
„	Filleigh, Castle Hill ...	7.36	...	„	Llanwrda, Dolaucothy	10.65	168
„	Barnstaple, N. Dev. Ath.	7.42	163	<i>Pemb.</i>	Haverfordwest, School	9.70	179
<i>Corn.</i>	Redruth, Trewirgie ...	8.30	158	<i>Card.</i>	Aberystwyth .....	6.62	...
„	Penzance, Morrab Gdn.	6.85	147	„	Cardigan, County Sch.	7.50	...
„	St. Austell, Trevarna...	7.28	138	<i>Brec.</i>	Crickhowell, Talymaes	8.70	...
<i>Soms.</i>	Chewton Mendip .....	8.02	166	<i>Rad.</i>	Birm W. W. Tyrmynydd	8.79	133
„	Long Ashton .....	7.26	...	<i>Mont.</i>	Lake Vyrnwy .....	9.34	164
„	Street, Hind Hayes ...	5.33	...	<i>Denb.</i>	Llangynhafal .....	4.33	...
<i>Glos.</i>	Cirencester, Gwynfa ...	5.01	152	<i>Mer.</i>	Dolgelly, Bryntirion...	8.69	143
<i>Here.</i>	Ross, Birchlea .....	5.61	170	<i>Carn.</i>	Llandudno .....	3.76	105
„	Ledbury, Underdown	5.20	169	„	Snowdon, L. Llydaw 9	...	...
<i>Salop.</i>	Church Stretton.....	5.16	143	<i>Ang.</i>	Holyhead, Salt Island	5.84	146
„	Shifnal, Hatton Grange	4.40	155	„	Lligwy.....	5.19	...
<i>Worc.</i>	Ombersley, Holt Lock ...	4.38	164	<i>Isle of Man</i>			
„	Blockley, Upton Wold	5.01	153	„	Douglas, Boro' Cem....	...	...
<i>War.</i>	Farnborough .....	4.34	137	<i>Guernsey</i>			
„	Birmingham, Edgbaston	4.70	169	„	St. Peter P't. Grange Rd.	9.21	204



## Rainfall: October, 1928: Scotland and Ireland

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	7.79	215	<i>Suth.</i>	Loch More, Achfary ...	6.88	88
"	Pt. William, Monreith	9.71	...	<i>Caith.</i>	Wick .....	2.53	85
<i>Kirk.</i>	Carsphairn, Shiel .....	13.29	...	<i>Ork.</i>	Pomona, Deerness .....	3.78	100
"	Dumfries, Cargen .....	9.25	212	<i>Shet.</i>	Lerwick .....	5.79	146
<i>Dumf.</i>	Eskdalemuir Obs. ....	11.80	218	<i>Cork.</i>	Caheragh Rectory .....	9.82	...
<i>Roxb.</i>	Bransholm .....	7.35	226	"	Dunmanway Rectory...	9.58	160
<i>Selk.</i>	Ettrick Manse .....	11.07	...	"	Ballinacurra .....	7.08	174
<i>Peab.</i>	West Linton .....	...	...	"	Glaumire, Lota Lo. ....	7.68	185
<i>Berk.</i>	Marchmont House.....	3.86	101	<i>Kerry.</i>	Valentia Obsy. ....	8.99	161
<i>Hadd.</i>	North Berwick Res. ....	2.74	93	"	Gearahameen .....	14.20	...
<i>Midl.</i>	Edinburgh, Roy. Obs.	3.00	115	"	Killarney Asylum .....	7.70	145
<i>Ayr.</i>	Kilmarnock, Agric. C.	6.71	191	"	Darrynane Abbey .....	8.68	173
"	Girvan, Pinmore .....	7.94	159	<i>Wat.</i>	Waterford, Brook Lo...	7.41	190
<i>Renf.</i>	Glasgow, Queen's Pk. .	5.72	176	<i>Tip.</i>	Nenagh, Cas. Lough...	6.74	199
"	Greenock, Prospect H.	10.98	204	"	Roscrea, Timoney Park	5.12	...
<i>Bute.</i>	Rothsaz, Ardencraig.	10.32	234	"	Cashel, Ballinamona...	5.60	156
"	Dougarie Lodge .....	8.68	...	<i>Lim.</i>	Foynes, Coolananes...	6.54	172
<i>Arg.</i>	Ardgour House .....	12.69	...	"	Castleconnel Rec. ....	5.72	...
"	Manse of Glenorchy ...	11.65	...	<i>Clare.</i>	Inagh, Mount Callan...	11.11	...
"	Oban .....	8.69	...	"	Broadford, Hurdlest'n.	7.36	...
"	Poltalloch .....	7.96	162	<i>Weast.</i>	Newtownbarry .....	...	...
"	Inveraray Castle.....	11.96	170	"	Gorey, Courtown Ho..	5.82	165
"	Islay, Ballabus .....	10.55	221	<i>Kilk.</i>	Kilkenny Castle.....	5.22	166
"	Mull, Benmore .....	13.50	...	<i>Wic.</i>	Rathnew, Clonmannon	6.07	...
"	Tires .....	6.56	...	<i>Carl.</i>	Hacketstown Rectory..	5.65	149
<i>Kinr.</i>	Loch Leven Sluice.....	5.43	158	<i>QCo.</i>	Blandsfort House .....	5.01	143
<i>Perth.</i>	Loch Dhu .....	13.00	182	"	Mountmellick.....	5.41	...
"	Balquhider, Stronvar	11.48	...	<i>KCo.</i>	Rirr Castle .....	5.43	186
"	Crieff, Strathearn Hyd.	6.17	157	<i>Dubl.</i>	Dublin, FitzWm. Sq...	2.60	97
"	Blair Castle Gardens ..	5.82	188	"	Balbriggan, Ardgillan.	3.72	138
"	Dalnaspidal Lodge .....	11.45	201	<i>Me'th.</i>	Beauparc, St. Cloud...	3.90	...
<i>Forf.</i>	Kettins School .....	4.62	162	"	Kells, Headfort .....	5.47	163
"	Dundee, E. Necropolis	3.80	143	<i>W.M.</i>	Moate, Coolatore .....	5.11	...
"	Pearse House .....	4.71	...	"	Mullingar, Belvedere..	4.94	158
"	Montrose, Sunnyside...	3.48	126	<i>Long.</i>	Castle Forbes Gdns.....	5.10	157
<i>Aber.</i>	Braemar, Bank .....	4.33	129	<i>Gal.</i>	Ballynahinch Castle ...	11.25	188
"	Logie Coldstone Sch....	2.72	84	"	Galway, Grammar Sch.	6.57	...
"	Aberdeen, King's Coll.	2.83	94	<i>Mayo.</i>	Mallaranny .....	9.70	...
"	Fyvie Castle .....	2.39	...	"	Westport House .....	7.91	176
<i>Mor.</i>	Gordon Castle .....	1.89	60	"	Delphi Lodge .....	14.98	...
"	Grantown-on-Spey .....	2.11	71	<i>Sligo.</i>	Markree Obsy. ....	7.36	179
<i>Na.</i>	Nairn, Delnies .....	2.31	98	<i>Cav'n.</i>	Belturbet, Cloverhill ..	4.14	142
<i>Inv.</i>	Kingussie, The Birches	4.47	...	<i>Ferm.</i>	Enniskillen, Portora...	5.27	...
"	Loch Quoich, Loan .....	17.00	...	<i>Arm.</i>	Armagh Obsy.....	4.70	173
"	Glenquoich .....	15.56	156	<i>Down.</i>	Fofanny Reservoir.....	17.50	...
"	Inverness, Culduthel R.	2.74	...	"	Seaford .....	5.88	165
"	Arisaig, Faire-na-Squir	7.30	...	"	Donaghadee, C. Stn ...	5.59	193
"	Fort William .....	10.53	...	"	Banbridge, Milltown...	4.41	160
"	Skye, Dunvegan .....	9.68	...	<i>Antr.</i>	Belfast, Cavehill Rd ...	6.41	...
<i>R &amp; C.</i>	Alness, Ardross Cas. ...	4.39	114	"	Glenarm Castle .....	7.77	...
"	Ullapool .....	3.91	...	"	Ballymena, Harryville	5.89	157
"	Torriddon, Bendamph...	9.09	113	<i>Lon.</i>	Londonderry, Creggan	5.99	163
"	Achnashellach .....	10.07	...	<i>Tyr.</i>	Donaghmore .....	6.51	...
"	Stornoway .....	5.07	98	"	Omagh, Edenfel .....	5.29	144
<i>Suth.</i>	Lairg .....	4.41	...	<i>Don.</i>	Malin Head .....	6.26	212
"	Tongue .....	3.43	82	"	Dunfanaghy .....	5.78	...
"	Melvich .....	4.29	117	"	Killybegs, Rockmount.	9.21	164

## Climatological Table for the British Empire, May, 1928.

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity.	Mean Cloud Am't	PRECIPITATION			BRIGHT SUNSHINE			
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values			Mean	Diff. from Normal			Days	Am't	Diff. from Normal.	Hours per day	Per-cent-ages of possible		
			Max.	Min.	Max.	Mtn.	1/2 max. and min.										Diff. from Normal	Wet Bulb
London, Kew Obsy. . . . .	1013.6	- 2.3	76	35	60.8	45.1	52.9	- 0.5	46.2	79	6.8	1.76	+ 0.04	9	5.3	34.5		
Gibraltar. . . . .	1014.5	- 1.6	79	52	69.0	56.1	62.5	- 3.0	55.1	81	4.6	1.93	+ 0.20	13	..	..		
Malta. . . . .	1013.0	- 2.0	77	54	69.5	59.2	64.3	- 1.6	59.1	77	4.5	0.00	- 0.41	0	10.1	72		
St. Helena. . . . .	1013.7	+ 2.5	69	56	66.8	58.5	62.7	- 0.9	59.5	93	7.5	1.61	- 2.54	14	..	..		
Sierra Leone. . . . .	1012.0	+ 0.8	91	69	87.4	73.7	80.5	- 1.0	76.5	80	8.6	7.60	- 3.87	23	..	..		
Lagos, Nigeria. . . . .	1009.8	- 1.2	89	71	86.6	75.8	81.2	- 0.6	76.9	83	7.6	15.33	+ 4.86	19	..	..		
Kaduna, Nigeria. . . . .	1014.4	+ 1.3	95	..	88.7	..	..	..	73.4	78	1.4	6.78	+ 0.84	13	..	..		
Zomba, Nyasaland. . . . .	1017.6	+ 2.5	78	49	71.7	56.2	63.9	- 1.9	..	79	6.0	0.81	- 0.23	5	..	..		
Salisbury, Rhodesia. . . . .	1017.5	+ 1.0	78	39	73.1	45.1	59.1	- 1.5	51.8	53	2.1	0.00	- 0.54	0	9.2	81		
Cape Town. . . . .	1021.1	+ 3.1	90	45	71.7	52.1	61.9	+ 3.0	52.5	87	4.8	0.36	- 3.47	5	..	..		
Johannesburg. . . . .	1023.2	+ 2.7	75	40	65.5	45.5	55.5	+ 1.1	44.5	48	1.5	0.20	- 0.56	1	9.3	86		
Mauritius. . . . .	1016.0	- 0.4	84	60	78.6	68.2	73.4	+ 0.8	71.2	79	5.3	14.91	+ 11.88	18	6.9	62		
Bloemfontein. . . . .	..	..	75	28	69.6	38.7	54.1	+ 1.4	42.7	57	0.9	0.04	- 1.14	1	..	..		
Calcutta, Alipore Obsy. . . . .	1003.9	+ 0.4	100	70	94.5	78.5	86.5	+ 0.5	80.1	83	6.6	7.06	+ 1.31	13*	..	..		
Bombay. . . . .	1007.5	+ 0.1	94	78	92.2	80.5	86.3	+ 0.4	77.6	71	3.3	0.00	- 0.55	0*	..	..		
Madras. . . . .	1004.8	- 0.6	110	77	101.1	83.3	92.2	+ 2.3	78.1	58	2.5	0.03	- 1.04	1*	..	..		
Colombo, Ceylon. . . . .	1009.3	+ 0.7	89	75	87.8	77.8	82.8	+ 0.3	79.1	79	8.0	7.92	- 4.76	26	7.8	63		
Hongkong. . . . .	1008.3	- 1.1	89	69	81.8	74.0	77.9	+ 0.5	74.5	85	8.0	18.41	+ 6.81	18	4.3	33		
Sandakan. . . . .	..	..	91	74	89.0	76.5	82.7	+ 0.1	79.0	83	..	7.34	+ 1.43	11	..	..		
Sydney. . . . .	1021.3	+ 2.7	74	46	66.1	50.3	58.2	- 0.6	51.6	77	4.1	2.74	- 2.39	14	6.4	61		
Melbourne. . . . .	1022.4	+ 2.9	71	35	61.1	47.3	54.2	+ 0.1	49.4	77	6.8	2.24	- 0.06	16	4.5	45		
Adelaide. . . . .	1022.7	+ 2.6	79	39	65.9	49.0	57.5	- 0.4	50.3	62	5.2	1.74	- 1.02	12	6.3	62		
Perth, W. Australia. . . . .	1018.7	+ 0.2	89	41	71.1	51.9	61.5	+ 0.9	54.7	66	5.4	5.08	+ 0.14	11	5.9	57		
Coolgardie. . . . .	1020.2	+ 0.4	84	33	70.3	45.7	58.0	+ 0.4	51.3	59	2.8	0.52	- 0.84	4	..	..		
Brisbane. . . . .	1020.6	+ 1.8	77	47	71.7	53.5	62.6	- 1.9	56.5	69	3.3	1.82	- 1.01	13	7.6	70		
Hobart, Tasmania. . . . .	1018.4	+ 2.8	68	35	57.2	44.8	51.0	+ 0.6	45.7	71	6.1	1.41	- 0.45	17	4.4	45		
Wellington, N.Z. . . . .	1012.5	- 3.1	65	40	59.6	49.0	54.3	+ 1.6	51.3	79	6.0	4.38	- 0.30	17	5.0	51		
Suva, Fiji. . . . .	1012.0	- 0.8	87	68	83.1	71.9	77.5	+ 1.0	75.0	86	5.6	13.64	+ 3.43	21	6.1	54		
Apia, Samoa. . . . .	1011.3	+ 0.2	87	71	85.4	73.9	79.7	+ 1.3	76.9	78	4.2	6.51	+ 1.00	15	7.9	69		
Kingston, Jamaica. . . . .	1012.8	- 0.3	89	64	87.1	72.9	80.0	+ 0.3	71.8	80	3.7	1.77	- 2.62	6	..	..		
Grenada, W.I. . . . .	1010.6	- 1.9	89	70	87.3	73.8	80.5	+ 0.9	75.0	69	4.7	0.63	- 3.96	13	..	..		
Toronto. . . . .	1013.6	- 1.2	82	33	64.1	44.2	54.1	+ 1.4	46.3	57	4.4	0.72	- 2.26	9	7.3	50		
Winnipeg. . . . .	1015.3	+ 1.0	96	26	69.4	42.4	55.9	+ 4.3	..	..	3.4	3.33	+ 1.03	5	10.0	65		
St. John, N.B. . . . .	1013.9	- 0.1	71	34	57.4	42.2	49.8	+ 2.1	45.3	69	6.5	2.17	- 1.54	14	6.1	41		
Victoria, B.C. . . . .	1017.9	+ 1.5	78	41	63.6	47.3	55.5	+ 2.4	51.2	70	3.8	0.32	- 0.98	3	10.5	69		

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## Sand Mirages

By L. G. VEDY, B.A., B.Sc.

It has been found that a very good place for the observation of mirage phenomena in this country is a sea beach having a wide stretch of level sand. Simple experiments on the nature of the effect were contemplated, but these have only reached preliminary stages. The effect, however, is so striking that a brief description may be of interest to many observers.

To lie on the sand and to see, all around, what appears to be a pool of water, at apparently about 30 yards away is a very striking experience. Objects having an angular height of  $\frac{1}{2}^{\circ}$  may be completely reflected, as in a mirror. The effect far surpasses, in magnitude and tranquillity, any road mirage that the author has ever seen. The best effects are produced over a long stretch of firm level sand, free both from small indentations and from slight inclines, on a warm or hot calm day. The effect is practically destroyed by a strong wind, and even a gentle breeze causes a shimmer; it is absent or very slight where rising air currents are apparent. I have often looked over a long regular bank of shingle, or over a smooth path of close turf, but have seen no mirage effects. It appears that slight irregularities in the surface aid convection currents, and thus the steady state of the layers of air near the ground is destroyed. Good effects can be seen looking up a gentle slope of firm sand, whereas in a direction at right angles, the effect is very small or entirely absent.

In general, when the eye is very close to the sand (say about half an inch above it) no image can be seen. As the eye is gradually raised, an image of part of the sky appears, giving the "pool of water" effect, and distant objects appear to be reflected in this. An optimum height of the eye is reached, and after this the effect grows less and finally disappears. In cases where the temperature gradient is not great enough, or where the air is not still, distant upright objects appear to be elongated near the ground.

The investigations contemplated were:—

(1) To determine whether the deviated ray is bent symmetrically with respect to the ground. It is reasonable to suppose that, when the object and eye are at the same height, the ray is symmetrical, but it would be interesting to test this experimentally.

(2) To determine the curvature of the ray, to obtain the magnitude and extent of the temperature gradient.

(3) The difference of temperature between air at the level of the object, and air at ground level can also be found from the observed deviation of the ray (as calculated below).

The experimental procedure is very simple and the apparatus consists of merely a few scales.

(a) To plot the path of the deviated ray an object AM is chosen, and its image A'M observed from a distance by one observer whose eye, B, is at about the same height from the ground as A (see diagram). A second observer walks a known distance from N, towards M, and places a rule or stick horizontally at say C, so that it appears, to B, to coincide with A'. By repeating this process, at larger distances from N, the portion BD of the ray can be mapped. It has not yet been determined whether this process can be continued over the portion DA; in which case the images both of C and A would have to be brought into coincidence, as seen from B. A measurement of the heights AM, BN, and of the distance MN completes the observation.

(b) To find the total deviation of the ray at a given distance from the object, and hence the variation of deviation with distance, only one observer is required. An object AM is chosen as before. The observer walks a known distance from M, looks towards A', and notes the height of his eye above the sand. If AM is a solid object, *e.g.*, a rock whose top is A, care must be taken to look towards A' each time. If the effect is not very great, or if AM is too high, only a portion of MA' will be visible, say MA'', and the point A'' may be mistaken for A'. This error may be prevented to some extent by measuring the angles subtended by AM, MA' at the eye\*, and making certain that

---

\*Vertical distortion, which in suitable circumstances might cause the true image of A to be at A'', is assumed to be absent.—Ed. *M. M.*

these are nearly equal ( $MA'$  not less than  $MA$ ) before recording the position of the eye. In both (a) and (b) perfectly level sand must be used.

The results deducible from these observations are as follows. If the ray is deviated symmetrically with respect to the ground, then the point  $D$  (where the ray is nearest to, and parallel to the ground) found in (a) will be very near to the mid-point of  $MN$ . Further, the curvature of  $DB$  at any point will be a function of the velocity gradient at that point, and therefore of the temperature gradient. Thus, if the temperature varies throughout the height  $MA$ , the ray will be curved throughout, as (I) in the

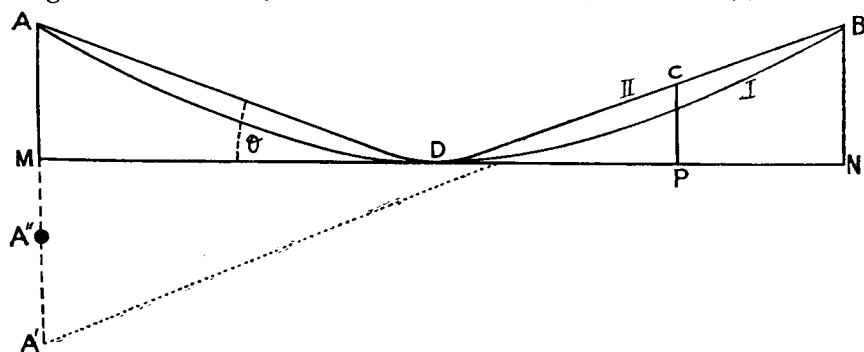


diagram. If, however, the temperature gradient exists only in the layers of air very near to the ground, then the ray will be curved in the neighbourhood of  $D$ , and straight at  $A$  and  $B$ , as (II) in the diagram.

In (II) the value of  $\theta$  can be calculated for each reading of experiment (b), (except those near  $D$ , where the ray is curved) if we assume that the ray is symmetrical. For example, when the eye is at the point  $C$  we have

$$CP/DP = AM/MD = \theta = (AM + CP)/MP$$

Thus the variation of deviation ( $2\theta$ ) with distance can be found. In this case it is clear that the deviation must be independent of distance for points not too close to  $D$ , since the curvature is produced only near to  $D$ ,

$$\text{i.e., } (AM + CP)/MP = \text{constant.}$$

Hence if the results of experiment (b) give points (say, for example, from  $C$  to  $B$ ) satisfying this equation, we may say that the temperature gradient can occur only in the air below the level of  $C$ . It may, of course, exist only in a very thin layer of air just above the surface of the sand.

It should be noted that the loci obtained in (a) and (b) are not the same. In (a), one particular ray  $ADB$  is plotted. In (b) rays leaving  $A$  in slightly different directions are used in turn. The loci plotted will differ widely near  $D$ , but gradually approach and finally touch as  $B$  is reached.

In case II the inclination of the ray at A is equal to  $\theta$ , *i.e.*, the ray makes an angle of  $(90^\circ - \theta)$  with the vertical at A. At D the ray is horizontal, *i.e.*, it makes an angle of  $90^\circ$  with the vertical. If we call  ${}_A\mu_M$  the refractive index of air at D with respect to air at A then clearly

$${}_A\mu_M = \sin(90^\circ - \theta) / \sin 90^\circ = \cos \theta.$$

Let the refractive index of air (with respect to a vacuum) be  $\mu$ . The temperature at D is greater than at A, and this causes  $\mu$  at D to be less than  $\mu$  at A, the change in the value of  $\mu$  between A and D being equal to  $({}_A\mu_M - 1)$ .

Now at normal temperature and pressure  $\mu - 1 = 29 \times 10^{-5}$ . If the pressure of the air is kept constant and the temperature increased by  $\Delta t^\circ \text{C.}$ ,  $\mu - 1$  decreases to the value  $29 \times 10^{-5} \left(1 - \frac{\Delta t}{273}\right)$ .

Hence if the deviation of the rays is due entirely to this temperature change, we must have

$$\begin{aligned} ({}_A\mu_M - 1) &= \text{change in value of } (\mu - 1). \\ &= -29 \times 10^{-5} \cdot \Delta t / 273. \end{aligned}$$

$$\therefore \Delta t = (1 - \cos \theta) \frac{273}{29} \times 10^{-5}.$$

Since the angle  $\theta$  is small and is equal to  $(AM + CP)/MP$ , this may be written

$$\Delta t = \frac{273}{29 \times 10^{-5}} \cdot \frac{1}{2} \frac{(AM + CP)^2}{MP}$$

Hence  $\Delta t$ , the temperature difference between A and D can be calculated.

Three occasions on which the phenomenon was examined in a general way were as follows:—

(1) at Llanaber sands, near Barmouth (2nd September, 1927). Hot, calm day;

(2) at Giltar sands, near Tenby (17th August, 1928). Warm day, slight breeze;

(3) at Swanlake sands, near Tenby (1st September, 1928). Fairly hot and calm.

All these effects were seen at about noon and in sunshine, on firm level sand which had been exposed for about an hour (the tide was ebbing rapidly in each case). Observations of the type (a) and (b) (see above) were found to be possible, though extensive readings were not taken. The results obtained are summarised in the table below.

In (3) only 80 yards of level sand were available. The heights of the eye, observed as in experiment (b), at distances of 60, 70 and 80 yards from the object, were found to be 1.3, 1.7 and 2.6 inches respectively. Calculation shows that the deviation is approximately the same in the last two cases, and hence it appears that on this occasion the temperature gradient was confined to the air within about  $1\frac{1}{2}$  inches of the ground.

In the following table, the observed heights of the object and the eye, and the distance between these are shown. The fifth column shows the deviation ( $= 2\theta$ ) produced, the next the calculated

approximate value of  $_{\Delta}\mu_x - 1 (= \cos \theta - 1)$ ; and in the last column the temperature difference  $\Delta t$ , between A and M, calculated as shown above.

Mirage	Height of Object (inches)	Distance from Eye (yards)	Height of Eye (inches)	Deviation produced ( $2\theta$ )	$\mu_x - 1$ ( $= \cos \theta - 1$ )	Temperature difference $\Delta t$
1.	12	40	3.5	about $1^\circ$	about } -00004 }	about } $35^\circ\text{C.}$ }
2.	40	600	30	$0.37^\circ$	-0000054	$5.0^\circ\text{C.}$
3.	6.5	80	2.6	$0.36^\circ$	-0000052	$4.7^\circ\text{C.}$

Thus the magnitude of the deviation produced is very considerable, and involves large values of  $\Delta t$ . The deviation could never exceed  $2.7^\circ$  as this involves  $_{\Delta}\mu_x = \mu$ , *i.e.*, a layer of air of refractive index unity at the surface of the sand. Even a deviation of  $2.0^\circ$  would require a temperature difference  $\Delta t = 150^\circ\text{C.}$  Thus the observed deviations are not far below the maximum we could expect, even in desert phenomena. The magnitude of the temperature gradient is obtainable in (3), as here the  $4.7^\circ\text{C.}$  difference occurred in about one inch from ground level. Hence in this case the vertical temperature gradient is of the order of  $1.5^\circ\text{C.}$  per cm.

It may be thought possible that at the large angles of incidence used, sand has an appreciable reflecting power. It is, however, unlikely that the above effects are due to this cause, as they are entirely absent in calm dull weather. It would seem that the effect must be due entirely to the atmospheric temperature gradient; if light vapours were present, these would tend to rise and thus to produce a negative gradient of  $\mu$  with height, thereby decreasing the effect caused by the temperature gradient.

It is hoped to continue these investigations at some future date. It would be interesting to determine the exact path of the rays and to compare this with the calculated curve for, say, rays in a medium with a constant temperature gradient; and also to compare the temperature gradient given by these results with that observed by direct measurement. Meanwhile it appears that, given a long enough stretch of level sand, we should see as fine effects as desert mirages on our very shores!

## Experiments with Wet Bulb Thermometers

The articles on the renewal of the muslin and wick on wet bulb thermometers contributed to the *Meteorological Magazine* by Mr. Sutcliffe and Mr. Durward, may be supplemented by a short account of the experiments which have been conducted at Kew Observatory during the last two years.

The problem which was presented for consideration here was the explanation of the consistent difference between the humidities registered in the screen on the north wall of the observatory and the Stevenson screen on the lawn. The north wall screen contains mercury thermometers with large bulbs. Two of these thermometers are used for photographic recording and the other two are the control thermometers. The north wall screen is open at the bottom and differs in other ways from a Stevenson screen. The "psychrometric difference" between dry and wet bulb readings is consistently greater in the north wall screen. As the same tables are used for the reduction of all the observations, both the relative humidity and the absolute humidity deduced from the readings are lower for the north wall screen than for the Stevenson screen.

After numerous observations intended to throw light on the anomaly had been made, it occurred to me that the explanation might be found in the way in which water was supplied to the wet bulbs in the different screens. As has been mentioned, the thermometers used in the north wall screen have very large bulbs. The bulbs are nearly cylindrical,  $4\frac{1}{4}$  in. long and 0.35 in. in diameter. The water supply is adjusted so that drips fall at long intervals from the bottom of the wet bulb. This has been the case from time immemorial.

In the Stevenson screen the normal practice is to use a thermometer with a spherical bulb 0.45 in. in diameter. The water is drawn up to the wet bulb by capillary attraction from a bottle about  $1\frac{1}{2}$  in. below.

During the summer of 1927 we tried the experiment of arranging the water supply of a number of wet bulb thermometers so that some had to draw up the water from below, others had the water dripping from them. As might have been expected it was found that when the water dripped freely the thermometer reading was comparatively high. With levels adjusted for slow drip we got low readings, but not much lower than those of the wet bulb arranged in the ordinary way. In the course of a few days larger differences began to develop, however, and we found that even though the ordinary wet bulb was still looking clean, its readings were higher than those of the well-watered thermometers. Evidently the water was not passing sufficiently freely through the pores of the muslin of the ordinary wet bulb. This effect occurred when boiled water was used, as is our general practice at Kew. With tap water the choking occurred much more quickly. Thus the result of this series of experiments was to show that a wet bulb thermometer becomes a less efficient evaporator as time goes on. If the muslin is only removed when it is obviously dirty, then the average reading of the thermometer will be considerably too high. During the summer the mean error on this account may amount to  $0.2^{\circ}\text{C}$ . or  $0.4^{\circ}\text{F}$ .



Thus we had found one of the causes of discrepancies between the humidities computed for different screens. That it was not the only cause was demonstrated by various comparisons, but most directly by setting up a dripping thermometer of the ordinary small bulb pattern alongside the big dripping wet bulb in the north wall screen. In warm weather there was a difference of about  $0.2^{\circ}\text{C}$ ., the little thermometer having the higher readings. The only likely explanation was that whilst the long bulb was comparatively well insulated from its stem, sufficient heat could reach the little bulb by conduction and so keep the temperature high. To test this hypothesis muslin was wrapped round the stem of the little thermometer, and the water supply was arranged so that this muslin should be kept wet and cool whilst drips fell slowly from the bottom of the bulb. This arrangement proved highly satisfactory. The readings of the two thermometers came into exact agreement.

When a wet bulb thermometer has to drip continually it is necessary to arrange for the head of water to be constant. The free surface of the water should be a millimetre or so above the bottom of the bulb. One plan which we have adopted is to invert in the water bottle a test tube in which a hole has been made about 2cm. from the mouth. The test tube is filled with water, corked and then inverted in the bottle. A rubber collar round the tube keeps it upright but leaves room for the threads to the wet bulb. As an alternative arrangement, we are now using a bottle such as is shown in the illustration to Mr. Durward's article. The bottle stands on a block of wood so that the water surface is a little above the level of the bottom of the bulb. A bottle of this type is hardly suitable for a climate in which frosts are frequent. We are trying to reduce the risk of breakage by putting through the mouth of the bottle a rubber tube containing air. This rubber tube is closed at the end which is inside the bottle and open at the end which is outside. The water has frozen completely on more than one occasion without damage to the bottle. It is likely, however, that a water container of some other type will have to be substituted.

The question naturally arises whether the new mounting which gives us greater cooling power and greater consistency can be used to obtain true values of the vapour pressure. Another way of putting the question is to ask whether the formula adopted in our official tables is appropriate for the reduction of readings obtained in a Stevenson screen with the new mounting. As far as experiments have gone the answer is in the affirmative. The critical observations were made on July 18th and July 21st, 1928, in warm dry weather. On each occasion a long series of readings was obtained from an aspirated psychrometer near the Stevenson screen. It was found that the values of the vapour pressure computed from the readings of the aspirated psychro-

meter by the "Strong wind" formula agreed well with the values computed from the readings of the dry and wet bulb thermometers in the Stevenson screen by the "Moderate wind" formula, the wet bulb being the dripping one with the swathed stem.

It is clear that too little stress has been laid in the past on the importance of a free supply of water to the wet bulb thermometer. Our experiments show that the muslin is only kept thoroughly moist when the water is supplied from a reservoir at or above the level of the thermometer bulb. There is an obvious difference in appearance between the wet bulb which is glistening with moisture and one which is barely kept damp, and it is by no means surprising that the evaporation from the former is the more effective in producing the cooling effect.

There is a temptation to recommend the immediate and general adoption of the plan of keeping the wet bulb in good condition by having the reservoir in a raised position; of course, such a departure from established practice should only be made after the likely effects have been carefully analysed. It is to be hoped that experiments will be made in various localities so that information may be gleaned as to the extent to which routine observations would be affected by a change of practice.

F. J. W. WHIPPLE.

## OFFICIAL PUBLICATIONS

The following publication has recently been issued:—  
PROFESSIONAL NOTES—

No. 50. Some regions of formation of depressions in the North Atlantic. By L. Doris Sawyer, B.A. (M.O.273j).

If anyone were capable of swimming from the eastern end of Nova Scotia to Bermuda, he would probably find as he travelled southwards that, on a rough average, the temperature of the surface of the sea increased about five times as rapidly during the first half of the journey as during the second. This is because the warm waters of the Gulf Stream come in contact with the cold Labrador Current near Newfoundland, some of the cold water continuing to flow southwestwards along the American coast towards Carolina. Such marked differences in sea temperature favour large differences of temperature in neighbouring masses of air, so that conditions might well be expected to be particularly unsettled in these regions. This is shown to be the case in both winter and summer, though owing to the seasonal changes in America disturbances tend to develop rather further north in summer than in winter.

Among other regions where depressions are particularly apt to form or deepen may be mentioned the Davis Strait and the ocean southeastwards of Greenland. In both these parts there is a seasonal variation largely dependent on the drifting of ice.

## Discussions at the Meteorological Office

The subject for discussion for the next meeting will be :—

January 21st.—*On the formation of ground inversions with a clear sky and a land breeze.* By R. Steiner (Abh. Rostocker Luftwarte) (in German). *Opener*—D. Brunt, M.A., B.Sc.

## Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, November 21st, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, in the chair.

*F. J. W. Whipple, D.Sc.—On the association of the diurnal variation of electric potential gradient in fine weather and the distribution of thunderstorms over the globe.*

It is well known that in fine weather the ground bears a charge of negative electricity, and that this charge persists in spite of the continuous flow of positive electricity from the air to the ground. On the other hand, during thunderstorms the air-earth current is mostly of the opposite sign and is much stronger. It is probable that the two phenomena are complementary. It has been suggested by C. T. R. Wilson that the connexion between the upward currents produced by thunderstorms and the downward currents elsewhere is via the Heaviside layer. If this hypothesis is sound then the air-earth current will vary through the 24 hours with the number of thunderstorms in progress. Inland thunderstorms are most frequent in the afternoon and least frequent in the morning, so by utilising statistics as to the geographical distribution of thunderstorms it is possible to compare the area over which storms are likely to be in progress at different hours of universal time. It is found that storms are least frequent from 2h. to 4h. G.M.T. (when it is afternoon over the Pacific), and most frequent between 14h. and 20h. G.M.T. (afternoon hours for Africa and South America). Observations of potential gradient in polar regions and at sea, *i.e.*, in parts of the world where there is likely to be little systematic variation in the conductivity of the air, indicate that the gradient has its minimum and maximum values within these same hours. The results of the investigation are all consistent with the Wilson hypothesis.

*N. K. Johnson, M.Sc.—Atmospheric oscillations shown by the microbarograph.*

The microbarograph, which was invented by Sir Napier Shaw and the late Mr. W. H. Dines, frequently gives a regular wave-like record representing oscillations of atmospheric pressure. In the present paper, an analysis is made of the records of four observatories. The period of the oscillations is found to range from about 6 minutes to an hour, but there is a very marked maximum frequency of oscillations with a period of about ten

minutes. The theory of the instrument is discussed, and it is shown that the distribution of frequencies observed is free from any appreciable errors due to instrumental causes.

Evidence is produced which indicates that the oscillations originate at the interface of two air currents possessing different densities and motions. The fact that oscillations with a period of about ten minutes occur most frequently is explained in terms of the natural period of vertical oscillation of the atmosphere. If the period of the oscillations agrees with that of the atmosphere, then the amplitude generated will be large and will be recorded at ground level. On the other hand, if the periods differ, the amplitude will generally be small and will not be felt at the ground. The natural period of vertical oscillation of the atmosphere is shown to be connected with the lapse rate of temperature, and it is further shown that the most frequent period of oscillation recorded corresponds with the most frequent lapse rate. Moreover, the distribution of these oscillations throughout the day also agrees with the above explanation.

*H. Jameson, B.Sc.—On the mean maximum rain falling in a time  $t$ .*

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### Suggestions for Improvements in Details of Certain Instruments

In many years' use of instruments, one meets with various small annoyances arising from the design, or want of design, of these. I venture to offer, through the *Meteorological Magazine*, a few suggestions; both to observers, and to makers. Some of these are merely trouble savers. Others are observation savers, for they obviate the loss of observations, and prevent the inclusion in returns of the humiliating entry, "No record."

My first suggestion is that a one-day clock is an unmitigated nuisance. Human nature being what it is, it is certain, sooner or later, that the winding will be forgotten. Result, a lost record, if the clock is that of a self-recording instrument, or a lost rate, if it is a chronometer. Here at Armagh Observatory we have a chronometer which runs for the very inconvenient time of 30 hours. If the customary time of winding is in the evening, and the formality is forgotten once, the chronometer stops about 4 a.m. If wound in the morning, and once forgotten, it stops about 4 p.m. In either case no one is likely to be about. Had it been made to go for another 6 hours even, it would last till breakfast time, and there would be a likelihood of its condition being noticed in time to save its stopping. But a two-day movement would be better still.

Then there are the Robinson-Beckley anemograph, and the

Beckley rain-gauge, both of which have one-day clocks. The former was very easily remedied. I fitted a pulley block and double string, after the manner of grandfather clocks, and doubled the weight. The clock now goes for nearly three days, and is thus practically safe against accidental forgetfulness. The strange thing about this clock is that its drum is designed to carry three days' coil of line, but no provision was made, in installing it, for taking advantage of this long going capacity. In the Beckley rain-gauge clock, unfortunately, the weight descends in a concrete chamber, closed at the bottom, and a bare fit for the weight. There is therefore no room to fit a double purchase string, nor to increase the size of the weight, though here again there is ample room on the clock drum for two or three days' line. I have thought of substituting a lead weight for the existing cast-iron one, and so giving the clock a few inches longer run down.

On two or three occasions the line of the anemograph clock has broken. To replace a broken line is a simple job, if it does not entail taking the whole clock movement to pieces. This defect has been remedied by the simple expedient of drilling a second hole in the clock drum, diametrically opposite to that in which the line is knotted. The extra hole is large enough to pass a knot on the line. Therefore, in case a new line has to be fitted, all that is necessary is to pass the end of the line in at the smaller hole, and out at the larger, make a knot, and pull it in again. The clock need not even be taken off its seat.

When I first made the acquaintance of the Beckley rain-gauge, it was frequently liable to get out of order, when there was a heavy fall of rain, and to lose an important record through the siphon failing to act. This was especially the case when a gentle rain lasted for several hours, the small flow seeming to be unable to start the siphon. Then, one day, I got a small brush and scrubbed out the receiver. I obtained a marvellous collection of miscellaneous organic matter from it. Wings, legs, and the horny parts of flies, ants, earwigs, etc.; grass seeds, and other vegetable flotsam, bird droppings, were all represented. After a drastic clean out, there was no more trouble for a long time. But I found that various times of year produced their various seasonable *débris* to choke the siphon. In spring, bracts from the beech trees; in summer, grass seeds; in autumn, winged ants and earwigs; at all times of year bird droppings; found their way into the receiver. Finally I designed a strainer, to fit in the throat of the receiver. It is made of the copper wire gauze used for petrol filters, soldered into a very light ring turned off the end of a 1½ in. brass tube. The *modus operandi* was as follows. The gauze was cut with a pair of snips to a circle a little larger than the tube, and pushed through the latter to near the other end, becoming convex in the process. It was then soldered in position, and the end cut off the tube with a

parting tool in the lathe. Before parting off, the outside was turned to a good fit for the throat of the receiving vessel. A light wire was soldered across the ring, for lifting off. Since introducing this little gadget to the Beckley gauge, there has been no more trouble with fouling of the siphon. The very slight extra weight is easily allowed for in fitting the chart to the drum. If preferred it could be compensated by adding a small quantity of mercury to the bath in which the receiver floats. At first it was found that, after a spell of dry weather, the strainer was liable to create an air lock, and prevent water entering the receiver. But this was remedied by drilling a very small hole in the neck of the vessel, just below the strainer, to act as an air release. Being only a sixteenth of an inch in diameter, the hole does not interfere with the emptying of the receiver with the breath in the usual manner.

The last of my criticisms is concerned with the soil thermometers. I have always thought that the readings of these are liable to be interfered with by convection currents. They are hung in iron pipes, 1ft. and 4ft. below the surface respectively. The pipes contain ample room, being 1½ in. diameter. On a night when the grass temperature is far below freezing point, while the soil temperature is in the forties or fifties, the projecting ends of the pipes cool down to the temperature of the grass. Cold air cannot fail to flow down to the thermometers and reduce their reading below the true temperature of the soil. It seems to me that the recommendation in the *Observers' Handbook*, that water should not be allowed to collect in the bottom of the tube, is a mistake. If the thermometer bulb were immersed in water, the water would have the temperature of the surrounding soil, and would effectually protect the bulb from the influence of inflowing cold air. Or the lower end of the iron pipe could be closed, and contain a few inches of oil, glycerine, paraffin, or any other non-freezing liquid. In the meantime, I have adopted a plan which protects the thermometers from down draughts of cold air, while not interfering with regulation methods. On the suspension ring of each thermometer, I have fixed a disc of sheet rubber, which fits the bore of the pipe. The instruments are therefore in a closed chamber, and cold air is held up, and will probably assume the temperature of the soil before penetrating past the obstructing rubber disc.

Mr. J. Durward's communication in the *Meteorological Magazine* for October prompts me to add a word on the wet-bulb thermometer.

The constant-level water container figured by him would be ideal but for one fatal defect. It would never survive a winter in British latitudes. The first hard frost would infallibly burst it. I find that a vessel of considerable size answers admirably, provided it be covered with a lid which leaves just sufficient

aperture to pass the wick without pressure. If this is placed a little to one side of the thermometer bulb, and at a slightly lower level, so that the wick slopes up, not too steeply, to the bulb, it is practically equivalent to a constant-level reservoir, for the portion of the wick within the lid is surrounded with a saturated atmosphere, and shielded from evaporation.

It is obviously undesirable to have a large area of uncovered water surface close to the bulb of the thermometer, for it will supply water vapour to the air in the neighbourhood of the bulb, and vitiate its reading, especially in still air.

The reservoir used at Armagh Observatory is a small glass mug, to which I have fitted a lead cover, cast to fit neatly, and having a notch to pass the wick, like that in the cover of a mustard pot. For some time I used a glass cover, but found it too light. It was often lifted in high winds, and sometimes blown clean out of the Stevenson screen.

WM. F. A. ELLISON.

*The Observatory, Armagh. November 1st, 1928.*

[Mr. Ellison's objection to clocks with an insufficient margin of safety is a very reasonable one. There is no real difficulty in providing clocks for "daily" drums which will run for several days on one winding, and such clocks are, in fact, fitted to many modern instruments, *e.g.*, the Dines anemograph.

Some form of removable filter, to prevent the ingress of rubbish, is essential in any self-recording rain-gauge employing a siphon. The best place for it is at the base of the funnel. Mr. Ellison's device is open to the objection that rubbish retained by it is represented on the record by an equivalent weight of rain. Could not the gauze be mounted on a fairly heavy ring turned to fit the funnel and placed in the bottom of the latter? The Casella natural siphon gauge has a very neat and efficient filter fitted to the inlet tube to the float chamber.

Water should be kept out of a Symons earth thermometer tube to minimize rust and deterioration of the thermometer mounts. A little mercury or oil at the bottom might improve the readings by ensuring better thermal contact, but experience shows that the Symons thermometer performs its function well enough without such additions. Mr. Ellison's steel tubes are much wider than the present pattern, which are only 1.25in. in diameter. Two rubber bands round the thermometer fit the tube fairly closely and give the same result as Mr. Ellison's discs of sheet rubber.

Letters such as Mr. Ellison's are of great interest and value. In many cases it may be found that defects existing in older instruments have been remedied in more recent patterns, but there is still need for improvement. Suggestions and criticisms from observers provide the best possible material on which to work.—E. G. BILHAM.]

### Wet Bulb Thermometers

In the interesting note by Mr. Durward on Wet Bulb Temperatures, which appeared in the October issue, a sketch is given of a constant level container which has recently been brought into use at Air Ministry Meteorological stations in the Middle East. This apparatus, which was originally suggested by Mr. G. W. Grabham, Geologist to the Sudan Government, has been in use in the Egyptian Meteorological Service for many years—and, in fact, the experiments described were carried out with containers supplied by this Service. They are commonly known as “bird-fountains” and are obtainable from Baird & Tatlock. They have a capacity of about 150cc. and have proved satisfactory.

L. J. SUTTON.

*Egyptian Meteorological Service, Cairo. November 4th, 1928.*

### Lunar Rainbow ; Artificial Halo

At 10.18 p.m. (G.M.T.) last night I observed a lunar rainbow which lasted two minutes. The bow was unbroken and was pure white in colour. A shower of moderate intensity had passed quickly overhead to between NE and N, the moon appeared from a break in the clouds to between S and SW. I have never observed one of these here before.

Also, during a heavy rainstorm about 8.15 p.m. (G.M.T.), I was walking along the Portsmouth Road towards Kingston (about 1 mile from it), when a car with bright headlights approached from behind. In front of me a large circle of white light appeared, resembling a lunar halo, and dispersed as the car drew near. This happened several times during the rain on the approach of further cars. The diameter of the ring appeared to stretch approximately from 1ft. above the ground to a few feet above the height of an ordinary gas lamp-post.

K. G. WILLIS.

*Tadram, Effingham Road, Surbiton. November 22nd, 1928.*

### Weather Lore of the Polynesians

A recent book (“Myths and Legends of the Polynesians” by Johannes C. Anderson, Harrap and Co., 1928) gives much interesting information as to the weather lore, mythical and otherwise, of the South Sea Islanders.

As might be expected amongst a seafaring people, who, moreover knew of the fury of tropical cyclones, the winds played a great part in the cosmogony. They were the children of Raka, and each had a hole allotted to him at the edge of the horizon through which he blew at pleasure. Raka also possessed a basket in which to confine the winds, much in the same way as Homer represents Aeolus giving Ulysses the contrary winds tied up in a bag. The white clouds were regarded as due to the domestic



labours of the goddess 'Ina who was forever preparing bark-cloth, and stretching it out to dry and bleach on the blue sky, securing it native fashion with huge stones. The bleaching finished, the stones were thrown on one side and the noise of their falling on the solid blue vault was thunder.

In the South Seas, as elsewhere, the rainbow was regarded as a bridge from heaven to earth.

But leaving myth on one side, the weather lore of the Polyne-sians was surprisingly accurate in the matter of prediction of wind and weather. Thirty-two winds were recognised, and the naming, as the following list shows, was elaborate and systematic:—

East. Marangai.

E. by N. Marangai-anau. "East giving birth" (to the new wind).

E.N.E. Marangai-akavaine. "East as gentle as a woman."

N.E. by E. Marangai-maoake. "East becoming North East."

N.E. Maoake.

The N.N.E. wind was called Maoake-ta—"The Terrible Northeast," in allusion to the extreme violence of this wind during a hurricane. Mr. Andersen says, "There was an un-failing natural indication of the approach of a cyclone expressed in the saying, 'Twisted is the core of the banana.' This twisting takes place some weeks before the coming of a hurricane, and at the same time there is an unusually luxuriant growth of food." One would like a little more definite information as to this; as it stands it seems rather obscure.

CICELY M. BOTLEY.

17, *Holmesdale Gardens, Hastings.* September 4th, 1928.

### Change of Climate

There has been a popular belief that the climate of western Europe has become generally milder during the past 30 to 50 years or so. The discovery of the great heat reservoir in the Arctic by the U.S. Coast Guard ship *Marion* certainly lends colour to this idea.\*

Take last winter in England also. After a severe cold spell in December instead of (as in former days) continuing into January and February, the cold disappeared suddenly for the rest of the winter, this being due to there being no mass of cold air over the Continent, even the snows of Switzerland melting from time to time. Evidence certainly goes towards showing a general amelioration in the winter climate of western Europe.

DONALD W. HORNER.

63, *Canute Road, Clive Vale, Hastings.* November 21st, 1928.

\* See *Meteorological Magazine*, 63 (1928), p. 217.

## NOTES AND QUERIES

### Our More Equable Climate

Having occasion recently to examine some figures of the average winter and summer shade temperature at London and Edinburgh. I was impressed by the remarkable decrease in the annual range of temperature which they revealed. Ten-year means are shown in the following table, based on the data in D. Brunt's *Periodicities in European Weather*,\* brought up to date by means of manuscript tables. Winter is December to February and Summer is June to August, the mean of two successive winters being subtracted from the intervening summer temperature to give the "seasonal range."

Ten years ending	Seasonal Range		Ten years ending	Seasonal Range	
	London	Edinburgh		London	Edinburgh
	°F	F		F	F
1927	19.2	17.4	1847	22.7	19.2
1917	19.7	18.2	1837	22.6	18.5
1907	20.9	18.5	1827	23.1	21.0
1897	22.5	18.3	1817	22.3	20.6
1887	22.2	19.2	1807	23.5	21.4
1877	22.1	18.8	1797	23.3	19.5
1867	20.9	18.1	1787	24.1	21.4
1857	21.7	19.3	1777	23.1	19.7

The average for the whole period is 22.1° at London and 19.3° at Edinburgh, and at the former place the range during the ten years ending 1927 was no less than 2.9° F. below this long-period average.

By far the greater part of the decrease is due to the winter temperature. At both stations the average winter temperature for the ten years ending 1927 was higher than that for any other series of ten consecutive years since 1765.

This high average was not due to the inclusion of two or three extremely mild seasons, but rather to the persistent recurrence of winters characterised by a moderate degree of warmth. During the same period the summers have been distinctly cool in London, but at Edinburgh they have been about normal.

C. E. P. BROOKS.

### The Effects of Height on Screen Temperatures

In an article on this subject on p. 107 of the *Meteorological Magazine* for June, 1928, it was found that in Malta the diurnal range of temperature is appreciably smaller on a roof than near the ground. A similar result has been obtained in Iraq, where readings in a Stevenson Screen on the roof of Air Headquarters at Baghdad have been compared with those in a similar screen on the ground at the neighbouring station of Hinaidi. The maximum on the roof is usually 2°F. below that on the ground,

\**London, Phil. Trans. R. Soc. A.* 225, 1925, pp. 247-302.

but the minimum on the roof averages 5°F. higher, and the difference has sometimes reached 13°F. The average readings during June, 1928, are as follows:—

	<i>Hinai'di</i> (ground).	<i>Baghdad</i> (roof).
	°F.	°F.
Mean daily max. ...	108.1	106.0
Mean daily min. ...	73.0	78.1
Mean daily range ...	35.1	27.9

### Rain-Makers

My interest has been aroused more than once in a reference to "rain-making" which appears in the Eleventh Edition of *The Encyclopaedia Britannica* (Vol. XVII, p. 309) under "magic." The statement runs:—"Rain-making ceremonies are far from uncommon in Europe. Sometimes water is poured on a stone; a row of stepping-stones runs into one of the tarns on Snowdon, and it is said that water thrown upon the last one will cause rain to fall before night."

During a recent visit to North Wales I commented to my guide, a native of the district, on my inability to connect the legend with any of the lakes on Snowdon, and was intrigued to find that the very lake towards which we were then bent boasted that tradition. At Llyn Dulyn, in the Carnedd Llewelyn range, there was just discernible a row of stepping-stones leading to a submerged larger stone or "altar." Llyn Dulyn is just below and to the north-east of the gully where snow is said to lie later during the year than anywhere else in England and Wales. Of recent years the level of the lake had been raised by a low dam in order to meet the increasing demands for water by Llandudno, and it is not improbable that the storage capacity of this natural reservoir will again be increased and the stones themselves no longer dumbly speak of ancient times and magic sages.

The average rainfall at Llyn Dulyn is about 100 inches a year and the number of rain-days exceeds 225. The choice of such a locality for the demonstration of their powers suggests a regard of natural laws which seems to be an integral part of so many of the charms of mediæval times.

J. GLASSPOOLE.

### Reshabar, Rushabar or Rrashaba?

One of the minor difficulties of meteorology is concerned with the transliteration of terms which are in use among peoples employing a different alphabet from our own. An example of this is a cold, gusty, north-easterly wind resembling the Bora in its origin, which blows down from the mountains of southern

Kurdistan when pressure is relatively higher there than to the southward over the plain of 'Iraq. The Kurdish name for this wind means "the black wind," a term which has not sufficient precision for scientific use. An attempt at a phonetic representation gave variously Rushabar and Reshabar; we are now informed that the correct transliteration is *Rrashaba*, which threatens difficulties of pronunciation. Incidentally one would wish to know why this particular wind should be described as "black."

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### Sunspots and Epidemics

On p. 47 of the present volume of the *Meteorological Magazine* we reviewed a paper by A. Tchijevsky in which it was claimed that historical events tend to occur more frequently near sunspot maximum than near sunspot minimum. He has now contributed a further study\* in which the occurrence of epidemics of cholera and influenza is related to the sunspot cycle. The relationship is found most clearly with the cholera epidemics, for of fifteen which occurred between 1766 and 1900, no fewer than twelve coincided with a sunspot maximum. The relationship of influenza to sunspots is less clear, for though this malady shows indications of a periodicity of 11·3 years, its outbreaks come not exactly at sunspot maximum but at an average interval of 2·3 years before or after.

The way in which the variations of solar activity take effect is not yet clear, but the author considers that it is probably through their influence on atmospheric electricity and especially potential gradient, which may affect both the bacteria themselves and also the power of humanity to resist disease.

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### The Colours of Pilot Balloons

Those who make regular observations with pilot balloons are well aware of the fact that the visibility of a balloon at a given distance is largely dependent on its colour in relation to the background—of cloud or sky—against which it is viewed. Unless a balloon bursts, enters or passes behind a cloud, the termination of the observation is reached when the observer can no longer see the balloon through the telescope of the theodolite. By judiciously selecting a balloon of the best colour, it is possible to prolong the observation considerably beyond the point when an unsuitable balloon would have vanished from sight.

Experience has shown that a choice of three colours, white (undyed rubber), dark blue and cherry red, is sufficient to meet ordinary requirements both at home and in the tropics. It is

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\*Über die Wechselbeziehungen zwischen der periodischen Tätigkeit der Sonne und den Cholera- und Grippe-Epidemien. *Deutsch-Russische Medizinische Zs.*, no. 9, 1927, pp. 511-538.

possible, however, to obtain balloons made half of one colour and half of another, and it will be convenient to describe these as "bi-coloured" balloons. A balloon rotates during its ascent, and it seemed probable that a balloon, only half of which was, say, blue, would be just as serviceable as a balloon wholly blue when the circumstances necessitated a blue colour. It thus seemed possible to combine the advantages of the two different colours in the same balloon. Moreover, it was known that observers were not altogether unanimous in their opinions as to the best colour to use in given circumstances. There would be, for instance, many occasions when a blue and a red balloon were almost equally suitable. Some observers would select one and some another. It seemed quite possible, therefore, that a standard bi-coloured balloon of two suitable colours might prove as effective, in actual practice, as a selected balloon in one of the three standard colours.

At this point it may be desirable to explain what advantages were likely to accrue from the use of bi-coloured balloons, which would, at best, be no better than self-coloured balloons from the observer's point of view. The object aimed at was to avoid the necessity of maintaining, at stations and in store, stocks of three different balloons. These balloons deteriorate in store, and it sometimes happens that demands for one particular colour suddenly increase or suddenly fall off. On account of such fluctuations, the reserve stocks must be maintained at a higher level than would otherwise be the case and, consequently, the average duration of storage before use is increased. It was felt, therefore, to be worth while experimenting with bi-coloured balloons with a view to selecting a standard balloon for all occasions.

Supplies of balloons combining the colours "red-blue," "red-white" and "blue-white" were obtained, and trials were carried out at Upper Heyford in England and at Aboukir and Heliopolis in Egypt. At both the Egyptian stations, it was found that the combination "blue-white" gave best results, especially when viewed through an orange filter. At Upper Heyford, the observer found it impracticable to select a combination suitable for all occasions. He thought it possible to replace separate red and blue balloons by the single combination "red-blue," but found it essential to retain undyed balloons in addition. He also reported that the bi-coloured balloons required more care in filling than single-coloured balloons, because one half tended to expand before the other.

On the basis of the above reports, it would be necessary to obtain supplies of "blue-white," "red-blue" and undyed balloons. Since three types are involved, the one advantage claimed for bi-coloured balloons would be lost and the idea was accordingly dropped. Although the results of the experiments

were negative, they demonstrated clearly that anyone undertaking pilot balloon work should have at his disposal balloons of the three colours already mentioned if the best results are to be obtained under all conditions.

E. G. BILHAM.

### Memoires Patxot

To encourage research in Physics and Mathematics, principally in Catalonia, M. Raphaël Patxot i Jubert in 1922 and the following years has offered prizes for essays on certain scientific subjects connected with Catalonia. The winning essays, published by M. Patxot i Jubert are known as the *Memoires Patxot*. The subject chosen for the 1928 (the seventh) competition is a meteorological one, the title being "Météorologie de la Méditerranée Occidentale et plus spécialement de la côte Catalane, en donnant préférence à l'aspect dynamique du problème." This competition is international and the essays may be written in Catalan, any one of the Latin languages or in English. The prize offered is 5,000 pesetas. The competition closes at 8 p.m. on December 31st, 1929. Further particulars can be obtained from M. R. Patxot i Jubert, Rue de la Cucurulla, 1 and 3, Barcelona.

### Unusually Low Pressure

An unusually low barometer reading was obtained at Edinburgh at 3.25 p.m. on November 23rd. After correcting to mean sea level and normal gravity, the reading deduced from the barograph is 950.7mb. (28.08in.).

Major A. H. R. Goldie writes that "we have to go back to December, 1886, before we find anything so low. In December, 1886, a pressure of 27.65in. (uncorrected for gravity) was attained, and in January, 1884, one of 27.45in. [The gravity correction is about +.027in., making these readings respectively 27.678in. (937.3mb.) and 27.478in. (930.5mb.).] The last mentioned was the lowest since records commenced in Edinburgh in 1769, and occurred during the passage of the depression of January 26th, 1884, when a reading of 27.33in. was recorded at Ochertyre in Perthshire. Isobars for this depression are given in Bartholomew's *Atlas*."

### Reviews

*Eos; or the Wider Aspects of Cosmogony.* By Sir J. H. Jeans, F.R.S. Size 6½ by 4½ in., pp. 88. *Illus.* London, Kegan Paul, Trench, Trubner & Co., Ltd., 1928, 2s. 6d. net.

In this little book Sir James Jeans gives a delightfully lucid account of the present position of our knowledge of the Universe, in a form suitable for reading by the educated layman. Modern conceptions of the universe deal in immensities of both space and

time, while making use of the infinitesimal as represented by the detailed structure of the atom. In the space of a brief review it is not possible to do more than to refer to a few of the points raised by the author.

It is pointed out that while man has only existed on earth during a period of some 300,000 years, the age of the earth is of the order of 2,000 million years, and the sun has existed for a time to be measured in millions of millions of years, and can go on for an equally long interval. The immensity of space is exemplified by the statement that whereas light from the most distant objects visible in the 100-inch telescope at Mount Wilson takes about 140 million years to reach us, travelling at 186,000 miles per second. Hubble estimates that space extends 1,000 times as far as this. If we adopt this value, then light will take 100,000,000,000 years to travel round space, though wireless waves having the same velocity travel round the earth in one-seventh of a second.

Jeans draws attention to the fact that whereas stars show very considerable variability in size, brightness, and distance, they show a restful uniformity as to their masses. The energy which is radiated outward from the stars is regarded as having its source in the annihilation of matter, and so the stars are continually losing weight. The rate of loss is greatest for the more massive stars, and the uniformity of mass of the stars is regarded by Jeans as being due to the equalising effect of this. The final fate of the radiation is discussed, and it is stated that the radiation from thousands of dead universes could be contained in space without our being aware of its presence. Apparently the process of conversion of mass into radiation is not reversible, and the universe is comparable to a clock which is continually running down and cannot be wound up again. The clock appears to have been wound up some 5 to 8 million million years ago.

Some very beautiful pictures of nebulae are given to illustrate the description of the evolution of star systems from spiral nebulae. The birth of a solar system such as ours is described as a rare event, and we reach the conclusion that very few stars are likely to have planets in a condition adapted to the existence of life as we know it on the earth.

This little book can be recommended as well worth close study. It gives a very clear idea of the way in which modern cosmogony depends upon the very latest advances in atomic physics. In places the statements made appear perhaps more dogmatic than the observations seem to justify, but this is probably largely due to the necessity for compressing a whole science into so small a compass. The author has succeeded in producing a stimulating little book which should interest a wide circle of readers.

D. BRUNT.

*Les Hivers dans l'Europe Occidentale.* Etude statistique et historique sur leur température: discussion des observations thermométriques 1852-1916 et 1757-1851: tableaux comparatifs: classification des hivers 1205-1916: notices historiques sur les hivers remarquables: bibliographie. By C. Easton. Size  $9\frac{3}{4} \times 6\frac{1}{2}$  in., pp. 210. Librairie et Imprimerie ci-devant E. J. Brill, Leyden, 1928.

Of the various matters promised on the title page, the historical notices and the bibliography occupy three-quarters of the book, and they are a remarkable monument to the author's industry in research among ancient tomes, as well as to his linguistic accomplishments. Although they do not become sufficiently numerous for statistical treatment until the 13th century, the records actually begin with 396 B.C., and the collection will be welcomed by all meteorologists who are interested in historical studies.

As a preliminary to discussing this mass of historical material, the author investigates the severity of the winters from 1852 to 1916, for which complete instrumental observations are available for nine stations in western Europe between Greenwich and Strasburg, and also those of the period 1757 to 1851, for which less complete data are available. Considering that the impression of "severity" is given quite as much by short spells of intense cold as by a low mean temperature, he evolves a "coefficient of temperature" in which the mean winter temperature is combined with the number of days of frost, days without thaw, very cold days (below  $14^{\circ}\text{F.}$ ) and the mean of the three lowest minima in different months from November to March, all expressed in terms of their standard deviation. A winter in which the coefficient of temperature is below the average value by more than four times the standard deviation of the coefficient is termed a "great winter," a deficit of three times the standard deviation characterises a "very rigorous winter," and so on. In the 160 years there was only one great winter, namely, 1829-30, when intense cold lasted from November 14th to February 22nd.

The winters from 1205 to 1756 are next arranged in estimated order of severity. Since 1757 to 1916 produced one "great winter," these 552 earlier winters should produce four; in the same way the theoretical numbers of "very rigorous," "very mild" winters, &c., can be calculated. Actually, the author selected five "great winters," ending in 1408, 1608, 1565, 1709 and 1435, four very mild winters, and 12 very rigorous. These are given the average coefficients of temperature of the same classes during the instrumental period, 4 for great winters, 10 for very rigorous winters and 90 for very mild winters, the theoretical range of the scale being from 0 to 100. In this way



the verbal descriptions of the chroniclers are ingeniously converted into numerical estimates suitable for statistical computations, without making any attempt to estimate the actual mean temperatures of the different winters, which would be impossible to sustain. It was in these "coefficients" of temperature that the author found his well-known periodicity of 89 years.

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*Annali del R. Ufficio Centrale di Meteorologia e Geofisica Italiano.* Serie terza. Osservazioni 1921. Size  $13\frac{1}{2} \times 10$  in., pp. x + 222., Rome, 1928.

The publication of the official year-books of the Italian Meteorological Office has been interrupted for some years, and we welcome this issue of the observations for 1921, which contains monthly summaries for 120 second order and 158 third order stations. At the former complete observations are recorded at 9, 15 and 21h., the mean temperature for the day being taken as the mean of the 9h. and 21h. observations and the mean daily maxima and minima—a very useful combination. Days of rain are given separately for totals less than, and equal to or greater than 1 millimetre.

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*A proposed guide-book to the world's weather and climates.*

By Robert De C. Ward. Proc. Amer. Phil. Soc., 67, 1928, pp. 67-94.

Professor R. De C. Ward is a great advocate of "field work" in the study of climatology, and in this interesting paper he outlines a few trips to regions of climatic interest. From our point of view it is unfortunate that the standard pleasure trips are planned to avoid climatic vicissitudes as far as possible, and there are no excursions to north-eastern Siberia in January or to Cherrapunji in July. Even on the ordinary trips, however, the tourist could find a great deal to interest him in an account of the weather and climate of the places he will visit, and the outstanding meteorological phenomena he should look for, subjects about which he is generally left in ignorance. We hope that Professor Ward will find opportunity to publish the full text of his proposed guide-book.

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## The Weather of November, 1928

The weather of November was generally mild, unsettled and stormy except during the first ten days and the last few days, when it was mainly cold and misty. For the first three days light northeasterly winds prevailed, and heavy rain in the south-east of England on the night of the 1st to 2nd and on the 2nd was associated with a shallow depression over France: 2·87 in. fell at Deal and 2·56 in. at Dover. Much mist and fog occurred from the 4th to 7th in the south and Midlands, while in the

north it was fair with slight showers. Anticyclonic conditions prevailed on the 8th and 9th, when many places experienced much sunshine, *e.g.*, 8·2hrs. at Southampton on the 9th, and severe frost occurred on the mornings of the 9th and 10th; the lowest reading for the month in the screen was 21°F. at Marlborough on the 10th, and on the ground 11°F. at Ford, Argyll, on the 9th. The change to mild unsettled conditions began in the north on the 9th, when 1·02in. of rain fell at Lerwick, and extended south on the 10th. Strong winds with local gales at times were frequently experienced until the 28th. The most notable gales were associated with the intense depressions which passed across England on the 16th, southern Scotland on the 23rd and northern Scotland on the 25th. These occasioned much destruction and some loss of life. Beaufort force 10 (59m.p.h.) was recorded at several places along the south coast of England on the 16th, and at one or two places in northwest England on the 23rd and 25th. The strongest gusts recorded were 93m.p.h. at Liverpool on the 23rd, 90m.p.h. at Cardington on the 16th (measured by the anemometer at 150ft.), and 87m.p.h. at Southport and South Shields on the 23rd. Rain fell on most days during this period with heavier falls locally on the 11th, 12th, 14th, 18th and 21st to 23rd. Amongst the heaviest falls were 2·47in. at Talyllyn (Merioneth) on the 11th, 2·58in. at Tynywaun (Glamorgan) on the 12th, 2·19in. at Sawrey (Lancashire) on the 14th, 2·00in. at Aasleagh (Mayo) on the 18th. At Rosthwaite (Cumberland) 4·80in. fell on two successive days, 2·44in. on the 22nd and 2·36in. on the 23rd. During the latter part of the month snow was reported on the hills in many parts of the north. Thunderstorms occurred at Waterford on the 14th and 15th, and in Yorkshire on the 23rd. In the rear of the depression on the 25th cold northerly winds flowed over the country and temperature fell considerably. On the 27th and 28th the temperature did not reach 40°F. at a few places, and at Aspatria the maximum value on the 28th was 37°F. Showers of rain, hail and snow occurred locally, while considerable periods of bright sunshine were enjoyed, especially on the 26th, when many places had over 6hrs. sunshine and Clacton as much as 7·1hrs. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	47	+4	Valentia	58	— 7
Aberdeen	63	+8	Liverpool	52	— 7
Dublin	70	—1	Falmouth	59	—17
Birr Castle	60	—4	Kew	55	+ 3

Pressure was below normal over the whole of northwestern and central Europe and Italy, and from Spitsbergen to Newfound-

land, the greatest deficit being 17·4mb. at Utsire. Pressure was above normal in a belt extending from Spain to Bermuda with the greatest excess, 5·2mb. at Horta. Temperature was above normal from Spitsbergen to Switzerland, but below normal in Portugal, while precipitation was in excess except in northern Norway, northwest Lapland and Spitsbergen. In Kalmar (Sweden) precipitation was three times the normal.

Owing to the heavy rains in Switzerland and northern Italy at the end of October and during the first two days of November, the level of the lakes of Lugano, Maggiore, Como and Iseo rose considerably and there was serious flooding in the neighbouring districts. The situation had improved somewhat by the 4th. Heavy southerly gales were experienced in the Balearic Isles on the 8th. The storm of the 17th and 18th caused much damage, especially to shipping, in Germany and Holland, with some loss of life in Holland. Further gales on the 23rd to 26th caused material damage and loss of life in Denmark, Germany, Holland, Belgium, France and Switzerland. In Holland and Schleswig-Holstein the dykes burst in several places with consequent flooding. Gales occurred in southern Spain on the 26th. By the 28th the weather had much improved in Switzerland.

Heavy rain and strong winds occurred over Sumatra on the 7th, and a typhoon swept across the Philippines about the 20th; 200 people were killed, and it is estimated that 10,000 were rendered homeless in the island of Leyte.

A blizzard swept over the Rocky Mountain region and Upper Mississippi valley on the 1st and continued across Nebraska, Kansas, Iowa and Missouri on the 3rd. High winds about the middle of the month caused considerable damage to the banana crops of Jamaica. Forty-one people were killed and injured by a cyclone which swept across the province of Cordoba, Argentina, about the 12th. Fine weather favourable for harvesting operations was experienced in the Argentine after the 16th.

Many gales were experienced on the North Atlantic during the month.

The special message from Brazil states that the rainfall in the northern regions was variable with 0·16in. above normal, plentiful in the central regions with 1·26in. above normal and scanty in the southern regions with 2·91in. below normal. In the south the weather was unfavourable for the crops. Six anticyclones passed across the country and windstorms occurred in the south. At Rio de Janeiro pressure was normal and temperature 0·2F. below normal.

### Rainfall, November, 1928—General Distribution

England and Wales	...	126	} per cent. of the average 1881-1915.
Scotland	... ..	134	
Ireland	... ..	142	
... British Isles	... ..	132	

**Rainfall: November, 1928: England and Wales**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>London</i>	Camden Square .....	2'15	91	<i>Leics</i>	Thornton Reservoir ...	3'50	155
<i>Sur</i>	Reigate, The Knowle...	2'85	98		Belvoir Castle.....	2'37	106
<i>Kent</i>	Tenterden, Ashenden...	3'79	125	<i>Rut</i>	Ridlington .....	2'80	...
"	Folkestone, Boro. San.	6'04	...	<i>Line</i>	Boston, Skirbeck .....	2'72	136
"	Margate, Cliftonville...	3'50	145	"	Lincoln, Sessions House	2'55	136
"	Sevenoaks, Speldhurst	3'19	...	"	Skegness, Marine Gdns	2'66	123
<i>Sus</i>	Patching Farm .....	4'10	115	"	Louth, Westgate .....	2'63	102
"	Brighton, Old Steyne	4'25	133	"	Brigg, Wrawby St. ...	2'78	...
"	Tottingworth Park ...	5'53	149	<i>Notts</i>	Worksop, Hodsock ...	2'61	133
<i>Hants</i>	Ventnor, Roy. Nat. Hos.	3'86	120	<i>Derby</i>	Derby .....	3'31	153
"	Fordingbridge, Oaklands	3'21	94	"	Buxton, Devon Hos. ...	3'29	177
"	Ovington Rectory .....	3'34	101	<i>Ches</i>	Runcorn, Weston Pt.	3'84	139
"	Sherborne St. John ...	2'85	100	"	Nantwich, Dorfold Hall	4'74	...
<i>Berks</i>	Wellington College ...	1'60	63	<i>Lancs</i>	Manchester, Whit. Pk.	4'48	170
"	Newbury, Greenham...	3'24	116	"	Stonyhurst College ...	7'07	157
<i>Herts</i>	Benington House .....	2'14	90	"	Southport, Hesketh Pk	5'72	182
<i>Bucks</i>	High Wycombe .....	3'47	139	"	Lancaster, Strathspey	6'89	...
<i>Oxf</i>	Oxford, Mag. College	2'61	118	<i>Yorks</i>	Wath-upon-Dearne ...	2'18	107
<i>Nor</i>	Pitsford, Sedgebrook...	3'23	147	"	Bradford, Lister Pk. ...	6'12	209
"	Oundle .....	1'83	...	"	Oughtershaw Hall.....	11'54	...
<i>Beds</i>	Woburn, Crawley Mill	2'35	105	"	Wetherby, Ribston H.	3'05	130
<i>Cam</i>	Cambridge, Bot. Gdns.	1'26	65	"	Hull, Pearson Park ...	2'44	111
<i>Essex</i>	Chelmsford, County Lab	2'13	95	"	Holme-on-Spalding ...	2'67	...
"	Lexden, Hill House ...	2'06	...	"	West Witton, Ivy Ho.	4'17	...
<i>Suff</i>	Hawkedon Rectory ...	1'99	88	"	Felixkirk, Mt. St. John	2'38	97
"	Haughley House .....	1'76	...	"	Pickering, Hungate ...	3'20	...
<i>Norfolk</i>	Beccles, Geldeston .....	...	...	"	Scarborough .....	2'35	95
"	Norwich .....	2'94	114	"	Middlesbrough .....	2'17	102
"	Blakeney .....	2'14	96	"	Baldersdale, Hury Res.	4'56	...
"	Little Dunham .....	2'74	106	<i>Durham</i>	Ushaw College .....	3'09	122
<i>Wilts</i>	Devizes, Highclere.....	2'98	112	<i>Nor</i>	Newcastle, Town Moor	2'50	103
"	Bishops Cannings .....	3'25	114	"	Bellingham, Highgreen	4'06	...
<i>Dor</i>	Evershot, Melbury Ho.	5'61	132	"	Lilburn Tower Gdns. ...	3'77	...
"	Creech Grange .....	3'99	...	<i>Cumb</i>	Geltsdale.....	5'43	...
"	Shaftesbury, Abbey Ho.	2'35	73	"	Carlisle, Scaleby Hall	4'34	145
<i>Devon</i>	Plymouth, The Hoe ...	3'70	101	"	Borrowdale, Rosthwaite	21'09	...
"	Polapit Tamar .....	5'35	126	"	Keswick, High Hill ...	11'03	...
"	Ashburton, Druid Ho.	9'11	161	<i>Glam</i>	Cardiff, Ely P. Stn. ...	4'98	120
"	Cullompton.....	4'38	127	"	Treherbert, Tynywaun	18'24	...
"	Sidmouth, Sidmount...	...	...	<i>Carm</i>	Carmarthen Friary ...	8'78	176
"	Filleigh, Castle Hill ...	5'87	...	"	Llanwrda .....	11'04	187
"	Barnstaple, N. Dev. Ath.	4'09	104	<i>Pemb</i>	Haverfordwest, School	7'27	145
<i>Corn</i>	Redruth, Trewirgie ...	4'71	97	<i>Card</i>	Aberystwyth .....	6'96	...
"	Penzance, Morrab Gdn.	3'98	87	"	Cardigan, County Sch.	6'12	...
"	St. Austell, Trevarna...	4'72	96	<i>Brec</i>	Crickhowell, Talymaes	7'50	...
<i>Soms</i>	Chepton Mendip .....	4'60	107	<i>Rad</i>	Birm W. W. Tynmynydd	11'71	176
"	Long Ashton .....	3'76	...	<i>Mont</i>	Lake Vyrnwy.....	13'83	249
"	Street, Hind Hayes ...	...	...	<i>Denb</i>	Llangynhafal.....	4'88	...
<i>Glos</i>	Cirencester, Gwynfa ...	4'03	135	<i>Mer</i>	Dolgelly, Bryntirion...	10'14	163
<i>Here</i>	Ross, Birchlea .....	2'81	111	<i>Carn</i>	Llandudno .....	3'55	115
"	Ledbury, Underdown	2'36	97	"	Snowdon, L. Llydaw 9	26'80	...
<i>Salop</i>	Church Stretton.....	4'85	165	<i>Ang</i>	Holyhead, Salt Island	6'04	146
"	Shifnal, Hatton Grange	3'79	159	"	Lligwy.....	5'94	...
<i>Worc</i>	Ombersley, Holt Lock	2'35	103	<i>Isle of Man</i>			
"	Blockley .....	3'11	...		Douglas, Boro' Cem. ...	7'94	168
<i>War</i>	Farnborough .....	4'30	157	<i>Guernsey</i>			
"	Birmingham, Edgbaston	3'69	156		St. Peter P't. Grange Rd.	4'57	109

**Rainfall: November, 1928: Scotland and Ireland**

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	6'52	164	<i>Suth.</i>	Loch More, Achfary	13'01	152
"	Pt. William, Monreith	7'13	...	<i>Caith.</i>	Wick	4'58	145
<i>Kirk.</i>	Carsphairn, Shiel	13'71	...	<i>Ork.</i>	Pomona, Deerness	4'28	109
"	Dumfries, Cargen	6'87	152	<i>Shet.</i>	Lerwick	5'33	125
<i>Dumf.</i>	Eskdalemuir Obs.	8'85	153	<i>Cork.</i>	Caheragh Rectory	8'24	...
<i>Rozb.</i>	Braxholm	4'59	139	"	Dunmanway Rectory	8'10	131
<i>Selk.</i>	Ettrick Manse	8'15	...	"	Ballinacurra	4'58	114
<i>Peab.</i>	West Linton	3'61	...	"	Glanmire, Lota Lo.	5'76	134
<i>Berk.</i>	Marchmont House	3'42	114	<i>Kerry.</i>	Valentia Obsy.	7'33	134
<i>Hadd.</i>	North Berwick Res.	2'48	111	"	Gearahameen	15'80	...
<i>Midl.</i>	Edinburgh, Roy. Obs.	2'98	139	"	Killarney Asylum	...	...
<i>Ayr.</i>	Kilmarnock, Agric. C.	5'48	146	"	Darrynane Abbey	6'05	119
"	Girvan, Pinmore	8'02	151	<i>Wat.</i>	Waterford, Brook Lo.	5'77	153
<i>Renf.</i>	Glasgow, Queen's Pk.	4'26	114	<i>Tip.</i>	Nenagh, Cas. Lough	6'26	156
"	Greenock, Prospect H.	9'87	154	"	Roscrea, Timoney Park	4'54	...
<i>Bute.</i>	Rothsay, Ardenraig	9'20	181	"	Cashel, Ballinamona	4'42	126
"	Dougarie Lodge	7'82	...	<i>Lim.</i>	Foynes, Coolnanes	5'96	147
<i>Arg.</i>	Ardgour House	15'03	...	"	Castleconnel Rec.	5'51	...
"	Manse of Glenorchy	11'24	...	<i>Clare.</i>	Inagh, Mount Callan	9'81	...
"	Oban	9'56	...	"	Broadford, Hurdlest'n.	6'87	...
"	Poltalloch	9'37	166	<i>Weaf.</i>	Newtownbarry	...	...
"	Inveraray Castle	15'10	179	"	Gorey, Courtown Ho.	6'76	194
"	Islay, Eallabus	9'30	173	<i>Kilk.</i>	Kilkenny Castle	4'11	133
"	Mull Benmore	19'10	...	<i>Wic.</i>	Rathnew, Clonmannon	5'70	...
"	Tiree	6'28	...	<i>Carl.</i>	Hacketstown Rectory	4'80	123
<i>Kinr.</i>	Loch Leven Sluice	3'85	107	<i>QCo.</i>	Blandsfort House	4'30	129
<i>Perth.</i>	Loch Dhu	11'75	135	"	Mountmellick	5'90	...
"	Balquhiddy, Stronvar	7'44	...	<i>KCo.</i>	Birr Castle	3'91	126
"	Crieff, Strathearn Hyd.	5'02	105	<i>Dubl.</i>	Dublin, FitzWm. Sq.	3'18	119
"	Blair Castle Gardens	5'03	143	"	Balbriggan, Ardgillan	4'13	144
"	Dalnaspidal Lodge	9'02	136	<i>Me'th.</i>	Beauparc, St. Cloud	3'81	...
<i>Forf.</i>	Kettins School	3'35	120	"	Kells, Headfort	5'49	161
"	Dundee, E. Necropolis	3'26	134	<i>W.M.</i>	Moate, Coolatore	3'92	...
"	Pearsie House	3'80	...	"	Mullingar, Belvedere	5'29	155
"	Montrose, Sunnyside	2'69	102	<i>Long.</i>	Castle Forbes Gdns	5'56	154
<i>Aber.</i>	Braemar, Bank	3'49	91	<i>Gal.</i>	Ballynahinch Castle	9'48	158
"	Logie Coldstone Sch.	2'56	83	"	Galway, Grammar Sch.	8'11	...
"	Aberdeen, King's Coll.	3'93	133	<i>Mayo.</i>	Mallaranny	3'33	...
"	Fyvie Castle	4'55	...	"	Westport House	6'23	127
<i>Mor.</i>	Gordon Castle	3'87	134	"	Delphi Lodge	13'01	...
"	Grantown-on-Spey	3'54	118	<i>Sligo.</i>	Markree Obsy.	5'64	135
<i>Na.</i>	Nairn, Delnies	3'37	143	<i>Cav'n.</i>	Belturbet, Cloverhill	4'57	147
<i>Inu.</i>	Kingussie, The Birches	4'59	...	<i>Ferm.</i>	Enniskillen, Portora	5'48	...
"	Loch Quoich, Loan	14'40	...	<i>Arm.</i>	Armagh Obsy.	4'26	150
"	Glenquoich	17'22	142	<i>Down.</i>	Fofanny Reservoir	9'98	...
"	Inverness, Culduthel R.	3'42	...	"	Seaford	6'42	169
"	Arisaig, Faire-na-Squir	6'25	...	"	Donaghadee, C. Stn	4'96	163
"	Fort William	11'34	...	"	Banbridge, Milltown	4'23	154
"	Skye, Dunvegan	9'97	...	<i>Antr.</i>	Belfast, Cavehill Rd	5'43	...
<i>R &amp; C.</i>	Alness, Ardross Cas.	5'35	133	"	Glenarm Castle	9'98	...
"	Ullapool	6'40	...	"	Ballymena, Harryville	5'68	140
"	Torridon, Bendamph	11'68	126	<i>Lon.</i>	Londonderry, Creggan	5'10	149
"	Achnashellach	10'69	...	<i>Tyr.</i>	Donaghmore	5'61	...
"	Stornoway	6'75	116	"	Omagh, Edenfel	5'38	142
<i>Suth.</i>	Lairg	4'70	...	<i>Don.</i>	Malin Head	4'89	149
"	Tongue	5'42	118	"	Dunfanaghy	5'53	...
"	Melvich	5'74	143	"	Killybegs, Rockmount	7'09	112

## Climatological Table for the British Empire, June, 1928.

STATIONS	PRESSURE		TEMPERATURE								Relative Humidity.	Mean Cloud Amt	PRECIPITATION			BRIGHT SUNSHINE	
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values				Mean	Am't in.			Diff. from Normal	Days	Hours per day	Per-centage of possible	
			Max.	Min.	Max.	Min.	1/2 max. and min.	Diff. from Normal									Wet Bulb
London, Kew Obsy.	1014.1	-2.6	75	42	65.8	57.5	49.3	51.6	77	6.2	2.24	+0.09	18	7.0	43		
Gibraltar	1016.0	-1.4	85	60	76.5	70.3	64.2	62.9	82	4.6	0.13	-0.35	1	..	..		
Malta	1017.0	+1.4	88	62	78.6	72.7	66.9	66.2	70	1.0	0.00	-0.09	0	12.5	87		
St. Helena	1015.1	+2.2	66	53	64.1	60.3	56.6	58.4	97	8.7	1.02	-3.05	9	..	..		
Sierra Leone	1012.5	+0.5	89	69	85.3	72.8	79.1	75.9	81	8.8	11.10	-8.94	22	..	..		
Lagos, Nigeria	1010.2	-2.7	87	70	84.0	74.4	79.2	76.0	85	7.2	21.05	+2.40	18	..	..		
Kaduna, Nigeria	1015.2	+1.4	91	..	86.2	..	..	71.5	80	1.3	5.38	-2.47	16	..	..		
Zomba, Nyasaland	1016.9	-0.6	81	49	73.6	64.5	55.5	..	71	5.4	0.22	-0.26	5	..	..		
Salisbury, Rhodesia	1016.5	-1.0	77	35	72.9	59.3	45.6	51.6	56	1.8	0.00	-0.05	0	9.5	86		
Cape Town	1020.1	0.0	72	34	61.6	54.7	47.7	48.9	88	5.8	4.36	-0.15	16	..	..		
Johannesburg	1022.6	-0.5	70	27	61.0	51.5	42.1	39.3	40	1.3	0.10	-0.04	1	9.6	91		
Mauritius	1018.8	-0.2	78	54	75.4	62.8	69.1	65.8	71	3.4	1.22	-1.58	12	7.9	72		
Bloemfontein	..	..	72	22	62.0	31.7	46.9	34.8	60	1.5	0.22	-0.25	1	..	..		
Calcutta, Alipore Obsy.	997.5	-2.2	101	76	90.0	84.5	78.9	79.5	89	8.7	17.99	+6.09	22*	..	..		
Bombay	1008.3	-0.7	95	73	89.4	84.1	78.7	78.3	81	7.1	27.71	+7.84	22*	..	..		
Madras	1002.2	-1.6	107	77	101.1	91.9	82.7	74.7	51	5.5	0.24	-1.65	10*	..	..		
Colombo, Ceylon	1008.3	-0.4	88	73	85.9	77.9	81.9	78.1	78	8.2	8.92	-0.95	20	..	..		
Hongkong	1004.4	-1.7	89	72	84.3	76.5	80.4	76.0	80	7.9	15.13	-0.96	22	5.9	44		
Sandakan	..	..	92	72	88.2	81.4	77.1	77.1	82	..	4.61	-2.59	12	..	..		
Sydney	1017.0	-0.8	72	41	62.2	55.5	48.7	49.7	75	4.9	7.40	-2.63	15	4.7	47		
Melbourne	1019.5	+1.0	66	32	56.3	43.0	49.7	46.5	86	7.4	1.44	-0.65	16	3.5	37		
Adelaide	1020.0	+1.0	67	39	60.5	46.2	53.3	49.0	81	6.7	3.52	-0.37	19	4.6	47		
Perth, W. Australia	1019.5	+1.6	75	45	66.3	50.7	58.5	52.9	70	5.4	5.50	-1.42	16	5.1	51		
Coolgardie	1021.3	+2.2	72	35	64.5	42.7	53.6	47.3	69	3.8	0.29	-0.94	5	..	..		
Brisbane	1017.0	-1.1	75	40	67.5	49.2	58.3	52.1	75	4.7	2.22	-0.41	10	6.8	65		
Hobart, Tasmania	1017.5	+3.2	59	34	52.9	41.1	47.0	42.4	81	6.1	1.84	-0.36	17	3.9	43		
Wellington, N.Z.	1013.1	-1.8	58	37	52.0	42.7	47.8	45.3	82	7.8	4.52	-0.25	17	2.7	29		
Suva, Fiji	1013.3	-0.3	86	63	79.9	69.1	74.5	70.2	78	6.1	2.17	-3.98	11	5.4	49		
Apia, Samoa	1011.6	0.0	87	68	84.5	77.5	74.2	71.7	74	5.6	1.29	-2.81	5	7.8	59		
Kingston, Jamaica	1013.2	-0.6	94	71	89.6	81.9	74.2	71.7	75	4.2	1.24	-3.92	4	7.1	63		
Grenada, W.I.	1009.8	-3.3	90	71	87.0	80.3	73.7	75.6	75	5.5	7.57	-0.75	21	..	..		
Toronto	1010.6	-3.7	81	39	70.5	61.5	52.5	55.0	71	5.9	3.97	+1.21	14	7.4	48		
Winnipeg	1010.6	-1.9	84	34	69.6	59.5	52.7	52.0	84	6.0	3.58	-0.32	13	7.8	48		
St. John, N.B.	1013.0	-1.0	75	44	64.1	55.5	47.0	52.7	76	6.0	4.80	+1.53	16	6.9	44		
Victoria, B.C.	1015.5	-1.4	77	48	63.0	56.7	50.3	53.1	77	5.1	0.51	-0.42	5	8.8	55		

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

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 SQUARE WEST, BELFAST; or through any Bookseller.

## A New Handbook of Climatology

By Sir GILBERT WALKER, C.S.I., F.R.S.

It is twenty years since the publication of the revised and enlarged third edition of Hann's *Handbook of Climatology*, which contained in its three volumes about 1,500 pages and was unrivalled in its wealth of reliable information as well as in its scientific discussion of essential principles. There is now therefore a need, both for theoretical and economic purposes, of a book in which the great mass of information that has accumulated in the meantime should be made available; and Messrs. Bornträger, of Berlin, have agreed to bring it out with Dr. Köppen, of Graz, and Dr. Geiger, of Munich, as general editors. Readers of Köppen's *Klimate der Erde*, with its original system of classification, will be confident that the work could not be in better hands, and will be filled with admiration at the vitality which enables such a task to be undertaken by one whose eightieth birthday was celebrated two years ago.

The scheme of the handbook is that it shall contain about twice as much as Hann's, and be provided with more tables, arranged on a uniform plan; in fact the tables are regarded as the most valuable element. The text consists of a general and a regional portion. The first volume, of 768 pages, deals with the factors which determine climate, and its distribution over the earth when classified according to Köppen's system; it also includes the chief effects on other features of nature and on mankind. Sections in this part have been allotted to Milanko-

vitch, Conrad, Köppen, Geiger, Wagner, Borchardt and K. Wegener.

The regional portion, in volumes 2 to 5, handles the climates of the different parts of the earth and the most important sources of information regarding them; agricultural and hygienic conditions are considered as well as those of pure meteorology. North America has been allotted to R. de C. Ward and C. F. Brooks; Central America to K. Sapper; South America to K. Knoch; Greenland to A. Wegener; north-west Europe to B. J. Birkeland and N. J. Föyn; central and south Europe to E. Alt; Russia and central Asia to L. Berg, A. Kaminskij and E. Rubinstein; Nearer Asia to L. Weickmann; British India to Sir Gilbert Walker; Japan, China and Micronesia to T. Okada; Further India and the East Indies to C. Braak; Australia and New Zealand to T. Griffith Taylor; Polynesia to K. Wegener; the Antarctic to W. Meinardus; west and central Africa to R. Geiger; east Africa to G. Castens; and the Oceans to E. Kuhlbrodt.

The regional portion is to contain about 2,400 pages, of which about 1,000 are devoted to tables on a uniform plan; of charts there are to be about 320 in black and white and 16 in colours.

The amount of labour involved in collecting the regional data is so great as to lie beyond the powers of some of the individuals responsible; and a satisfactory result would be impossible without co-operation of the heads of a number of meteorological services. This has been generously promised by Canada, the United States, India, Mexico, and presumably other countries.

It will be seen that the handbook is neither a text-book nor a collection of everything that has been published on climate; but aims at a critical selection of essential features, arranged on a uniform plan for reference by all with a slight meteorological equipment.

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## The Life and Work of Sir Norman Lockyer\*

Through the happy inspiration of Sir Richard Gregory, this book, which deals with the life and work of Sir Norman Lockyer, is cast in a rather novel form. The first half consists of a biographical sketch of Lockyer's life, while the second half consists of a series of chapters by different writers, who discuss different aspects of Lockyer's work, and show the relation of his ideas to those which are current to-day.

The biographical sketch was prepared by Lady Lockyer and Miss Lockyer with the assistance of Professor Dingle, and the

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\*By T. Mary Lockyer and Winifred L. Lockyer with the assistance of Prof. H. Dingle. Size  $8\frac{1}{2} \times 5\frac{1}{2}$  in. pp xii + 474. *Illustrations*, London, Macmillan and Co. 1928. 18s. net.



personal details of Lockyer's life are described in a clear and simple style. Lockyer was born in 1836, and after an education whose bias appears to have been literary rather than scientific, was nominated to an established clerkship at the War Office in February, 1858. In was in the scanty leisure afforded by his official duties that he became an enthusiastic astronomical observer. It was probably through his drawings of the planet Mars that his name first came to be widely known, but in the next few years he produced many astronomical papers. Lockyer for many years followed a plan that when he sent a paper to the Royal Astronomical Society for publication, he also prepared an account of his discoveries in popular language, for publication in the *Spectator*. Would that some of our meteorological colleagues would follow the same plan!

A weekly review called the *Reader* started in January, 1863, by J. M. Ludlow and Tom Hughes, who were Lockyer's colleagues at the War Office and his neighbours at Wimbledon, gave Lockyer scope for his marked gift of clear exposition of the scientific discoveries of the day. He became its scientific editor, and his contributions aroused considerable interest. The review was, however, a financial failure, and the last number appeared in June, 1865. During this time Lockyer was devoting his nights to astronomical observation, and his days to work at the War Office. In December, 1865, he was made editor of the new Army Regulations. We also find him devising a new form of pay sheet suitable for use by all units.

Fame came to Lockyer from the results of his application of the spectroscope in astronomy. He believed that it should be possible to see the spectrum of the prominences in daylight. His first attempt was unsuccessful, owing to the small dispersion of his spectroscope, but when after long delay a suitable spectroscope was available in October, 1868, he was immediately successful. In the meantime, however, a French physicist, Janssen, had hit on the same idea, and had actually succeeded several months before Lockyer. One result was the striking of a gold medal by the French Government to commemorate the discovery; another was a life-long friendship between Lockyer and Janssen.

Lockyer's activities covered a very wide field, but not the least of his achievements was the establishment of the weekly journal, *Nature*, in 1869, while he was still a clerk at the War Office. Nor must the part played by Messrs. Macmillan in this matter be overlooked. Every year from its inception until 1899, the annual balance sheet for *Nature* came out on the wrong side, and it was only through the mutual trust between editor and publisher that the journal continued to exist. Before Lockyer resigned the editorship to its present holder, Sir Richard Gregory, in 1919, *Nature* had been set on a firm basis. The

value of this journal to the scientific worker of to-day needs no elaboration, but a letter from Benjamin Gould, who had just established an observatory in the lonely region of Cordoba, in the Argentine, shows how inspiring the weekly arrival of *Nature* was to an isolated worker.

From 1870 to 1878 Lockyer was occupied by his duties as Secretary of the Royal Commission under the Chairmanship of the Duke of Devonshire, to inquire into scientific instruction and research; and with the exhibition of scientific instruments held in 1876. In 1879 the Solar Physics Observatory was established at South Kensington with Lockyer in charge. He was Professor of Astronomy in the Royal College of Science until 1902, and remained Director of the Solar Physics Observatory until it was removed from South Kensington to Cambridge.

Lockyer's contributions to astrophysics cannot be briefly summarised with any justice to their magnitude. He was a leader at the time when this science was little more than a new-born babe, and his observations of spectra of the different parts of the sun, of the stars, and of elements in the laboratory, were solid additions to knowledge. His name is perhaps most frequently associated with the meteoritic hypothesis of the origin of stars and stellar systems, and with the idea of the dissociation of the chemical elements at such high temperatures as are to be found in the stars. But his work was many-sided, and he found time in the midst of his preoccupation with spectroscopy to investigate the orientation of Egyptian temples, British stone circles and other ancient monuments. And from time to time we find him putting up a vigorous fight to save the site at South Kensington from the danger of underground railways and the intrusion of buildings of a non-scientific character. Lockyer's motto in life might well have been "Whatsoever thy hand findeth to do, do it with thy might."

His work was characterised by boldness of conception and fertility of imagination rather than by minute accuracy of detail, and some of his observational evidence, particularly that relating to the supposed existence of spectral lines common to different elements, was very decidedly shaky, and was so regarded by his contemporaries.

Not the least of Lockyer's gifts was his gift for friendship. He counted among his intimate friends such men as T. H. Huxley, Janssen, Tennyson, Sir Michael Foster, Dr. Isaac Roberts, to name but a few. The assistance of his many friends counted for much in keeping *Nature* in existence in its early days. Nor must the devotion of his assistants be forgotten. Among his assistants at South Kensington were A. Fowler, now Yarrow Professor of the Royal Society, Sir Richard Gregory, the present editor of *Nature*, and Professor Raphael Meldola, men whose names are familiar to all scientific workers.

Lockyer approached meteorology from a standpoint which was novel at that time. He had great faith in the possibilities of meteorology, and believed that solar physics and meteorology should go hand in hand. He used the method of "curve parallels" to investigate world weather, and derived results which are now more frequently expressed in terms of coefficients of correlation or of periodogram analyses. He found that heat pulses in the sun had their counterpart in pulses in monsoon rainfall, in the rainfall of the Nile and Mississippi valleys, and in the pressure over India and elsewhere. He found a barometric surge or "see-saw" of pressure between a region covering a large part of Asia, Australia and eastern Africa, and a region covering most of the American continent. This result was confirmed by Bigelow, and has been stated since in terms of coefficients of correlation by Sir Gilbert Walker. In the opinion of the reviewer, the value of Lockyer's contribution to meteorology is not sufficiently recognised to-day.

Lady Lockyer and Miss Lockyer and their collaborators are to be congratulated on the production of a volume which is full of interest and inspiration. It describes not only a man, but an epoch in the history of astrophysics. The evolution of the War Office clerk into the scientist of world-wide fame is worthy of close study by all who have any interest in things scientific. Moreover, the chapters in the latter half of the book, dealing with the relation of Lockyer's ideas to the astrophysics of to-day form an admirable introduction to some of the latest ideas in that science. Of the production of the book, by Messrs. Macmillan, with whom Lockyer was so long associated as editor of *Nature*, we need say no more than that it reaches the highest standard.

D. BRUNT.

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## OFFICIAL NOTICE.

### Certification of Balloon Meteorographs

For many years past, the balloon meteorograph designed by the late Mr. W. H. Dines has been the standard instrument for use in the exploration of the upper air from British stations. From time to time instrument makers have been approached from outside sources to supply the meteorographs, and the need has been felt for some means of ensuring that instruments supplied in this way are satisfactory. To meet this need, it has been decided to place at the disposal of manufacturers the testing facilities which exist at Kew Observatory. For a fee of 7s. 6d., meteorographs will be tested and certified if in accordance with the official specification. Further particulars of this service may be obtained on application to the Director, Meteorological Office, South Kensington, London, S.W.7.

## Discussions at the Meteorological Office

The subjects for discussion for the next two meetings will be:—  
January 28th.—*Results of visibility measurements in Karlsruhe and comparative investigations.* By A. Peppler (Karlsruhe, Abh. Badischen Landeswetterwarte, No. 6, 1927) (in German). *Opener.*—Mr. C. D. Stewart, B.Sc.

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.

NOTE—The dates of the Discussions of this session are one week earlier than those originally stated in the *Meteorological Magazine*, September, 1928, p. 184.

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## Royal Meteorological Society

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

*L. H. G. Dines, M.A.—The Dines Float Barograph.*

This instrument was designed by the late Mr. W. H. Dines about 20 years ago, and has been in use at the Observatories of the Meteorological Office for a number of years. It is a pen-recording barograph, of which the leading feature is the care taken to reduce friction in the mechanism. The record will indicate barometric oscillations of amplitudes down to one or two tenths of a millibar. The instrument is described in detail, and calculations are appended showing how to compute the scale value and how to adjust the device provided to render the readings independent of temperature.

Opening the discussion, the President pointed out that the float barograph was an ingenious scientific adaptation of the old wheel or clock barometer. Dr. Whipple pointed out that it was actually superior in several respects to the photo-barograph, and urged that its manufacture should be taken up on a commercial scale.

*Dr. J. Glasspoole, M.Sc., Ph.D.—The distribution of the average seasonal rainfall over Europe.*

The proportion of the average annual rain falling in the seasons in different parts of Europe can be considered as of three main types. In western Europe there is abundant rain at all seasons with a minimum in summer and a maximum in winter. In the Mediterranean region there is very little rainfall at all during the summer, while there is generally a preponderance at this season in central Europe. In the three months June to August only one-fiftieth of the average annual rain falls in the south of Spain, while more than half the annual amount falls in the same period in north-eastern Russia. The paper

includes maps showing the proportion of the average annual rain falling in each season. These maps emphasise that the distribution of the rainfall amongst the seasons depends very largely on the physical features, especially on the distance from the sea and the arrangement of mountain and plain.

The discussion emphasised the practical value of the paper. It was also remarked that while there were ready explanations for the distribution of winter and summer rains, it was very difficult to account for the excess of rainfall in autumn in western Europe.

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The Buchan Prize of the Royal Meteorological Society for 1929 has been awarded to Dr. Harold Jeffreys, D.Sc., F.R.S., for the following papers contributed to the *Quarterly Journal* of the Society during the years 1924-1927:—"The cause of cyclones"; "On fluid motions produced by differences of temperature and humidity"; "On the dynamics of geostrophic winds"; and "Cyclones and the general circulation."

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## Correspondence

To the Editor, *The Meteorological Magazine*

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### Grass Minimum Temperatures

The standard specification for the exposure of a grass minimum thermometer is "one or two inches above the ground which should be covered with short grass." Some recent observations at South Farnborough showed very considerable differences between two thermometers both exposed in the standard way on sites in close proximity. The results were stimulatingly surprising and in a discussion about them with Mr. J. S. Dines, the question of the character of the grass covering was raised. As he was shortly afterwards visiting Farnborough, he made a point of examining the grass and found the one site covered with a carpet of short grass and moss while on the other site the bare earth could be seen between the blades of grass. The grass minimum temperatures on this second site were usually lower than on the first site, the average difference for 50 nights between August 9th and October 8th, 1928, was 5°F., the largest difference being 12°F. I am led to suggest the following explanation of the differences.

It seems likely that on the second site the bare earth radiates "to the sky" and becomes colder than the air above it: the layers (of air) of minute thickness just above the surface become then each colder than the next layer above it so that there is a progressive increase of temperature from the surface upwards: a very stable condition, made more stable by the blades of grass stopping any horizontal movement of the enmeshed air.

On the first site, on the other hand, the effective radiating surface will be the top of the carpet of short grass and moss. This will become colder than the layer of air entangled in the grass and moss beneath it and colder also than the surface of the ground underneath. This condition will be unstable; and there will be a continued minute turbulence which will distribute the "cold" through a rather more extensive layer of air. Moreover, the process of cooling the grass, air and earth beneath the radiating upper surface of the carpet will be much slower than if radiation were directly effective.

This result naturally suggests that the standard specification is not sufficiently precise to secure comparable records. Possibly the thermometer should be placed on a standard square board either bare or covered with artificial "blades" of grass of uniform length and evenly distributed. It would be necessary to place the board in such surroundings that the temperatures in proximity to it would not be lower than those over the board itself, and to fix it so that its surface was level with the surface of the earth (not of the grass) to prevent the cold air running off the board and producing a more or less horizontal exchange of heat. Conduction of heat upwards from the earth beneath the surface must play a part, but normally this will be of a lower order of magnitude than the quantity involved in radiation (or even evaporation).

January 5th, 1929.

E. GOLD.

### **Aurora off the Coast of Ireland**

A note regarding a display of aurora which I observed off the coast of Ireland, in the St. George's Channel on October 18th, 1928, may be of interest.

The night was fine and clear, sky practically cloudless. There had been a faint glow in the northern sky all the evening and at 23h. 10m. G.M.T. several patches of brighter light appeared low down on the horizon. Five minutes later these resolved into a number of distinct beams of light about 10 degrees in length and extending nearly vertically from north to north-north-west. These lasted with some brilliance until 23h. 30m. G.M.T. and the glow faded shortly after.

The beams appeared to vary in intensity during their most brilliant phase and were a very pale green in colour.

R. H. STENHOUSE.

R.M.S.P. "*Sabor*," Rio de Janeiro, Brazil. December 8th, 1928.

### **Unusual Thunderstorm Phenomena**

In one or two recent numbers of your magazine, I have noticed references to a "click" accompanying a stroke of lightning. During a thunderstorm which occurred here this afternoon I heard this noise accompanying an unusually close stroke followed

within a second by the thunder. Subsequent queries elicited the information that the click was heard by the observer of this station and also by one of the clerks. The fact that this office is liberally supplied with overhead wires for the electric light and telephone services is rather in favour of Mr. McAdie's suggestion as published in your number for August, 1928.

NOEL P. SELICK.

*Dept. of Agriculture, Salisbury, Southern Rhodesia. November 23rd, 1928.*

### **The Appearance of the Sun and Moon through a Cloud**

For some time past I have thought 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. Alto-stratus clouds consist usually, though not always, of ice-crystals, and the blurred appearance of the sun is well known, the example in the *Observer's Handbook* being typical. The photograph of fracto-stratus on Plate XVII of that publication (also reproduced in Plate II of *Cloud Forms*) shows the sun's disc just visible, with sharp edges, and I think this holds for all water-drop clouds, if the exact position of the sun or moon can be made out at all. The fact that some alto-stratus consist of water-drops, often with a corona, seemed to present a difficulty, but this has now been removed by the publication of a photograph by Prof. A. McAdie\* showing a very good corona in alto-stratus clouds, with the edges of the sun's disc perfectly sharp. There remains the possibility of the disc being blurred by high clouds, and a feeble corona being produced by a lower layer, or by the lower part of a diffuse mass of alto-stratus, but this does not affect the point at issue. It would be interesting to have the opinions of observers on this question.

The blurred appearance is sometimes described as "watery," but if it can only be produced by ice-crystals the term is misleading.

C. K. M. DOUGLAS.

*December 13th, 1928.*

## **NOTES AND QUERIES**

### **Lapse Rates in Polar and Equatorial Air**

The statement is sometimes made that the lapse rate of temperature is greater in a current of polar air than in an equatorial one. The writer has lately made inquiry into this question, the results of which may be worth putting on record.

The material employed was the whole of the British sounding balloon data from 1911 onwards. The method of the investigation was to find occasions on which the whole atmosphere was moving either from a southerly or a northerly direction at a

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\* *Observations and Investigations made at the Blue Hill Observatory, 1927.*

considerable speed, while at the same time the temperature at a height of one kilometre was in the cases of the southerly winds above the normal for the time of year, and in those of the northerly ones below the normal. Under these circumstances it was assumed that the northerly current had a polar origin and the southerly one an equatorial.

The actual criteria employed for the purpose were first that in every case the balloon fell at least 100 kilometres from the starting point, second that the direction of the falling point lay for the southerly winds between  $20^\circ$  west of north and  $45^\circ$  east of north and for the northerly winds between  $45^\circ$  west of south and  $45^\circ$  east of south. Third, that the direction of the geostrophic wind at the time of the start did not differ from that of the run of the balloon by more than  $32^\circ$ . These criteria proved to be so exacting that only eight cases of equatorial air and ten of polar were found on occasions when balloon soundings were made during the period of 17 years covered.

The mean results are given in the table below.

	Excess of the temperature at 1 km. over the mean for the time of year.	Pressure at Mean Sea Level.	Lapse Rates in degrees abs. per km. between heights given in kilometres:						
			0-1	1-2	2-3	3-4	4-5	5-6	6-7
Equatorial air	+3.6 a.	1009.5 mb.	4.3	4.7	6.4	6.3	6.7	7.4	7.2
Polar air	-5.3 a.	1016.8 mb.	7.9	4.3	5.9	5.9	6.3	6.8	6.5

In each case the mean of the geostrophic wind was 10 m/s. Near the surface the polar air has appreciably the greater lapse rate, while from above 1 km. it seems to have a rather smaller one. It will be seen, however, that the mean pressure was smaller in the case of the equatorial air, and low pressure is on the average found to be associated with a larger lapse rate, hence it is not certain that the higher lapse rate above 1 km. can fairly be attributed to properties of the equatorial air, and it would seem that the only significant difference between the two rows of the table is the higher lapse rate below 1 km. in the polar air.

The number of observations is too small to base any final conclusion on the result, but is enough to illustrate any pronounced tendency. It seems to show that it is difficult to establish statistically any pronounced systematic difference between the thermal structures of polar and equatorial air currents.

L. H. G. DINES.



### **The Liverpool Observatory and Tidal Institute**

*The Times* of December 12th contains a message from Liverpool to the effect that the Bidston Observatory, which was maintained by the Mersey Docks and Harbour Board, and the Tidal Institute, which was established by the University, are to be combined into a single institute under the above title, to be governed by a joint committee of the Dock Board and the University.

The Observatory was founded in 1845 on the Waterloo Dock Pierhead, its objects being the communication of time to the port, the testing and rating of chronometers, astronomical observations and meteorological observations. In 1867 the reconstruction of the Waterloo Dock necessitated the removal of the Observatory, and in 1869 it was moved to a new site on Bidston Hill, which has been occupied ever since. The objects for which the Observatory was established have been faithfully carried out for many years, but the development of wireless telegraphy, which enabled a time signal to be broadcast from Greenwich over the whole country, has recently decreased the practical importance of the local time-service, and consequently of the astronomical observations. The testing and rating of chronometers has been maintained, and the meteorological observations have, if anything, increased in importance. The Tidal Institute was established in 1919, and quickly achieved recognition as the centre of tidal information for the British Empire.

The Director of the new combined Institute will be Professor J. Proudman, F.R.S., of the University, while Dr. A. T. Doodson will become Assistant Director, and will reside at the Observatory.

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### **New Site for Instruments at Aberdeen**

In consequence of extensions to the buildings of King's College, Aberdeen, the site of the Stevenson screen and rain gauge, from which observations have been obtained for many years for publication in the *Daily, Weekly and Monthly Weather Reports* of the Meteorological Office, was moved to a new site about 170 yards away to the northeast, on June 1st, 1928. A Dines pressure tube anemometer has occupied another site in an open field 500 yards away to the east of King's College since September, 1922. The new site is not suitable for the anemometer nor the anemometer site for the thermometers and rain gauge: it is hoped that one site may eventually be found for all the ordinary meteorological instruments.

The hourly readings of temperature for Aberdeen, which are published in the *Observatories Year Book* of the Meteorological Office, will, however, continue to be taken from the north wall screen, which is too high up to be appreciably affected by the new buildings.

### **New Meteorological Service in Chile**

A Naval Meteorological Service has been established in Chile under the Ministry of Marine, to work in collaboration with the Central Meteorological Institute of the Ministry of Education. The new service is charged with forecasting for the Navy and Merchant Service and the coastal regions, the study and investigation of scientific methods, contributions to the international study of meteorological phenomena and the preparation of wind charts for maritime and aerial navigation.

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### **Brazilian Daily Weather Reports**

In pursuance of his policy for developing the Brazilian Meteorological Service, Senor Sampaio Ferraz has now initiated the publication of a *Daily Weather Report*. The first number was issued on September 1st, 1928, and contains a synoptic weather chart for 9h. (Noon G.M.T.) of the day of issue, a short summary of the weather of the past 24 hours, and a forecast of the weather for the next day. Data for 74 stations are also included, together with hydrological and upper-air information. The issue of these Daily Weather Reports is especially welcome, as previously the Argentine was the only country in South America to issue reports daily.

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### **The Meteorological Conditions for Deserts**

The *Geographical Journal* for July, 1928, contains an interesting review of a book by Hans Mortensen, "Der Formenschatz der Nordchilenischen Wüste," published in 1927. The old idea of a desert as a waste of shifting sand applies only to the margins of the Chilean desert; its heart is dead and motionless as the moon, covered by a skin of compacted dust or a layer of stones, but no sand. The wind, having no tools, cannot abrade, and the land forms are those of running water resulting from the torrential rains which occur at intervals of ten years or more.

The climatic causes of desert formation are fully discussed, and the author successively eliminates temperatures, wind velocity and cloudiness as unable to account for the most extreme conditions; amount of rainfall is also ruled out, but its rarity may be an important contributory cause. The most important factor is shown to be the deficiency of rainfall below evaporation, the difference amounting to 160in. a year in the heart of the desert. The characteristic dust skin is formed by excessive evaporation of the soil moisture, derived from occasional rain or from hygroscopic absorption by the saline ground.

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### **1928, Another Wet Year**

Although 1928 was the sixth successive year in which the rainfall over the British Isles as a whole was in excess of the average, the

year is more likely to be remembered, in southeastern England at any rate, for its sunshine and a summer favourable to holiday makers. It will be recalled that since about 1907 wet years have predominated. Initially the excesses were contributed more especially by wet winters, but of more recent years the summers have been particularly wet. In each of the six summers since 1921 the rainfall has exceeded the average over the country generally, so that the summer of 1928 stands out in comparison as unusually dry although the deficiency was only 4 per cent. Out of the previous 12 summers only 1919 and 1921, with deficiencies of 17 and 27 per cent., received less than the average.

April, May, July and September were all dry over the British Isles, but only September was markedly so. The general fall over England and Wales for September was rather less than half the average, and it was the driest September for 18 years, *i.e.*, since 1910, when the general fall was only one quarter of the usual amount. Although several towns experienced a restricted water-supply during the late summer this was probably due to the increasing demands having been met in previous summers by the abnormally heavy rains, and should not be taken as an indication of an abnormal drought. Apart from December, when there was a small deficiency, the rainfall of the other months was in excess of the average. January was the wettest month of the year, with more than twice the usual amount. Over the country generally it was the wettest January since comparable statistics became available in 1870. So far as can be ascertained the total of 7·7in. recorded at Manchester, was the largest there for over 135 years. It is noticeable that even in this wet month the characteristic feature of the year, an excess of sunshine, was apparent in many districts. October, with 150 per cent., was the wettest October since 1916, when the general fall was 162 per cent. During November more than 34in. of rain fell at the head of Borrowdale in the English Lake District.

Among the more striking incidents in the rainfall of the year was the severe storm at Gunn to the east of Barnstaple on August 28th, when for 10 minutes frozen ice of various shapes fell with great violence, destroying vegetation and cutting off the stalks of corn. Two hours after the storm a large number of pieces were found as large as a sixpence and half an inch thick. There was also a violent thunderstorm at Armagh on August 29th when 1·69in. was recorded in 50 minutes, of which 1in. fell in 20 minutes. The hailstones were as big as nuts or marbles and choked up the gutters and drains so that much flooding occurred. So intense a fall is a rare occurrence especially in Ireland. The year 1928 will also be remembered for one of the worst Thames floods in history, caused by a gale in the North Sea which coincided with a high spring tide on January 7th. London also suffered from a "tornado" which caused much damage during

the evening of October 22nd, although it is reported as having lasted no longer than 30 seconds.

The most remarkable feature of the rainfall of 1928 was the large area with an excess in Ireland and in the western half of the British Isles, especially in the English Lake District and in the Southern Uplands of Scotland where the excess amounted to 50 per cent. Locally in both districts 1928 was the wettest year in the 60 years of comparable data. The rainfall appears to have exceeded 90 per cent. of the average everywhere and only about one-twentieth of the total area recorded less than the average. Deficiencies were confined almost entirely to stations in the east of England, occurring over an area in the neighbourhood of the Wash, including most of Suffolk and Norfolk and stretching from the coast as far west as Bedford and Lincoln and along a narrow coastal strip as far north as Berwick-on-Tweed. Less than the average was recorded in the neighbourhood of Keith in Banffshire and at Llandudno.

Over England and Wales more than 130 per cent. was recorded between Ventnor and Brighton, round Bala and Lake Vyrnwy and over a large area in the northwest. In Scotland more than 130 per cent. occurred over most of the southwest and more than 140 per cent. was recorded over two large areas, the western half of the Southern Uplands and from the Isle of Mull to the Grampians. The fall exceeded 150 per cent. only in the former region and reached 160 per cent. locally near Langholm. In Ireland falls of 120 per cent. were widespread and more than 130 per cent. was recorded in the neighbourhood of Cork, in Kerry and Connemara, to the north of the Mourne Mountains and between the mountains of Donegal and Londonderry. The rainfall in Ireland was remarkable in that it exceeded the average everywhere and we have to go back to 1903 to find a similar year of so widespread an excess.

From information at present available the following general values for 1926 have been computed:—

England and Wales	39.8	} in.	113	} per cent of average 1881-1915
Scotland	62.4		124	
Ireland	54.1		125	
British Isles	48.9		118	

The annual general values for England and Wales were considerably exceeded in 1924 and 1927. Over Scotland and Ireland the rainfall was much more remarkable. During the last 60 years the rainfall of 1928 over Ireland has only been exceeded once, in 1872 with 128 per cent., while in Scotland only the three years 1872, 1877 and 1903 were wetter with 134, 131 and 129 per cent. Over the country as a whole 1928 was as wet as 1927. Since comparable statistics became available in 1868 there have been only four wetter years, 1872, 1877, 1882 and 1903, when the general percentage values were 137, 127, 120 and 127 respectively.

J. GLASSPOOLE.

### Parallel Weather Sequences

In a discussion of any season of abnormal weather, it is natural to make a comparison with a previous season of similar abnormality. An interesting example of such a comparison is illustrated in the *Meteorological Magazine* for April, 1926, where the changes of pressure during January, February, March and April, 1912, are compared month by month with those of December, 1925, and of January, February and March, 1926. The way in which the two sequences run parallel for four full months is very striking, and it seemed worth while to make a systematic search through the monthly charts of deviation of pressure from normal illustrated in *Geophysical Memoirs*, No. 31,\* to see whether such sequences are so frequent that they must be due to similar causes leading to similar results, or whether they are so rare that their occurrence may be attributed to coincidence.

It was first of all necessary to group the maps roughly into classes according to the distribution of pressure deviation from normal. This had been done in the memoir, but it was found that the types and sub-types used there were too numerous and too detailed for this purpose. The maps were therefore grouped into four classes according to their intrinsic similarity with reference chiefly to the British Isles, all individual distributions in a group giving approximately a similar type of weather. The four classes are briefly as follows:—

(1) Pressure above normal near or over the British Isles with pressure below normal directly to the south-east.

(2) Pressure above normal near or over the British Isles with pressure below normal directly to the north-west.

(3) Pressure below normal near or over the British Isles with pressure above normal directly to the south-east.

(4) Pressure below normal near or over the British Isles with pressure above normal directly to the north-west.

Class (1) gives mainly fine weather over the British Isles with a weakening of the normal south-westerly winds; class (2) on the other hand gives mainly fine weather with a strengthening of the south-westerly winds. Classes (3) and (4) give generally rainy weather, in class (3) of the orographic type and in class (4) of the cyclonic type.

The classification of the maps was completed up to May, 1928, with the exception of January to September, 1922, for which

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\*London, Air Ministry, Meteorological Office. *Geophysical Memoirs*, No. 31. Classification of Monthly Charts of Pressure Anomaly over the Northern Hemisphere, by C. E. P. Brooks and W. A. Quennell.

months the data were not readily available. This gave a series of 548 maps to be examined, between January, 1873, and May, 1928, broken between 1900 and 1910 and in 1922. The investigation was directed towards discovering any runs of four months in different years in which the same sequence of classes occurred in corresponding months of the year or in the series one month before or one month after. For example, the months October, November, December and the following January were compared with the same months of all the other years, and also with September to December and with November to February of all the other years. Thus the months of October, 1878, to January, 1879, gave the sequence (4, 1, 1, 1), and the same sequence of classes was found in the months of November, 1916, to February, 1917 (Fig. 1). In this way about 22,000 comparisons were made, resulting in the finding of 221 pairs of similar sequences. It then remained to be discovered how this number compares with the number of pairs which would be expected on the supposition that there is no real connexion between the weather of one month and the next.

The four types are not of equally frequent occurrence, being distributed as follows:—(1) 28 per cent; (2) 22 per cent.; (3) 36 per cent; (4) 14 per cent.

Four types give  $(4)^4$ , i.e., 256 possible sequences of four months, and the probability of occurrence of each of these 256 sequences with a random distribution was calculated on the assumption that the above distribution of frequencies held for each season as well as for the whole year. This is not strictly accurate, but the arithmetic involved in the full computation would have been prohibitive. Actually the distribution during January and July was as follows:—

January ... (1) 33%, (2) 19%, (3) 37%, (4) 11%.

July ... (1) 36%, (2) 20%, (3) 33%, (4) 11%.

The probability that any two series of four months selected at random would have the same sequence is the sum of the squares of the probabilities of occurrence of the 256 possibles. For example, the probability of occurrence of the sequence (3, 3, 1, 1) is  $0.36^2 \times 0.28^2 = 0.0102$ , and the probability of two series selected at random both giving this sequence is  $(0.0102)^2 = 0.000103$ , or approximately 2 in the 22,000 distributions. A similar computation was carried out for each of the 256 possible sequences and the result showed that with a random distribution, 22,000 comparisons should give 132 similar pairs. The number actually found, 221, is appreciably higher and suggests that there is a real tendency for similar sequences to occur at about the same time in different years; and consequently that there is some physical connexion between the weather of successive months.

By far the most frequent parallels were given by runs of four

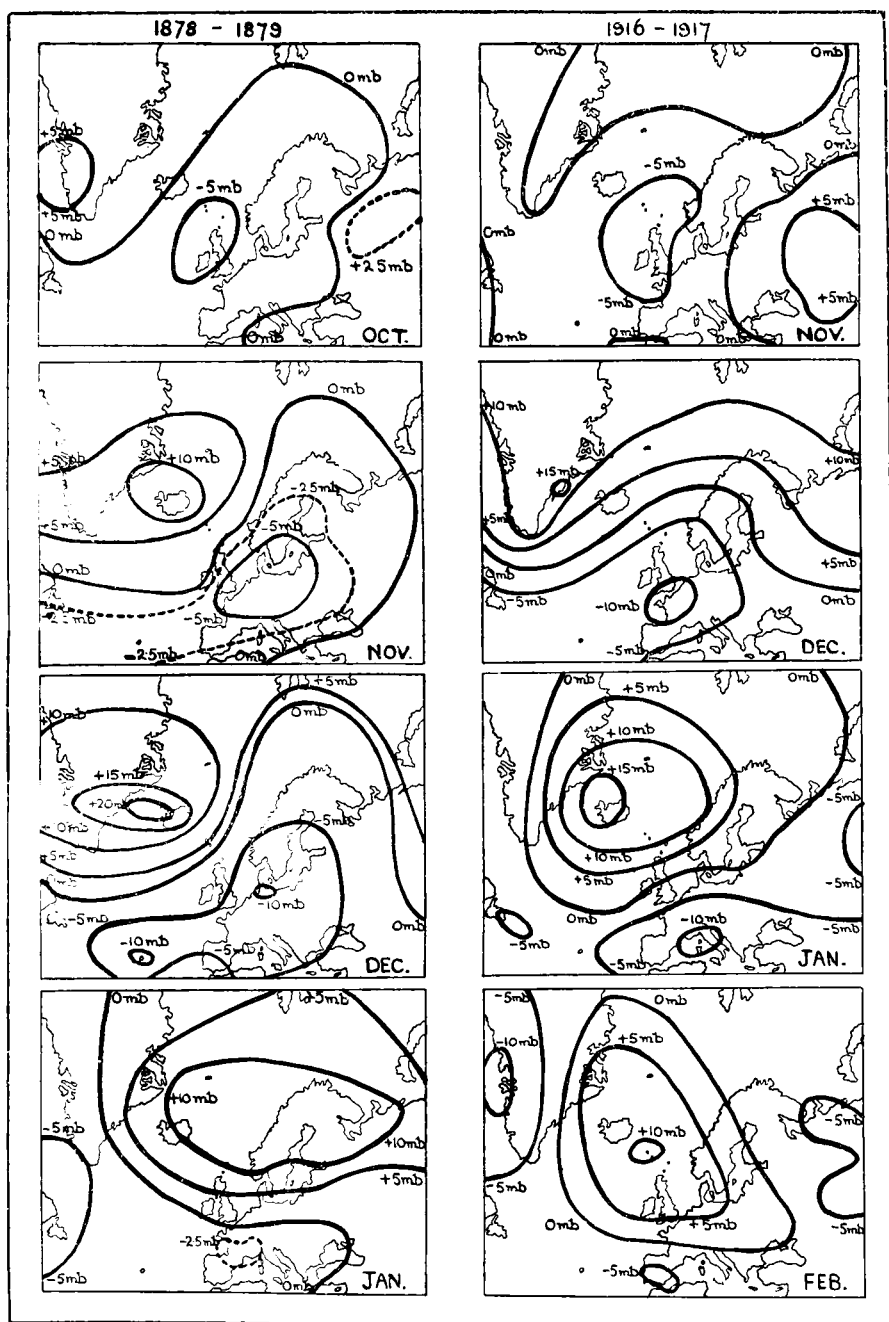


FIG. 1. PRESSURE ANOMALIES.

examples of type 3, there being 32 such pairs during the period, all starting in late spring or in summer. As the expectation for the whole year is only 7, it appears that once type 3 is established it tends to persist during the summer months.

TABLE I. WEATHER DURING THREE PARALLEL SEQUENCES.

	1st Month.	2nd Month.	3rd Month	4th Month
1878 October to 1879 January.	Cyclonic type, wet and at times cold.	Wet at first, then cold and foggy.	Cold and wintry, dry on the whole.	Sharp frosts, dry on the whole, but with some snow.
1916 November to 1917 February.	Often wet and stormy; some- times cold, but mostly mild.	Remarkably quiet; cold, variable pre- cipitation.	Cold, wintry, much snow in many places.	Unusually severe frost, very dry.
1887 December to 1888 March.	Changeable and unsettled.	Quiet, foggy and damp, but not rainy.	Dry and cold.	Changeable, squally and wet, tempera- ture low.
1924 January to April.	Warm and unsettled, mainly rather wet.	Dull and very dry, cool in England.	Cold and very dry, sunny in England.	Mainly cool and dull.
1898 July to October.	Mostly fair and dry, thunder- storms at the end of the month.	Mostly fair, warm and dry.	Changeable in W and N, elsewhere fair and very dry especially in eastern half.	At first most- ly fair and dry, then gales and heavy rain.
1926 July to October.	Fair and warm, with occasional breaks and widespread thunder- storms.	Warm and mainly fine, rainfall irreg- ular but below normal generally.	Warm, very dry in south- ern England and Ireland.	Unsettled, first few days unusually warm, last fortnight very cold.

Although these pairs of sequences show sufficient similiarity when a broad view is taken of the pressure distribution over western Europe, the classes are wide enough to permit of considerable variation in individual cases. The corresponding sequences were therefore more closely scrutinised by going back



to the original maps, and the final result gave 108 pairs of sequences which could be regarded as showing good agreement and as giving substantially the same weather over the British Isles in corresponding months. The best examples are as follows:—

(d) 1878, October, to 1879, January, and 1916, November, to 1917, February.

(b) 1887, December, to 1888, March, and 1924, January to April.

(c) 1898, July to October, and 1926, July to October.

The charts showing the isanomalies of the first example are given in Fig. 1. The weather during the corresponding months was on the whole, very similar, and the remarks in Table I are taken from the *Monthly Weather Report* of the Meteorological Office, with the exception of 1878 and 1879, for which years the remarks are taken from *Symons's Meteorological Magazine*.

W. A. QUENNELL.

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### Obituary

We regret to learn of the death of Lady Strachey, widow of Sir Richard Strachey, Chairman of the Meteorological Council of the Royal Society, 1883-1905, on December 14th, 1928, at the age of 88.

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We regret to learn that Mr. Andrew Watt, formerly Secretary of the Scottish Meteorological Society, died suddenly on January 9th, 1929.

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### News in Brief

We are glad to learn that a Chair of Meteorology and Climatology has been created in the University of Salonica. The post has been accepted by Dr. E. G. Mariolopoulos, formerly chief of the Meteorological Section of the National Observatory of Athens. Dr. Mariolopoulos will also become Director of the Meteorological and Climatological Institute, which has been formed in connexion with the University.

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The Simms Gold Medal of the Royal Aeronautical Society for the best paper on any subject allied to aeronautics, has been awarded to Captain F. Entwistle, B.Sc., Superintendent of the Aviation Services Division, for his paper on "Fog," read before the Society on December 8th, 1927.

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## The Weather of December, 1928

The weather of December was very variable. During the first few days the weather was mild and anticyclonic with light westerly winds and much sunshine, although mist or fog was

experienced in the early mornings. On the 6th a depression passing across the country was associated with rain in most districts, the amounts, however, were small, among the largest being 0·37in. at Kilmarnock. In the rear of this depression the winds became northerly and cold and there were showers of snow, hail or sleet and bright intervals. From the 7th to the 15th the temperature was low and the frosts severe; the lowest minima of the month occurred during this period when 18°F. was recorded in the screen at Burnley on the 9th and 11°F. on the ground at Rhayader on the 15th. Day temperatures failed to reach 32°F. in places on the 14th and 15th, the maximum being 29°F. at Oxford on the 14th and at Ross-on-Wye on the 15th. On the other hand, the duration of bright sunshine exceeded 6½ hrs. at several places on the 7th, 8th, 9th and 14th, and over 7 hrs. at a few places, *e.g.*, 7·4 hrs. at Bognor on the 8th. This period of sunshine was interrupted temporarily on the 9th and 10th when a depression centred to the west of the British Isles was associated with gales and heavy rain in Ireland and western England, *e.g.*, 2·47in. fell at Fofanny (Down) on the 10th. On the 15th there was a general change to milder southwesterly conditions and rain fell heavily in the west on the 15th and in Scotland on the 16th, 5·45in. occurred at Fofanny (Co. Down) and 2·24in. at Delphi (Mayo) on the 15th. This was followed by a bright sunny day on the 17th when between 6 and 7 hours bright sunshine was recorded at many places. Slight precipitation occurred on most of the next few days with much mist and fog in the mornings and severe frost at night. From the 24th the weather was unsettled with strong winds, local gales and occasional heavy precipitation until nearly the end of the month when the northern part of the country came under the influence of an anticyclone to the north and west of the British Isles. Precipitation was most general on the 25th, 27th and 29th, 3·24in. fell at Tynywaun (Glamorgan) on the 25th and 1·97in. at Filleigh (Devon) on the 27th. The sunshine totals for the month were generally below normal except in the eastern districts. The distribution for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	22	—1	Valentia	32	— 9
Aberdeen	43	+7	Liverpool	33	—10
Dublin	40	—8	Falmouth	43	—12
Birr Castle	38	—5	Kew	47	+10

Pressure was above normal over the whole of western Europe, Iceland and the northern North Atlantic to Newfoundland and Bermuda, the greatest excess being 7·1mb. at Malin Head (north Ireland). Pressure was below normal at Spitsbergen. Temperature was above normal except in the British Isles, Portugal and

the extreme northeast of Sweden. The excess in central Sweden and Spitsbergen amounted to between 4°F. and 5°F. Rainfall was below normal in Scandinavia and central Europe but above normal at Spitsbergen. The deficit was as much as 40 per cent. in Svealand and Gothaland.

It is reported that a severe storm occurred on the 2nd in the Gulf of Finland and wrecked the Finnish ship *Neptun*. Heavy falls of snow were reported from Austria at the beginning of the month and part of the railway line between Austria and Switzerland was blocked. Snow was also very plentiful in the higher parts of Switzerland and traffic was rendered difficult owing to avalanches, some villages and chalets being cut off for several days. In some districts of the Bernese Oberland and Canton Valais the snowfall is reported to have been the heaviest for the time of year within living memory. Towards the end of the month nearly 7,000 acres in the district north of Termonde (Holland) were under water, a violent gale and high tide causing the Scheldt to overflow its banks. A glazed frost occurred in Munich on the morning of the 26th rendering the streets dangerous, many persons sustained injuries.

Heavy floods occurred in Smyrna about the 7th. Widespread and heavy falls of snow occurred in Afghanistan about the 27th.

A cloudburst was reported from Shabani (southern Rhodesia) on the 27th, causing the deaths of 14 natives working in the asbestos mines; 2½ in. of rain is said to have fallen in 20 minutes.

Abnormally heavy rain in Jamaica at the beginning of the month caused landslips and much damage to main roads. On the 23rd eastern Canada had the first severe blizzard of the winter; the snowfall was sufficiently heavy to block communications and impede traffic. Temperature was above normal in the United States at the beginning of the month but a severe cold spell swept across the country during the second week. There was a return to warmer conditions during the third week but over Christmas the conditions were variable.

The special message from Brazil states that the rainfall in the northern regions was scarce with 1·8lin. below normal, and the rainfall distribution in the central and southern regions irregular with 0·3lin. above normal and 0·3lin. below normal respectively. Nine anticyclones passed across the country and windstorms were experienced in the extreme south. Cotton, cocoa and wheat crops were gathered in good condition. At Rio de Janeiro pressure was 0·7mb. below normal and temperature 0·9°F. below normal.

### Rainfall, 1928—General Distribution

	Dec.	Year	} per cent. of the average 1881-1915.
England and Wales ...	88	113	
Scotland ... ..	96	124	
Ireland ... ..	96	125	
British Isles ... ..	<u>92</u>	<u>118</u>	

## Rainfall: December, 1928: England and Wales

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond.</i>	Camden. Square.....	2'66	111	<i>Leics.</i>	Thornton Reservoir ...	2'06	77
<i>Sur</i>	Reigate, The Knowle...	3'38	113	"	Belvoir Castle.....	1'59	65
<i>Kent</i>	Tenterden, Ashenden...	2'49	80	<i>Rut</i>	Ridlington .....	2'45	...
"	Folkestone, Boro. San.	3'49	...	<i>Linc</i>	Boston, Skirbeck .....	2'47	115
"	Margate, Cliftonville...	3'42	150	"	Lincoln, Sessions House	1'65	75
"	Sevenoaks, Speldhurst	3'86	...	"	Skegness, Marine Gdns	2'09	95
<i>Sus</i>	Patching Farm .....	4'09	122	"	Louth, Westgate .....	2'13	76
"	Brighton, Old Steyne	3'78	122	"	Brigg, Wrawby St. ...	2'07	...
"	Tottingworth Park ...	4'23	114	<i>Notts</i>	Worksop, Hodsock ...	2'26	96
<i>Hants.</i>	Ventnor, Roy. Nat. Hos.	3'53	107	<i>Derby</i>	Derby .....	1'93	74
"	Fordingbridge, Oaklands	...	...	"	Buxton, Devon Hos. ...	3'03	53
"	Ovington Rectory .....	3'78	95	<i>Ches</i>	Runcorn, Weston Pt.	2'21	70
"	Sherborne St. John ...	2'80	85	"	Nantwich, Dorfold Hall	2'46	...
<i>Berks.</i>	Wellington College ...	...	...	<i>Lancs.</i>	Manchester, Whit. Pk.	1'77	55
"	Newbury, Greenham...	2'78	87	"	Stonyhurst College ...	3'15	65
<i>Herts.</i>	Benington House .....	2'39	96	"	Southport, Hesketh Pk	2'95	91
<i>Bucks.</i>	High Wycombe .....	...	...	"	Lancaster, Strathspey	3'92	...
<i>Oxf.</i>	Oxford, Mag. College	2'18	94	<i>Yorks.</i>	Wath-upon-Dearne ...	1'65	65
<i>Nor</i>	Pitsford, Sedgebrook...	2'32	96	"	Bradford, Lister Pk....	1'99	60
"	Oundle .....	1'74	...	"	Oughtershaw Hall.....	5'59	...
<i>Beds.</i>	Woburn, Crawley Mill	2'43	104	"	Wetherby, Ribston H.	1'33	54
<i>Cam.</i>	Cambridge, Bot. Gdns.	1'81	94	"	Hull, Pearson Park ...	1'84	76
<i>Essex</i>	Chelmsford, County Lab	2'90	131	"	Holme-on-Spalding ...	1'57	...
"	Lexden, Hill House ...	3'51	...	"	West Witton, Ivy Ho.	2'24	...
<i>Suff</i>	Hawkedon Rectory ...	3'15	130	"	Felixkirk, Mt. St. John	1'56	65
"	Haughley House .....	2'44	...	"	Pickering, Hungate ...	1'96	...
<i>Norfol</i>	Beccles, Geldeston .....	...	...	"	Scarborough .....	1'43	60
"	Norwich .....	3'21	123	"	Middlesbrough .....	1'19	61
"	Blakeney .....	1'30	59	"	Baldersdale, Hury Res.	1'77	...
"	Little Dunham .....	2'90	119	<i>Durh.</i>	Ushaw College .....	1'88	5
<i>Wilts.</i>	Devizes, Highclere.....	2'82	92	<i>Nor</i>	Newcastle, Town Moor	1'57	65
"	Bishops Cannings .....	2'99	91	"	Bellingham, Highgreen	3'29	...
<i>Dor</i>	Evershot, Melbury Ho.	3'37	65	"	Lilburn Tower Gdns....	2'29	...
"	Creech Grange .....	4'87	...	<i>Cumb.</i>	Geltsdale.....	2'97	...
"	Shaftesbury, Abbey Ho.	2'33	64	"	Carlisle, Scaleby Hall	2'21	69
<i>Devon.</i>	Plymouth, The Hoe ...	4'07	81	"	Borrowdale, Rosthwaite	...	...
"	Polapit Tamar .....	5'09	100	"	Keswick, High Hill ...	5'18	...
"	Ashburton, Druid Ho.	6'49	86	<i>Glam.</i>	Cardiff, Ely P. Stn. ...	5'19	100
"	Cullompton.....	3'87	88	"	Treherbert, Tynywaun	1'44	...
"	Sidmouth, Sidmount...	2'79	71	<i>Carm.</i>	Carmarthen Friary ...	6'84	119
"	Filleigh, Castle Hill	6'20	...	"	Llanwrda .....	5'57	81
"	Barnstaple, N. Dev. Ath.	5'72	129	<i>Pemb.</i>	Haverfordwest, School	...	...
<i>Corn.</i>	Redruth, Trewirgie ...	6'19	99	<i>Card.</i>	Aberystwyth .....	4'16	...
"	Penzance, Morrab Gdn.	5'44	96	"	Cardigan, County Sch.	5'18	...
"	St. Austell, Trevarna...	6'16	101	<i>Brec</i>	Crickhowell, Talymaes	4'60	...
<i>Soms.</i>	Chewton Mendip .....	4'27	79	<i>Rad</i>	Birm W. W. Tyrmynydd	4'95	60
"	Long Ashton .....	3'75	...	<i>Mont</i>	Lake Vyrnwy .....	5'75	84
"	Street, Millfield ...	2'85	...	<i>Denb</i>	Llangynhafal.....	2'51	...
<i>Glos.</i>	Cirencester, Gwynfa ...	3'07	92	<i>Mer</i>	Dolgelly, Bryntirion...	5'45	80
<i>Here</i>	Ross, Birchlea .....	2'53	85	<i>Carn</i>	Llandudno .....	2'70	87
"	Ledbury, Underdown	2'50	89	"	Snowdon, L. Llydaw 9	14'55	...
<i>Salop</i>	Church Stretton.....	2'27	68	<i>Ang</i>	Holyhead, Salt Island	3'93	94
"	Shifnal, Hatton Grange	1'75	68	"	Lligwy.....	3'45	...
<i>Worc.</i>	Ombersley, Holt Lock	2'02	77	<i>Isle of Man</i>	Douglas, Boro' Cem....	4'41	89
"	Blockley .....	2'93	...	"	St. Peter P't. Grange Rd.	4'42	108
<i>War</i>	Farnborough .....	3'03	103	<i>Guernsey</i>			
"	Birmingham, Edgbaston	1'94	72				

## Rainfall : December, 1928 : Scotland and Ireland

Co.	STATION	In.	Per- cent. of Av.	Co.	STATION	In.	Per- cent. of Av.
<i>Wigt.</i>	Stoneykirk, Ardwell Ho	...	...	<i>Suth.</i>	Loch More, Achfary ...	8'37	91
"	Pt. William, Monreith	4'50	...	<i>Caith.</i>	Wick .....	3'47	113
<i>Kirk.</i>	Carsphairn, Shiel. ....	8'41	...	<i>Ork.</i>	Pomona, Deerness .....	4'05	97
"	Dumfries, Cargen .....	4'48	83	<i>Shet.</i>	Lerwick .....	5'88	123
<i>Dumf.</i>	Eskdalemuir Obs. ....	5'90	84	<i>Cork.</i>	Caheragh Rectory .....	7'33	...
<i>Roab.</i>	Bransholm .....	2'85	78	"	Dunmanway Rectory...	7'76	96
<i>Selk.</i>	Ettrick Manse .....	5'25	...	"	Ballinacurra .....	4'81	94
<i>Peeb.</i>	West Linton .....	3'50	...	"	Glanmire, Lota Lo. ...	5'68	103
<i>Berk.</i>	Marchmont House .....	1'99	71	<i>Kerry.</i>	Valentia Obsy. ....	6'93	104
<i>Hadd.</i>	North Berwick Res. ...	1'79	83	"	Gearahameen .....	12'20	...
<i>Midl.</i>	Edinburgh, Roy. Obs.	1'85	86	"	Killarney Asylum .....	5'05	69
<i>Ayr.</i>	Kilmarnock, Agric. C.	3'70	87	"	Darrynane Abbey .....	6'08	103
"	Girvan, Pinmore .....	6'11	102	<i>Wat.</i>	Waterford, Brook Lo...	4'15	88
<i>Renf.</i>	Glasgow, Queen's Pk. ...	3'72	83	<i>Tip.</i>	Nenagh, Cas. Lough...	4'96	108
"	Greenock, Prospect H.	8'28	105	"	Roscrea, Timoney Park	3'12	...
<i>Bute.</i>	Rothsay, Arden Craig	6'86	126	"	Cashel, Ballinamona...	3'86	99
"	Dougarie Lodge .....	6'58	...	<i>Lim.</i>	Foynes, Coolnanes .....	5'11	108
<i>Arg.</i>	Ardgour House .....	11'60	...	"	Castleconnel Rec. ....	5'39	...
"	Manse of Glenorchy ...	8'10	...	<i>Clare.</i>	Inagh, Mount Callan...	7'73	...
"	Oban .....	6'78	...	"	Broadford, Hurdlest'n.	5'80	...
"	Poltalloch .....	6'40	100	<i>Wexf.</i>	Newtownbarry .....	4'55	...
"	Inveraray Castle .....	10'09	102	"	Gorey, Courtown Ho ..	4'13	108
"	Islay, Ballabus .....	8'65	146	<i>Kilk.</i>	Kilkenny Castle .....	3'45	100
"	Mull Benmore .....	...	...	<i>Wic.</i>	Rathnew, Clonmannon	4'71	...
"	Tiree .....	6'08	...	<i>Carl.</i>	Hacketstown Rectory..	4'15	101
<i>Kinr.</i>	Loch Leven Sluice .....	3'61	92	<i>QCo.</i>	Blandsfort House .....	3'50	95
<i>Perth.</i>	Loch Dhu .....	9'65	96	"	Mountmellick .....	4'18	...
"	Balquhidder, Stronvar	8'04	...	<i>KCo.</i>	Birr Castle .....	3'52	107
"	Crieff, Strathearn Hyd.	4'68	104	<i>Dubl.</i>	Dublin, FitzWm. Sq...	2'62	106
"	Blair Castle Gardens ...	3'49	92	"	Balbriggan, Ardgillan.	3'80	131
"	Dalnaspidal Lodge ...	6'60	87	<i>Me'th.</i>	Beauparc, St. Cloud...	3'03	...
<i>Forf.</i>	Kettins School .....	3'09	103	"	Kells, Headfort .....	3'64	95
"	Dundee, E. Necropolis	2'30	86	<i>W.M.</i>	Moate, Coolatore .....	3'13	...
"	Pearsie House .....	3'15	...	"	Mullingar, Belvedere..	3'80	103
"	Montrose, Sunnyside...	2'56	87	<i>Long.</i>	Castle Forbes Gdns. ....	2'75	69
<i>Aber.</i>	Braemar, Bank .....	2'99	84	<i>Gal.</i>	Ballynahinch Castle ...	7'49	100
"	Logie Coldstone Sch. ...	2'22	79	"	Galway, Grammar Sch.	3'42	...
"	Aberdeen, King's Coll.	2'80	87	<i>Mayo.</i>	Mallaraunty .....	7'99	...
"	Fyvie Castle .....	2'78	...	"	Westport House .....	5'16	90
<i>Mor.</i>	Gordon Castle .....	2'12	79	"	Delphi Lodge .....	13'23	...
"	Grantown-on-Spey ...	2'29	84	<i>Sligo.</i>	Markree Obsy. ....	4'85	103
<i>Na.</i>	Nairn, Delnies .....	1'83	82	<i>Cav'n.</i>	Belturbet, Cloverhill...	2'14	58
<i>Inv.</i>	Kingussie, The Birches	2'86	...	<i>Ferm.</i>	Enniskillen, Portora...	3'08	...
"	Loch Quoich, Loan ...	13'00	...	<i>Arm.</i>	Armagh Obsy. ....	2'45	78
"	Glenquoich .....	12'50	85	<i>Down.</i>	Fofanny Reservoir .....	13'59	...
"	Inverness, Culduthel R.	2'21	...	"	Scaforde .....	4'46	108
"	Arisaig, Faire-na-Squir	6'75	...	"	Donaghadee, C. Stn ...	3'45	108
"	Fort William .....	7'77	...	"	Banbridge, Milltown...	2'07	72
"	Skye, Dunvegan .....	8'47	...	<i>Antr.</i>	Belfast, Cavehill Rd ...	4'17	...
<i>R &amp; C.</i>	Alness, Ardross Cas. ...	4'28	104	"	Glenarm Castle .....	6'45	...
"	Ullapool .....	5'15	...	"	Ballymena, Harryville	4'18	94
"	Torridon, Bendamph...	10'49	103	<i>Lon.</i>	Londonderry, Creggan	3'76	86
"	Achnashellach .....	8'56	...	<i>Tyr.</i>	Donaghmore .....	3'57	...
"	Stornoway .....	5'53	89	"	Omagh, Edenfel .....	3'48	82
<i>Suth.</i>	Laig .....	5'21	...	<i>Don.</i>	Malin Head .....	3'43	102
"	Tongue .....	3'44	69	"	Dunfanaghy .....	4'64	...
"	Melvich .....	6'58	158	"	Killybegs, Rockmount.	7'20	99

## Climatological Table for the British Empire, July, 1928.

STATIONS	PRESSURE		TEMPERATURE					Relative Humidity.	Mean Cloud Am't	PRECIPITATION		BRIGHT SUNSHINE		
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values					Am't in.	Diff. from Normal in.	Days	Hours per day	Per- cent- age of possi- ble
			Max.	Min.	Max.	Min.	1/2 max. and min.							
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	%	0-10					
London, Kew Obsy.	1019.4	+3.6	87	50	74.8	55.8	+2.6	76	5.2	2.06	0.11	9	9.4	58
Gibraltar	1017.5	+0.7	99	63	83.0	70.9	+2.2	75	2.6	0.00	0.03	0	..	..
Malta	1016.9	+1.6	95	68	85.7	73.5	+1.3	70	0.5	0.00	0.05	0	12.6	88
St. Helena	1017.4	+3.7	67	50	62.7	54.6	-0.3	98	8.7	2.03	2.00	15	..	..
Sierra Leone	1014.3	+1.6	89	70	82.7	72.1	-1.2	74	9.1	33.15	2.43	30	..	..
Lagos, Nigeria	1012.8	+1.0	84	70	81.3	74.2	-0.3	85	6.7	2.53	8.15	12	..	..
Kaduna, Nigeria	1015.9	+1.9	89	63	83.8	66.0	+1.3	87	1.2	13.46	5.26	24	..	..
Zomba, Nyasaland	1020.6	+2.1	76	47	70.3	51.5	-1.1	61	4.5	0.03	0.32	1	..	..
Salisbury, Rhodesia	1020.8	+0.7	76	35	69.6	40.1	-1.2	54	1.5	0.00	0.03	0	10.1	90
Cape Town	1022.6	+1.3	84	37	64.6	49.8	+2.5	79	5.0	1.56	2.09	5	..	..
Johannesburg	1026.3	+1.8	69	30	62.3	41.6	+1.4	36	0.9	0.00	0.33	0	9.9	93
Mauritius	1020.4	0.0	79	55	74.5	63.5	+0.7	78	4.9	2.15	0.34	24	7.4	67
Bloemfontein	999.6	+0.4	71	27	63.9	31.3	+0.3	51	0.6	0.00	0.38	0	..	..
Calcutta, Alipore Obsy.	1003.9	0.0	93	76	88.8	79.1	+0.4	90	8.7	22.12	9.61	26*	..	..
Bombay	1003.9	0.0	90	75	85.7	77.0	0.0	87	8.5	30.93	6.66	27*	..	..
Madras	1004.2	-0.3	103	75	96.4	80.1	0.9	75	7.8	3.04	0.90	12*	..	..
Colombo, Ceylon	1009.4	+0.2	87	73	85.1	77.5	+0.2	77	9.1	5.65	0.78	10	5.8	46
Hongkong	1004.3	-0.5	93	76	88.5	79.9	+1.7	81	6.0	4.78	8.60	14	9.1	68
Sandakan	1016.8	-1.7	91	73	88.1	74.9	-0.3	81	..	4.02	2.53	11	..	..
Sydney	1016.8	-1.7	73	41	63.1	47.9	+2.8	73	5.4	6.66	1.82	9	5.5	54
Melbourne	1016.4	-2.7	63	32	57.0	42.7	+1.3	77	5.7	0.65	1.18	9	4.5	46
Adelaide	1017.3	-3.1	70	36	60.4	45.9	+1.4	70	6.5	2.79	0.14	14	4.6	46
Perth, W. Australia	1017.4	-1.6	71	40	63.0	48.2	+0.4	76	6.5	11.89	5.44	21	5.1	50
Coorgardie	1018.7	-1.2	74	31	62.2	40.2	0.0	74	2.2	0.35	0.06	6	..	..
Brisbane	1011.0	-2.8	..	..	..	..	..	..	..	..	..	..	..	..
Hobart, Tasmania	1011.0	-2.8	61	35	54.9	43.0	+3.5	72	5.7	1.72	0.42	18	4.6	49
Wellington, N.Z.	1015.6	+1.7	59	37	53.6	42.8	-0.5	76	5.9	3.52	2.11	10	3.9	41
Suva, Fiji	1012.5	-1.7	85	62	78.9	67.9	+0.2	77	5.8	5.56	0.96	20	6.4	57
Apia, Samoa	1011.3	-0.7	86	68	82.6	72.6	+0.4	79	4.8	8.76	6.12	15	6.5	57
Kingston, Jamaica	1014.4	-0.3	94	71	89.8	73.6	0.0	79	4.3	0.31	1.31	2	7.9	60
Grenada, W.I.	1010.7	-2.5	90	71	86.9	74.3	+1.6	81	5.7	7.70	2.60	23	..	..
Toronto	1013.7	-0.4	90	52	79.4	60.4	+1.7	74	4.5	5.64	1.28	14	8.3	58
Winnipeg	1013.6	+0.9	90	48	77.1	57.7	+1.2	88	6.0	4.44	1.28	14	7.8	49
St. John, N.B.	1013.8	+0.1	80	50	69.9	54.6	+1.9	78	6.5	4.14	0.51	10	6.8	44
Victoria, B.C.	1016.5	-0.2	90	50	68.9	53.2	+0.8	73	4.4	0.25	0.11	2	11.6	74

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