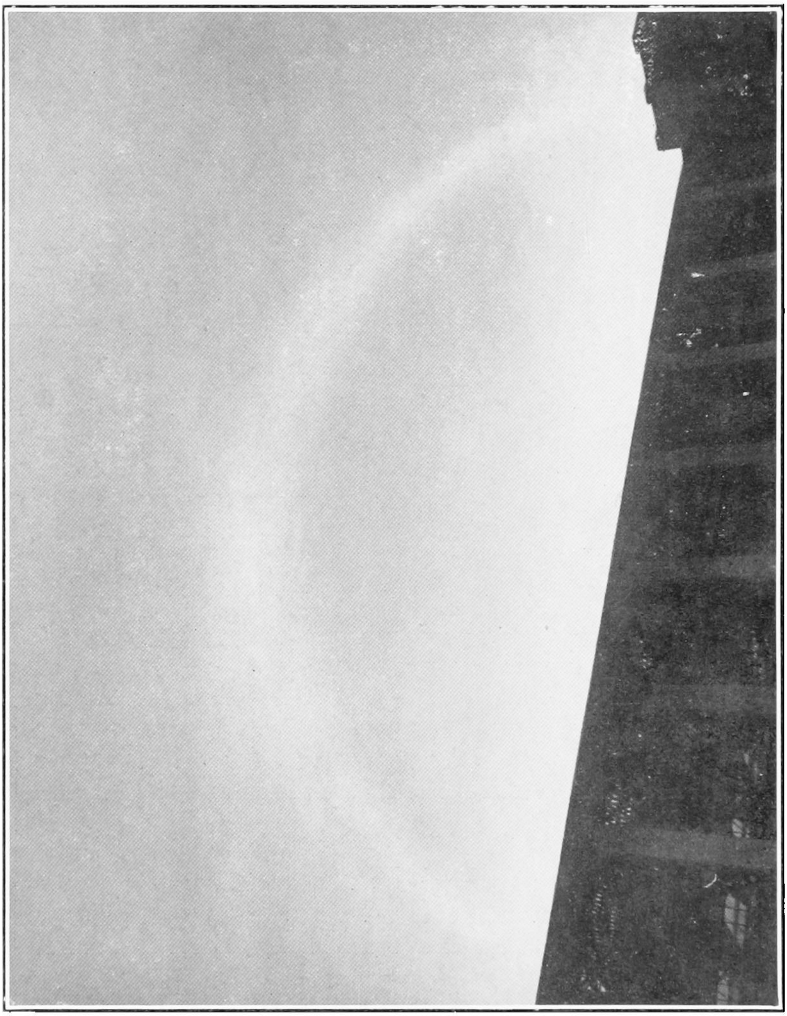

Solar Halo. Leuchars, (Fifeshire) November 16th. 1931, 14h. (see p. 290).

M.O. 339.

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A note on Alto-Cumulus Cloud

By C. S. DURST, B.A.

Alto-cumulus cloud is formed at a height far above the limit of the normal convection due to the heating of the air by contact with the ground. That the cloudlets are due to convection in a comparatively shallow unstable layer of the atmosphere has long been suspected and recently in the work of S. Mal* has been fairly definitely established. But for that shallow layer to persist without degenerating into neutral equilibrium demands that there should be (i) some source of heat below and cold above, or (ii) a rising of the whole layer in which convection is taking place (with a discontinuity in the water content above and below the convection layer), or (iii) the continuous introduction of a (potentially) colder stream of air over a warmer.

I.

The first alternative is the simplest, since on a clear night the radiation from the earth and the atmosphere below the cloud layer will be greater than the radiation flowing from the cloud's lower surface, while the cloud's upper surface will be giving out more radiation to space than it receives from the atmosphere above the cloud layer. The same argument, however, does not necessarily apply during daylight hours, since then insolation may be taking place on the upper surface of the cloud. At a meeting of the Royal Meteorological Society when Sir Gilbert

Beitr. Physik. Atmosph. Leipzig, 17, 1930, pp. 40-68.

(96957) 107/27 1,075 1/32 M. & S. Gp.303

Walker's paper on Mal's work* was being discussed, Col. Gold suggested that it was probable on these grounds that there was a definite diurnal variation in the frequency of alto-cumulus cloud. It is, however, remarkable that the observations made by Russell† do not support this expectation. His figures (for the whole year) show a maximum frequency of 8·0 per cent in the occurrence of alto-cumulus at 9 a.m. followed by a decrease to 4·8 per cent at 2 p.m. and after a slight increase between 3 p.m. and 7 p.m. a decrease to a minimum of only 0·7 per cent at 1 a.m. and 2 a.m. The frequency of cirro-cumulus, it is interesting to note, also follows almost the same curve.

In the obtaining of frequencies of occurrence of the higher clouds such as Russell attempted there are two grave difficulties, (*a*) on many occasions the higher cloud is hidden by lower cloud. This will throw out statistics of the diurnal frequency of the upper cloud if there is a pronounced diurnal variation of the amount of low cloud, (*b*) on a dark night it is practically impossible to assign a classification to upper cloud, and, especially when not near the zenith, it may even go unobserved. The first difficulty may be in part overcome if instead of the frequency of occurrence there is obtained the amount of sky covered. Since the amount of low cloud can be observed it is easy to obtain the proportion of the remaining sky which is covered by the particular type of higher cloud.

Observations made at Cardington for January, April, July and October of three years were treated in this way, with the result shown below :—

PERCENTAGE OF SKY (UNCOVERED BY LOW CLOUD) COVERED WITH ALTO-CUMULUS CLOUD.

Hour G.M.T.	7h.	10h.	13h.	16h.	18h.	21h.	Mean Sunset Hour G.M.T.
January	(5)	10	10	14	(8)	(5)	16h. 17m.
April	9	9	7	8	11	(3)	18h. 54m.
July	10	12	11	10	14	(9)	20h. 8m.
October	11	8	9	9	(9)	(5)	17h. 7m.

The figures in brackets in this table refer to observations made after sundown and show how the apparent extent of the alto-cumulus cloud decreases after sundown. The daylight figures are in general corroboration of those of Russell in showing a tendency to a minimum during the afternoon.

The second difficulty mentioned above can be dealt with by the selection of dates, for, at seasons of full moon, the character of

London, Q.J.R. Meteor Soc. 57, 1931, p. 413.
†*London, Q.J.R. Meteor. Soc.* 39, 1914, p. 271.

high cloud can be distinguished almost as easily by night as by day. There were unfortunately not a sufficient number of night observations made at Cardington for the Cardington data to be used, so recourse was made to the telegraphic reports of the *Daily Weather Report*. The years 1928 and 1929 were used and on days of full moon as well as two days before and two days after the amount of sky predominantly covered by alto-cumulus cloud at Cranwell, Croydon and Lympne was extracted for the hours 1h. and 13h. G.M.T. The results are shown in the table below :—

PERCENTAGE OF SKY (UNCOVERED BY LOW CLOUD) COVERED WITH ALTO-CUMULUS CLOUD.

Month Hour G.M.T.	D.J.F.	M.A.M.	J.J.A.	S.O.N.	Year
1h.	13	8	14	11	12
13h.	5	4	3	5	4

It should be noted that in this table the figures are based on the occasions when alto-cumulus cloud is reported, though it may be present on other occasions when it is not the predominant cloud. It is quite clear from this table that from two to four times as much alto-cumulus cloud is present by night as by day and that the apparent minimum which Russell found at night may be attributed to the invisibility of the cloud rather than to its absence.

The monthly variation obtained by Russell ranged from a percentage frequency of 6·1 in September to 2·6 in July. The figures for the seasons being :—

PERCENTAGE FREQUENCY OF OBSERVATIONS OF ALTO-CUMULUS CLOUD.

D.J.F.	M.A.M.	J.J.A.	S.O.N.
5·1	3·9	3·5	5·8

which follows closely the same course as the percentage of sky covered at 13h. in the last table. The seasonal variation of the percentage of sky covered at 1h. does not, however, follow the same definite seasonal variation.

It may be concluded then that radiation plays an important part in the formation of alto-cumulus cloud, and that even in the cases in which the cloud is not due to this cause the intensity of the solar radiation dissipates the cloud as is shown by the smaller extent of alto-cumulus cloud by day in summer than in winter.

II.

It is of interest to see if any quantitative values can be assigned to the radiation received by cloud at the height of alto-cumulus and if such values show that radiation is sufficiently potent to play this rôle. The simplest case will be taken, namely, a limited sheet of alto-cumulus cloud at night at a height of 5 Km. above the earth's surface, the temperature of the air at that height being assumed to be 255°A. and the earth's temperature 282°A.; there are assumed to be no other clouds in the sky.

In fig. 1 is given a diagram showing the radiation which has to be considered. It is first to be noticed that any radiation which passes the level of the cloud (which is assumed to be of small area) and is then scattered and reflected, will pass the cloud level in both directions, and so need not be taken into account (item **e**).

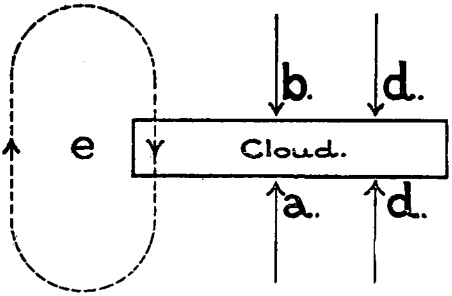


FIG. 1.—NOTE—The arrows marked **d** should be pointing away from the cloud.

Item **a** represents the flux of long-wave radiation emitted from the earth and its atmosphere below the cloud. Item **b** represents the flux of long-wave radiation emitted from the earth's atmosphere above the cloud. Item **d** represents the radiation emitted by the cloud, which is the same both upwards and downwards. The computation of these values may be made on the lines adopted by Simpson in his paper on terrestrial radiation.*

This computation was made, the earth's temperature being assumed to be 282°A. and the cloud being assumed to absorb and emit radiation as a black body, at a temperature of 255°A. The conclusion reached was that the excess of long-wave radiation falling on the lower surface of the cloud over that falling on the upper surface (item **a**—item **b**) would be not less than 0·15 cal/cm²/min. or 30 per cent of the black body radiation at 282°A.

It is not known how much of this radiation is absorbed by the surface of the cloud and how much transmitted into the interior or even through the whole cloud. Water is a very powerful absorber of long-wave radiation, however (Shaw† states that it lacks but 4·4 per cent. of radiating and absorbing as much as a perfect radiator), so that it is possible, if the cloud is of the right texture to absorb the available radiation, the amount absorbed on the lower surface will be of the order of 0·10 cal/cm²/min. in excess of that absorbed on the upper surface.

If we consider the temperature in a column of ascending air in a cloud layer, it is seen that if v is the velocity averaged over the whole of the ascending column, and $\frac{\delta T}{\delta z}$ is the upward vertical gradient of potential temperature, the upward flux of heat across any plane is approximately $-\rho\sigma v \frac{\delta T}{\delta z} dt$ in time dt, (ρ being the density and σ the specific heat). This has to be counter-balanced by a (cooling or) warming at the bottom and

*London, *Mem. R. Met. Soc.*, Vol. III., No. 21.
†*Manual of Meteorology*, Part III., p. 157.

a (warming or) cooling at the top which may be called $\rho\sigma \frac{\delta T'}{\delta t} dt$

Hence we get the relation

$$v = -\frac{\delta T'}{\delta t}\Big/\frac{\delta T}{\delta z} \qquad \text{(i)}$$

Now if h is the thickness of the cloud, a formula due to Rayleigh* gives the relation for stability in the cloud. This formula is

$$\frac{\rho_2 - \rho_1}{\rho_1} < \frac{27\pi^4 \kappa\nu}{4gh^3} \qquad \text{(ii)}$$

where ρ_1 and ρ_2 are densities at the top and bottom of the cloud, κ the coefficient of thermal conduction and ν the coefficient of viscosity.

For stability in a thin layer this may be thrown into the form

$$\left|\frac{\delta T}{\delta z}\right| > \frac{27\pi^4 \kappa\nu T'}{4gh^4} \qquad \text{(iii)}$$

where T′ is the temperature.

Moreover, let R_1 be the net flow between incoming and outgoing radiation absorbed in the upper surface of the layer and R_2 be the net flow absorbed in the lower surface of the layer.

Then $$\rho\sigma \frac{\delta T'}{\delta t}\frac{h}{2} dxdydt = \frac{R_1 + R_2}{2} dxdydt \qquad \text{(iv)}$$

or $$\frac{\delta T'}{\delta t} = \frac{R_1 + R_2}{h\rho\sigma} \qquad \text{(v)}$$

Substituting in (i) from (iii) and (v) the value of v for critical values of temperature gradient is

$$v = \frac{(R_1 + R_2)\, 4gh^3}{27\pi^4 \kappa\nu T'\rho\sigma} \qquad \text{(vi)}$$

If T′ is 255°, $\rho = 5{\cdot}9 \times 10^{-4}$ and $R_1 + R_2$ is assumed to be 0·1 calories per square centimetre per minute, and if h is assumed to be of the order of 50 metres which is in accordance with Mal's† observations, then $$v = \frac{1{\cdot}2 \times 10^8}{\kappa\nu} \text{ m/s} \qquad \text{(vii)}$$

The values to be assigned to the coefficient of thermal conductivity and to the coefficient of turbulence at such heights are not known, but near the earth's surface they are both of the order of 10^4 (though at height of 5 Km. or so they probably are less than that value). Hence v would appear to be of a magnitude that is not unreasonable, though it must be recognised that the value of v increases rapidly with increase of h. At the same

Phil. Mag., London, XXXII, 1916. p. 529.

†*London, Q.J.R. Meteor. Soc.*, 57, 1931, p. 413. This is, however, probably a low estimate, as Gregg in "Aeronautical Meteorology" gives 120 metres, and Hann in "Lehrbuch de Meteorologie" gives 194 metres as the average thickness.

time any diminution of the amount of radiation absorbed (*e.g.*, by reflection) would decrease the value of v.

Hence it may be considered that the hypothesis of alto-cumulus cloud being due to radiation is not contradicted by the magnitudes of the quantities involved.

III.

In the computation above it has been assumed that no radiation is being received from the sun. The amount of short-wave radiation reflected by clouds is known to be high but until considerably more accurate quantitative values are known for the coefficient of reflection, it is not possible to say how far radiation can be accountable for the formation of alto-cumulus cloud by day.

An Example of the use of Percentiles in Climatology

By H. JAMESON, B.Sc.

The extreme values of meteorological factors already observed at a station are frequently tabulated, as an indication of the extreme values likely to be observed in the future. "Likely," however, is an indefinite term, and it is desirable to give some indication of the frequency of outstanding values.

For this purpose, the statistical method of percentiles,* applied to tables of the maximum values observed in each of a number of years, seems advantageous. As an example, the highest daily rainfall in each calendar year is usually tabulated among the records of a rainfall station. If the figures of such a table are ranked in order of magnitude, then a number which has 10 per cent of these figures, and 90 per cent less than it, is the highest decile. It may also be more usefully defined as a value of daily rainfall that will probably not be exceeded in more than one year out of ten. It is, of course, usually indeterminate within limits, and must be computed according to an arbitrary definition, but if the table is of reasonable length, the possible error is not serious. Similarly, the upper quartile and the median are unlikely to be exceeded in more than one year in four, and one year in two, respectively.

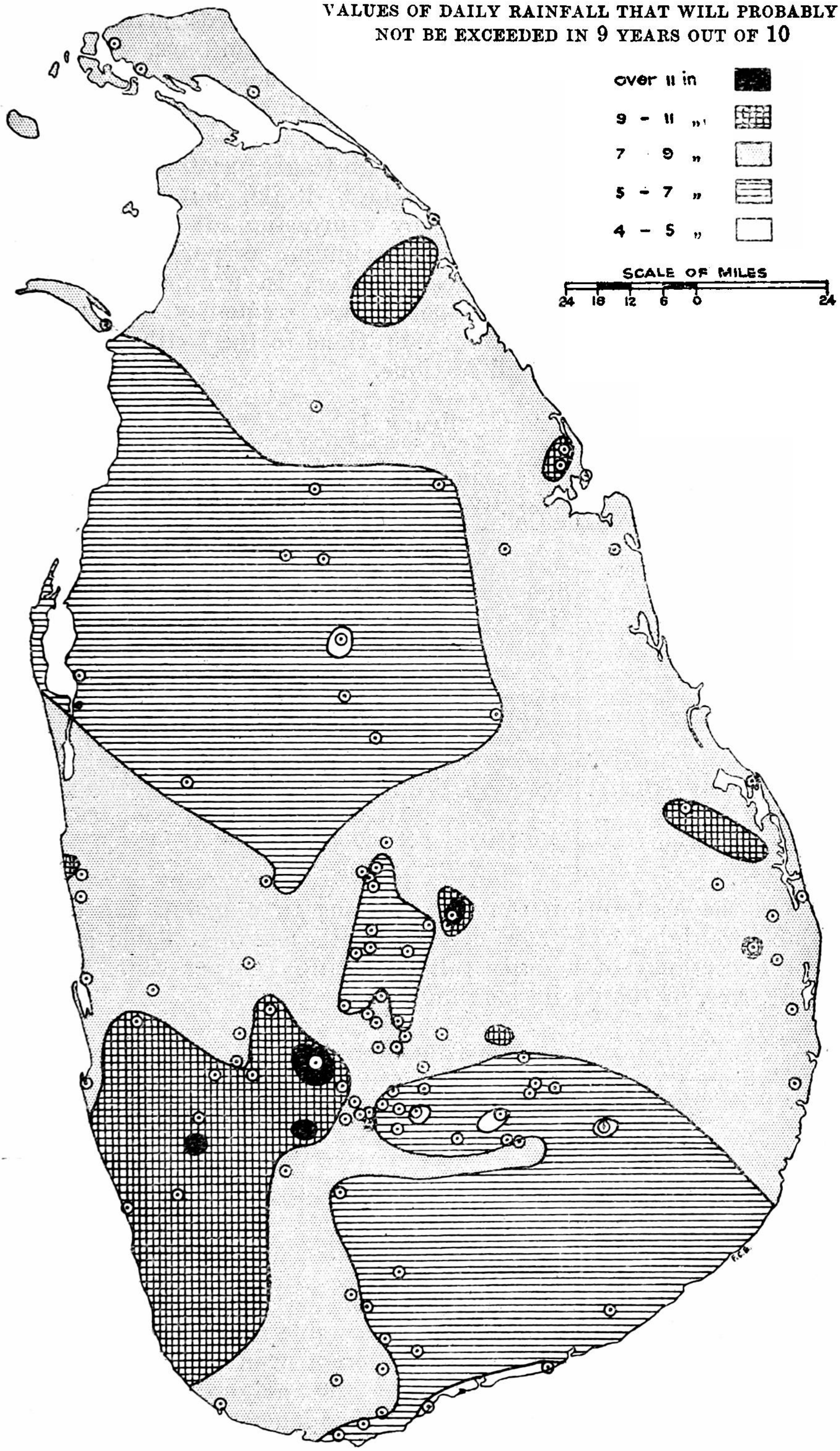
These figures will be referred to as the decile, quartile, and median maximum, respectively.

For all Ceylon stations, having, to the end of 1930, at least 40 years' records (40-62 years), from the tables of maximum daily rainfall each year the decile, quartile and median maxima have been computed and plotted as rainfall maps.

These give fairly smooth contours. The decile maxima are shown in the map. Although only stations with at least 40 years

*See, for example Yule's "Introduction to the Theory of Statistics."

VALUES OF DAILY RAINFALL THAT WILL PROBABLY NOT BE EXCEEDED IN 9 YEARS OUT OF 10



of records are shown on this map, shorter records have been used with judgment as a guide in drawing the contours, where sufficient long period records are not available. The quartile and median maxima give contours of approximately the same shape, but, of course, with lower values.

Ceylon records are not long enough to give reasonably accurate percentiles higher than the highest decile, but some further information can be obtained by expressing all figures in any table, greater than the decile maximum, as percentages of it, and taking these percentages together, in groups of stations. The table below shows the percentage frequency of such percentages, grouped as follows:—Stations to the south-west of the island; other stations; all stations.

TABLE I.

Group	100% – 110%	110 –120	120 –130	130 –140	140 150	150 –160	160 –170	170 –180	180 –190
South-west stations	40·5	20·4	17·3	10·1	4·3	2·3	2·1	0·6	1·6
Other stations ...	34·5	19·1	15·7	9·2	5·7	5·4	0·7	2·2	2·2
All stations... ...	37·3	19·7	16·4	9·6	5·1	3·9	1·3	1·4	1·9

Group	190 –200	200 –210	210 –220	220 –230	230 –240	240 –250	250 –260	260 –270	over 270%
South-west stations	0·4	0·4	0	0	0	0	0	0	0
Other stations ...	1·4	0·7	0·7	0·4	0·2	0·2	0·9	0·5	0·4
All stations... ...	1·0	0·6	0·4	0·2	0·1	0·1	0·5	0·3	0·2

On the assumption that all stations in a group are equally liable to high percentages of their decile maxima, Table II shows the expectancy of a daily fall exceeding 110 per cent, 120 per cent, &c., of the decile maximum.

TABLE II.

Group		110%	120%	130%	140%	150%
South-west stations...	One year in	17	26	46	85	135
Other stations	,, ,, ,,	15	22	33	47	63
All stations	,, ,, ,,	16	23	38	59	84

From a consideration in detail of the figures from different stations, this assumption seems reasonable over the greater part of the south-west of the island, though even there certain districts, the Kegalle district and the neighbourhood of the Ginigathena Pass, show a greater tendency to unusually high rainfalls. Data from the rest of the island are much more scanty in proportion to area, but the liability to abnormal rainfall is certainly greater there than in the south-west, and this greater liability seems to be distinctly concentrated in certain areas, *e.g.*, the Mullaittivu district and the northern slopes of the hills. Eliminating all figures from such districts, both in the south-west of the island and elsewhere, the expectancy of a daily fall exceeding 110 per cent, 120 per cent, &c., of the decile maximum becomes as shown in Table III.

TABLE III.

Group		110%	120%	130%	140%	150%
South-west stations...	One year in	17	26	47	97	152
Other stations	,, ,, ,,	16	25	42	82	133
All stations	,, ,, ,,	16	25	45	89	141

From the figures of Tables II and III the following rule would seem to be a reasonable extension of the idea of the decile maximum, for Ceylon.

"If the records of a district do not show an unusual number of abnormal falls, increases of 10 per cent, 20 per cent and 30 per cent in the decile maximum of any station will give figures for daily rainfall that are not likely to be exceeded in more than one year in 16, 25 and 45 respectively."

Table I shows a fairly regular decrease of frequency with increase of rainfall till 170 per cent of the decile maximum is reached, but frequencies beyond this are higher than might be expected. This phenomenon seems analogous to that found in the theory of errors, that the number of large errors found exceeds that given by theory, and, like it, probably indicates some cause of an abnormal character. Rainfalls between 100 per cent and 170 per cent of the decile maximum might therefore be termed exceptional, and those above 170 per cent abnormal. At the 109 stations, with records between 40 and 62 years, that appear on the map, 34 such abnormal falls were recorded, from 28 stations. These were booked as occurring on 26 different days, though, owing to the possibility of misdating rainfalls, this figure might have to be reduced to 23, of which two were consecutive. While some of these figures might be spurious, owing to observers' mistakes, corresponding figures from the same 109 stations for the last 20 years (1911-30), which have been under much more careful supervision than the earlier records, are 15 falls, from 14 stations, on 10 separate days (two consecutive), giving a frequency of about the same order of magnitude.

Nearly all these abnormal falls occurred between October and January (principally in December), and in May.

Discussions at the Meteorological Office

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

January 18th, 1932.—*Geophysical evidence in support of changes in solar radiation.* By J. Bartels (Ergeb. exakt. Naturwiss., Berlin, 9, 1930, pp. 38-78) (in German). *Opener*—Prof. S. Chapman, F.R.S.

February 1st, 1932.—*Investigations concerning the variations of the general circulation.* By A. Wagner (Geog. Ann., Stockholm, 11, 1929, pp. 33-88) (in German). *Opener*—Dr. C. E. P. Brooks.

February 15th, 1932.—*Synoptic-aerological investigations on cold fronts.* By E. Palmén (Beitr. Geophysik, Leipzig, 32, 1931, pp. 158-172) (in German). *Opener*—Mr. R. Corless, M.A.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, December 16th, in the Society's Rooms, at 49, Cromwell Road, South Kensington, Mr. R. G. K. Lempfert, M.A., F.Inst.P., President, in the Chair.

W. C. Kaye, B.Sc., and C. S. Durst, B.A.—Some examples of the development of depressions which affect the Atlantic.

Three typical cases are examined of the development of families of depressions over North America and its eastern seaboard. These show examples of :—

(1) a polar depression being intensified by the introduction of warm air from the Gulf of Mexico;

(2) the formation of a family of depressions between Pacific maritime polar air and warm Gulf air;

(3) the formation of depressions on a quasi-stationary front.

It is suggested that a majority of the families of depressions which cross the Atlantic originate in one or other of these ways.

Alfred A. Barnes, Assoc.M.Inst.C.E.—(a) *Rain-gaugings near Belper and Duffield, Derbyshire;* (b) *Rainfall reviewed: A common long-average period for each country of the British Isles.*

(*a*) This paper represents a complete analysis of the yearly readings taken at 19 rain gauges at the southern end of the Pennine Chain during a period of 66 years from 1865 to 1930 inclusive. All annual records are quoted, the long-average rainfall at each gauge is established, and the percentage relation to the individual long-average is given at each gauge for every year. In addition, a complete table is presented which accumulates these percentages on a common basis, thus illustrating the correct continuity of all the readings and producing one standard gauge for the district over the 66 years. A symmetrical residual-mass percentage curve is shown, which proves that the 44-year period 1865 to 1908 inclusive correctly balances the wet and dry years. This period has therefore been adopted for the long-averages. A later short period of 35 years, 1891 to 1925 inclusive, is found, giving a result which is practically identical with the basic normal, and which may therefore be used in this district for long-averages in the future.

(*b*) This review forms a new survey of the annual rainfall over England and Wales, Scotland, Ireland and the British Isles as a whole, during a period of 68 years from 1863 to 1930 inclusive. The rainfall of each country is tabulated—the annual figures being based upon the percentages given in the *Rainfall Atlas*—and the residual-mass tables and diagrams show a remarkable symmetry about the end of the year 1908. The period of 44 years 1887 to 1930 inclusive is shown by three methods to give the true normal rainfall for each country, and on this common basis a complete comparison is deduced for 34 overlapping periods of 35 years. The presentation of these last-named values in the form of 4 superimposed curves proves that the 35-year period 1891 to 1925 also gives a correct long-average for each country. The writer accepts the recognised annual figures for the individual countries, and the result of his review is to place a higher value on the normal for each country as follows :—

	1881-1915.	1887-1930.
England and Wales ...	35·23 inches.	35·65 inches.
Scotland	50·32 ,,	51·41 ,,
Ireland	43·30 ,,	43·96 ,,
British Isles	41·41 ,,	41·81 ,,

W. H. Pick, B.A., F.Inst.P.—***Visibility with saturated air.***

This paper examines for two stations, Worthy Down and Felixstowe, over a period of 4 years, the horizontal visibilities which occurred whenever the air was saturated, and shows that all degrees of visibility (except the very best) were well represented. Especially it is shown that a large percentage of the cases of saturated air were unaccompanied by either fog or mist. The effect of wind force upon the visibility accompanying saturated air is also examined.

Correspondence

To the Editor, *The Meteorological Magazine.*

Fog, Friday, December 18th

The following may be of some interest. Morning, thick fog and hoar frost. Fair and sunny midday. Wind light—NE. Afternoon and evening, blinding fog, which made the eyes run with water, and smelling strongly of soot. My brother and I, after pedal-cycling through fog during the evening, returned home with complexions and clothes the colour of nigger minstrels. Traffic was chaotic. Next morning trees, vegetation, telegraph wires and clothes lines were an inch thick with dirty black frost. Cabbages, &c., were filthy and had to receive many ablutions.

The evening fog drifted from north-west and visibility was at times less than three feet. F. CLAUDE BANKS.

Market Gardens, Horndon-on-the-Hill, Essex. December 28th, 1931.

Gale on December 23rd, 1931

At 9h., using my anemometer (or rather small air meter) as a check, I estimated the force of the wind as 12, velocity = 80 m.p.h. at least. It was difficult to make a correct estimate as I had to cling to a paling post to keep steady. Some structural damage was done; a brick chimney was blown down, some roofs of outhouses lifted clean off and others shifted. I heard of some elderly people being blown down, but no one on this island seems to have been hurt. The gale lasted for about 15 hours. During some of the gusts my car was actually blown to a standstill. (Car, a 23 h.p. Ford.)

T. EDMONSTON SAXBY.

Baltasound, Kirkwall, Orkney.

Sunless Periods

Dr. C. C. Vigurs has sent the following records of sunless periods of 6 or more consecutive days in 39 years at Newquay, Cornwall :—

WET DAYS.

1893, January 3rd-10th, 8 days, rain 0·85 in. cool.

1910, November 22nd-27th, 6 days, rain 1·27 in., temperature normal.

1912, December 22nd-28th, 7 days, rain 2·58 in., warm.

1918, November 28th-December 4th, 7 days, rain 1·45 in., mild.

DRY DAYS.

1898, January 24th-February 1st, 9 days; January 24th-31st, rainless; February 1st, 0·11 in., pressure high, mild, lowest minima 41°F.

1917, November 17th-23rd, 7 days, rain 0·01 in. on the 19th, 0·06 in. on the 23rd, pressure high, temperature normal (a minimum of 51°F) from the 20th -23rd.

1926, December 9th-14th, 6 days, rain 0·04 in., pressure high, temperature normal.

1931, December 10th-15th, 6 days, rain 0·01 in., pressure high, temperature normal.

Loss of Human Life in Blizzards in Cornwall

The great snowfall of December, 1630, in Cornwall referred to by Mr. Fox in the *Meteorological Magazine* for December, 1931, was also noted by Dr. Vigurs in the issue for December, 1924

(p. 261). In reply to Mr. Fox's query about other instances of loss of human life in blizzards in Cornwall, I find on referring to the "Blizzard in the West, March, 1891," a little book now out of print (see *Meteorological Magazine*, April, 1927), that persons were found lying dead in the snow or buried in drifts near Penzance, Newquay, Redruth and Padstow. In each case the victims had lost their way in the storm and were overwhelmed, the accounts answering to their having been "drowned" in the snow as in 1630. L. C. W. Bonacina.

27, Tanza Road, Hampstead. December 26th, 1931.

NOTES AND QUERIES

Remarkable Coloured Halos

The remarkable halo complex observed by Mr. W. F. A. Ellison on September 4th, 1931, at the Observatory, Armagh, and described in the *Meteorological Magazine* for October, 1931, p. 210, was also seen by Mr. Patrick L. J. Heron, of Castleroe, Coleraine, Co. Derry. Mr. Heron saw the halos across the waters of Lough Beg, Toome, Co. Antrim, between 5 and 6 p.m The weather at the time was fine but hazy with a cold north wind. At about 5.30 p.m., when the sun was 15° above the horizon, according to Mr. Heron's sketch, reproduced in fig. 1, the

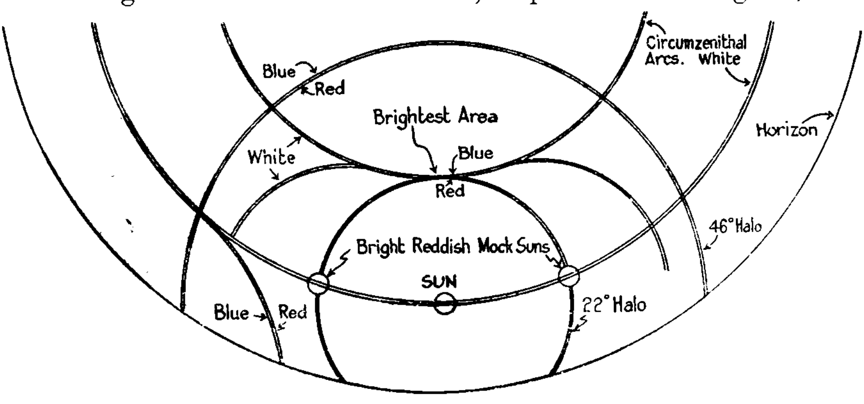


FIG. 1.

complex showed a white halo of 22°, with the mock sun ring and bright reddish mock suns on either side. Above this the upper arc of contact was visible, with a brilliant parhelion at the point of contact. The sketch also shows a circumzenithal arc tangential to the upper surface of the 22° halo. The halo of 46° was present and showed prismatic colours, while on the left-hand side of this arc a short coloured arc convex to the sun extended from at or near the point of intersection with the mock sun ring obliquely downwards towards the base of the 22° halo. This arc was most brilliant in its middle and lower parts.

The phenomena agree with those seen by Mr. Ellison, with, in addition, the mock sun ring, the upper circumzenithal arc and the small oblique arc on the left. The two latter features are most unusual; the upper circumzenithal arc resembles one observed by Lambert on January 24th, 1838, in Wetzlar, and reproduced as fig. 97 in the second edition of Pernter and Exner's "Meteorologische Optik."

The small arc on the left descending from the point of intersection of the mock sun ring and the halo of 46° was observed in a halo complex in South Finland on March 10th, 1920.* Only two of ten observers in Finland noted this peculiarity, of whom one saw the arc in the same position as Mr. Heron, while the other some distance off recorded a similar arc in an almost corresponding position to the right of the sun. The sketch made by the former of these two observers bears a remarkably close resemblance to Mr. Heron's. The altitude of the sun at the time was 22°. Johansson remarks that this arc had not previously been described.

The whole complex must be one of the most remarkable and complete ever observed in these islands, and our thanks are due to Mr. Ellison and Mr. Heron for calling attention to it.

Solar Halo observed at Leuchars

An abnormally bright solar halo of 22° radius was observed at Leuchars on November 16th, 1931. At 12h. 50m. cirrus cloud began spreading over the sky from the north-west, and by 13h. 30m. the sky was almost completely covered, the cloud appearing to be abnormally thick vertically, judging by its very grey appearance. This gave rise to the bright halo, which was easily distinguishable with the naked eye. The colours, however, were not brilliant. At 14h., when the photograph forming the frontispiece to this number of the magazine was taken, the complete ring, with an upper arc of contact, was visible, though in order to save blurring by the sun, the plate was exposed behind a hangar. The halo persisted with decreasing brilliancy until 15h. 40m., when the sun had sunk so low that only the upper part of the halo was visible. It is probably only a coincidence that the 18th was the wettest November day recorded at Leuchars.

High Upper Air Temperature

A very large temperature inversion was observed at Duxford (near Cambridge) at 9h. on January 4th, 1932, the readings being 37·5°F. at 3,500 feet and 53°F. at 5,000 feet, the latter figure being 28°F. above the January normal. Comparison may be made with December 30th, 1926, when there was an inversion

*Helsingfors. *Acta Soc. Sci. Fenn.*, 50, No. 1. 1920. Die ausserordentliche Haloerscheinung am 10 Marz, 1920, in Sud-Finnland, by O. V. Johansson.

of 18°F. and a reading of 52°F. at 5,500 feet.* This was the highest temperature recorded at that level in the British Isles during the period December to April, the season of low upper air temperature. The recent example creates a new record at 5,000 feet, but at greater heights the temperature was slightly lower than in the earlier case. On both days the synoptic situation was the northern boundary of an anticyclone, and the relative humidity was low above the inversion, so that dynamical warming due to subsidence had evidently played its part, in addition to the source of the air.

At 5,000 feet there was a rise of temperature amounting to 40°F. during the four days ending on the morning of January 4th, while at 20,000 feet there was a rise of 36°F. in five days, the rise commencing a day earlier. Most of the change may be attributed to the replacement of polar air by tropical air. Probably the greater part of the rise had taken place by January 2nd, but there was no observation till the 4th.

C. K. M. DOUGLAS.

Exhibition by the Royal Meteorological Society at the Science Museum

An exhibition, which has been arranged by the Royal Meteorological Society, is being held in the Geophysical Gallery of the Science Museum, by permission of the Director, Sir Henry Lyons. The exhibition was formally opened on January 11th, when Mr. R. G. K. Lempfert, President of the Society, took the Chair at an inaugural address by Sir Napier Shaw. The exhibits include modern types of observing instruments approved by the Meteorological Office, such as the latest type of thermometer screen with steel stand, equipped with sheath thermometers, the "octapent" mountain rain-gauge and a stream-lined wind-vane which embodies a number of new features. These are lent by the Director, who is also showing a series of instruments illustrating the history of the sunshine recorder, culminating in the latest type Mark II with adjustments for level and azimuth, and several historical meteorological instruments of various types. Stands of instruments of special interest are shown by some of the leading British makers, including a new form of automatic pollution gauge and examples of "distant-reading" thermometers. Another case illustrates the development of lightning conductors and there are a few examples of meteorolgical work in schools. Another feature is a magnificent collection of cloud photographs, including a series arranged by Sir Gilbert Walker to illustrate recent work on the artificial production of cloud forms. The exhibition will be open until February 10th.

In connexion with the exhibition a series of lectures is being

* See *Meteorological Magazine* 61, 1926, p. 291.

given on Thursdays at 4.30 p.m. in the public lecture theatre. On January 14th Mr. D. Brunt described the influence of meteorology on history. The remaining lectures are as follows :—

January 21st.—Dr. G. C. Simpson, F.R.S., on "Weather forecasting."

January 28th.—Capt. C. J. P. Cave, on "Clouds."

February 4th.—Sir Henry Lyons, F.R.S., on "Historic Meteorological Instruments."

The Rainfall of 1931

The year 1931 continued the remarkable run of wet years which set in about 1922. General values for the rainfall of 1931, expressed as percentages of the average, 1881 to 1915, are:— England and Wales 108, Scotland 104, Ireland 109, British Isles 107. The accumulated excess over the British Isles during the last 10 years has amounted to 97 per cent., so that in that period we have received practically as much rain as falls on the average in 11 years. Over the country generally 1931 was not as wet as any of the recent years 1930, 1928, 1927, 1924 or 1923, while in Scotland only two of the previous eight years were drier.

The rainfall over the country as a whole was below the average in only three months, viz., March, October and December. The rainfall of each of the six summer months, April to September, exceeded the average, the total excess during this period amounting to 5·7 in. Practically the whole of this excess was confined to the four months, April to July, and the rainfall of these months exceeded that of any other April to July since before 1870. November was the wettest month of the year, with 6·4 in., and the total rainfall equalled that of the whole of March, October and December. July and June were the next wettest months with 4·6 in. and 4·4 in. respectively, and August and January were nearly as wet.

General values for each month are set out in the table below, as percentages of the average for the period 1881 to 1915 :—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	%	%	%	%	%	%	%	%	%	%	%	%
England and Wales	103	124	36	173	150	148	153	143	123	32	143	45
Scotland	128	118	42	106	145	193	136	61	55	82	143	81
Ireland	88	104	101	111	162	174	121	81	101	56	192	66
British Isles	107	118	51	143	151	165	142	104	102	49	153	57

Among the more striking features of the rainfall of 1931, mention may be made of the following incidents. The thunderstorm rains of May 27th-28th gave as much as 4·18 in. at

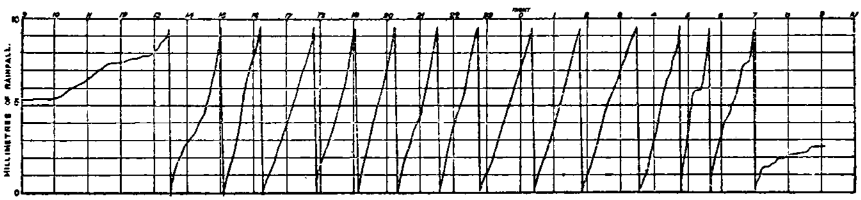
Cardiff, of which 3·60 in. fell in 3½ hours. The last occasion on which so much rain fell in a day in Cardiff was July 14th, 1875. The tornado of June 14th, which caused devastation in Birmingham, was also accompanied by heavy rain in certain localities. The weather of August was characterised by an extraordinary series of violent storms, of which in south-west London those of the 5th and 14th were most striking. On the former occasion 0·88 in. fell in 25 minutes at Merton Park and on the latter 2·34 in. during a few hours at Worcester Park. The rainfall of September 3rd was remarkable in that 4·97 in. was recorded at Kildale Hall, in the north Yorkshire Wolds, the same station which recorded 11·04 in. during the persistent cyclonic rains of July 20th-23rd, 1930. Perhaps the most striking rains of the year were those of November 2nd and 3rd, which were not only widespread but gave as much as 8·65 in. at Patterdale in the English Lake District and 9·61 in. at Blaenau-hydfer to the north of the Black Mountains.

In each country less than the average rainfall was recorded at many stations. These were most numerous in the north-west of Scotland and the south-east of England, while less than the average was also recorded in the south-west of Ireland, along the north-east coast of England and in Anglesey. Deficiencies occurred over most of Scotland to the north-west of a line drawn from Arran to Elgin, but excluding most of Sutherland and Caithness. In London the rainfall was slightly above the average, though less than the average occurred both to the north and to the south, the latter area including most of the south coast from Margate to Weymouth. Less than the average also occurred near Louth in Lincolnshire and from Morpeth to Berwick-on-Tweed. The areas with the largest excesses occurred in the central portion of England and Wales. There was more than 120 per cent. over a large area stretching from Barmouth and Birmingham in the south-west, to Hull and Middlesbrough in the north-east. More than 120 per cent. was also recorded over small areas in central and eastern Ireland and in the Isle of Man. Small areas in the neighbourhood of Manchester, Barnsley and Goole received rather more than 130 per cent. of the average. In most parts of the British Isles the rainfall was therefore fairly close to the average. The main features of the distribution of the rainfall of 1931 was the area across the southern Pennines with a rainfall markedly in excess of the average. This was mainly due to the unusual prevalence of cyclonic rains, especially in the summer months. The more congenial weather in the north-west of Scotland during the late summer and autumn stands out in marked contrast. The dry October and December in the south-east of England were mainly responsible for the small annual totals in that region.

J. GLASSPOOLE.

Rainfall at Princetown, November 3rd-4th, 1931

In the article on *The Abnormal Weather of November*, 1931, in the December number of this magazine, details are given of the unusually heavy rain of November 2nd and 3rd, at certain stations in the mountainous areas of the west of England and Wales. A copy of the trace from the recording rain-gauge at Princetown Prison on Dartmoor for the "rainfall day" of the 3rd is reproduced. The amounts recorded at this station for



the 2nd and 3rd were 0·80 in. and 5·39 in. The gauge was not apparently in perfect adjustment as the pen-arm has not risen to the top of the chart. The amount recorded by the check gauge alongside is, however, in close accord with that shown by the chart if each ascent is taken as 10 mm. The fall is remarkable not only for the amount, but also because of the persistence of the heavy rain. The total duration of the rainfall of that day was 23 hours. The rain was accompanied by fog.

J. GLASSPOOLE.

Books Received

Deutsches Meteorologisches Jahrbuch, 1929. Freie Hanrestadt, Bremen. Edited by Dr. A. Mey, Jahrgang 40, Bremen, 1930.

Rêsumés mensuels et annuels des Observations Météorologiques faites aux stations de II ordre du Réseau de l'Observatoire Geophysique à l'orient lointain. Année 1920. Fascicule III. Vladivostok, 1930.

Tätigkeit des Schweizerischen Forschungsinstitutes für Hochgebirgsklima und Tuberkulose in Davos, 1929-30.

La perméabilité de tissus de vêtements pour le rayonnement solaire dans diverses régions spectrales. (Reprinted from C.R. Soc. Suisse de Géophys. Météor. Astr.).

Obituary

Mr. Preston C. Day.—We regret to record the death of Mr. P. C. Day on his 72nd birthday, on October 21st, 1931. Mr. Day was born near Damascus, Md.; he joined the Signal Corps of the United States Army in June, 1883, and was associated with meteorology from that date until his retirement in 1930. For nearly 25 years he compiled or edited the climatological text, charts and tables in the *Monthly Weather Review*. He also prepared a number of statistical monographs, including "Winds of the United States and their economic uses" and "Daily, monthly and annual normals of precipitation," and edited the well-known "Bulletin W," a series of climatic summaries for the United States, Alaska and Hawaii.

News in Brief

The Prix Henri Wilde, of the French Academy of Sciences, has been awarded to M. Edmund Rothé, Director of the Institut de Physique du Globe at Strasbourg, for his geophysical work, including the first radiogoniometric researches in France

Capt. A. Hoffmann has been appointed Chief of the Meteorological Bureau of Chile. M. Waldo Nuño, the former Chief, will continue to assist the service.

The Weather of December, 1931

Pressure was above normal in a belt extending from north Africa and Turkey across southern and central Europe, southern Scandinavia, the Azores, Iceland, southern Greenland to north-east Canada and also over the Atlantic in the neighbourhood of the Bermudas, the greatest excess being 15·7 mb. at the Scilly Isles. Pressure was below normal over northern Scandinavia, Russia, Spitsbergen, part of the North Atlantic from Madeira to Newfoundland and over most of the United States and western Canada, the greatest deficit being 12·9 mb. at Spitsbergen. Temperature and rainfall were both above normal in Spitsbergen and Scandinavia, being as much as 11°F. and 54 mm. respectively in excess at Spitsbergen. Further south they were about normal, and in central and southern Europe they were both below normal.

Apart from two cold spells from about the 16th-22nd and again from the 29th-31st, December was very mild. The month was also very dry and in many parts sunshine was below normal. On the first the western part of a large anticyclone, which was moving away eastwards, still lay over England and caused widespread mist and fog inland and much sun on the coasts, 6·5 hrs. at Falmouth and 6·0 hrs. at Lowestoft, while Scotland and Ireland were already under the influence of the depression centred over the North Atlantic. From now until about the 10th, depressions continued to move north-east off the north of Scotland. Strong winds or gales occurred in the western half of the country on the night of the 2nd-3rd and extended to all districts on the 3rd and 4th. Weather was unsettled with rain, heavy locally at times but bright intervals, 1·60 in. of rain fell at Blaenau-hydfer (Brecon) and 1·35 in. at Dunmanway (Co. Cork) on the 2nd, 1·81 in. at Dalwhinnie on the 3rd and 0·99 in. at Brighton on the 6th. The 7th was a sunny day over the kingdom generally, 7·2 hrs. bright sunshine occurred at Rothamsted. Thunderstorms occurred in Lincolnshire on the 3rd and at Eskdalemuir on the 5th. Temperature began to rise on the 2nd and on the 4th maxima reached 60°F. locally in the south. At Kew the maximum, 60°F., was a record for December. On the 10th, the weather became anticyclonic but continued mild until the 14th, when a depression west of Iceland moved eastwards, displacing the anticyclone. In the rear of this depression cold northerly winds brought a considerable drop in temperature and an anticyclone moved south from Iceland. This remained centred near the British Isles until the 22nd, giving very cold weather with slight local rain and from the 17th-20th considerable fog, though the 18th was sunny in some districts. Some low maxima were reported, 27°F. at Ross-on-Wye on the 18th and 19th and at Cheltenham on the 19th, and 31°F. at Leamington on the 18th, while minima in the screen fell to 18°F. at Rhayader on the 19th and on the grass to 10°F. at Rhayader on the 18th and to 14°F. at several places. By the 23rd the winds had become south-westerly again and mild weather was experienced everywhere, especially in Scotland where maxima were higher than in England or Ireland. At Aberdeen the maximum on the 24th, 61°F., was a record for December. Heavy rain was experienced in the west on the 23rd, 3·02 in. at Dungeon Ghyll and 2·65 in. at Sawrey (Lancs.), but over the Christmas season the weather was mild and dry with some sun most days. Thunderstorms occurred in north-west England on the 28th. On the 29th, however, cold northerly winds swept across the country and snowstorms were reported from Scotland, north-east England and the Midlands, and slight snow or sleet from elsewhere in the British Isles. On the 30th and 31st snow still lay thick in the north and it remained cold in the south, but from the evening of the 31st until January 2nd there was a large rise in temperature as the wind backed to south-west. Mr. Wooldridge, of 17, Gardiner Street, Market Harborough, has sent the following notes :—

"December 31st.	Maximum 34°	11 p.m.	18° (minimum).
January 1st.	9 a.m. 35°	9 p.m.	49°
,, 2nd.	,, 51°	,,	53° (minimum).

Thus from a minimum of 18°F. on the night of December 31st-January 1st we had a continuous rise to 53°F. two nights later."

The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	11	—12	Liverpool	36	— 7
Aberdeen	45	+ 9	Ross-on-Wye	46	+ 4
Dublin	30	—18	Falmouth	42	—13
Birr Castle	32	—11	Gorleston	35	—10
Valentia	14	—27	Kew	29	— 8

The special message from Brazil states that the rainfall was scarce in the northern and central regions with averages 0·91 in. and 2·64 in. below normal respectively, and irregular in the southern regions with an average 0·04 in. above normal. Coffee, cane and cotton crops were in good condition, but the weather was unfavourable for vegetables and cereals. Eight anticyclones passed across the country. At Rio de Janeiro pressure was normal and temperature 1·1°F. above normal.

Miscellaneous notes on weather abroad culled from various sources.

Bad weather was experienced in central and southern Italy about the middle of the month, and a gale and snowstorm swept across Tuscany on the 13th. After 3 days of continuous rain the Maritza overflowed and interrupted railway communications between Bulgaria and Turkey. Severe cold occurred in Switzerland about the 22nd and several minor lakes were frozen over, but owing to the drought there was no snow under 5,000 ft. The rain which fell in Florence on the 28th froze on reaching the ground and formed a surface of ice, a rare occurrence so far south. Snow fell in Switzerland on the 29th down to 3,000 ft., breaking the drought which had prevailed throughout December. Navigation had closed at most of the Finnish ports by the 24th (*The Times*, December 9th-30th).

Severe storms occurred off the coasts of Algiers on the 9th-14th, and Constantine and the surrounding country were covered with snow. A storm in Tunis disorganised all communications to that town. Heavy SE. gales which swept Cape Province from the 28th to January 1st brought torrential rains (unusual for December) over wide areas, especially the Midlands district. The Sundays River and the Gamtoos River both flooded low-lying lands in their vicinity, and the railway between Riversdale and Port Elizabeth was badly damaged (*The Times*, December 15th-January 2nd).

Floods occurred in the south of Queensland early in the month destroying much of the wheat crop and drowning three people. A heat wave was experienced in South Australia from about the 24th to the end of the month, when a temperature of 115°F. was reported from Adelaide on the 29th, which is a record there for December (*The Times*, December 10th-30th).

Temperature was above normal generally in the United States except during the first half of the month in the Mountainous Regions and along the Pacific coast, and rainfall was mainly about normal except in the Gulf States and Ohio Valley about the middle of the month, when it was heavy (*Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*).

Rainfall, 1931—General Distribution

	Dec.	Year	
England and Wales ...	45	108	per cent of the average 1881-1915.
Scotland	81	104	
Ireland	66	109	
British Isles	57	107	

Rainfall : December, 1931 : England and Wales

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	·82	34	*Leics* .	Belvoir Castle	·76	31
Sur .	Reigate, Alvington	·85	27	*Rut* .	Ridlington	·96	38
Kent .	Tenterden, Ashenden	·58	19	*Linc* .	Boston, Skirbeck	·88	41
,, .	Folkestone, Boro. San.	·67	...	,, .	Cranwell Aerodrome	·97	44
,, .	Margate, Cliftonville	·41	18	,, .	Skegness, Marine Gdns	1·32	60
,, .	Sevenoaks, Speldhurst	·55	...	,, .	Louth, Westgate	1·24	44
Sus .	Patching Farm	·90	27	,, .	Brigg, Wrawby St.	1·07	...
,, .	Brighton, Old Steyne	1·24	40	*Notts* .	Worksop, Hodsock	1·02	43
,, .	Heathfield, Barklye	1·13	31	*Derby* .	Derby, L. M. & S. Rly.	1·14	44
Hants .	Ventnor, Roy. Nat. Hos.	·93	28	,, .	Buxton, Devon Hos.	2·02	36
,, .	Fordingbridge, Oaklnds	1·04	26	*Ches* .	Runcorn, Weston Pt.	1·57	50
,, .	Ovington Rectory	·62	16	,, .	Nantwich, Dorfold Hall	1·75	...
,, .	Sherborne St. John	·72	22	*Lancs* .	Manchester, Whit. Pk.	1·39	43
Berks .	Wellington College	·52	18	,, .	Stonyhurst College	3·29	68
,, .	Newbury, Greenham	·95	30	,, .	Southport, Hesketh Pk	1·82	56
Herts .	Welwyn Garden City	1·09	...	,, .	Lancaster, Strathspey	3·58	...
Bucks .	H. Wycombe, Flackwell	·84	...	*Yorks* .	Wath-upon-Dearne	·60	25
Oxf .	Oxford, Mag. College	·96	41	,, .	Bradford, Lister Pk.	1·48	44
Nor .	Pitsford, Sedgebrook	·81	33	,, .	Oughtershaw Hall	4·00	...
,, .	Oundle	·57	...	,, .	Wetherby, Ribston H.	1·09	44
Beds .	Woburn, Crawley Mill	·88	38	,, .	Hull, Pearson Park	1·07	44
Cam .	Cambridge, Bot. Gdns.	·82	42	,, .	Holme-on-Spalding	·86	...
Essex .	Chelmsford, County Lab	·63	28	,, .	West Witton, Ivy Ho.	1·95	53
,, .	Lexden Hill House	·51	...	,, .	Felixkirk, Mt. St. John	1·38	57
Suff .	Hawkedon Rectory	1·16	48	,, .	Pickering, Hungate	1·00	40
,, .	Haughley House	·79	...	,, .	Scarborough	1·57	66
Norf .	Norwich, Eaton	1·79	69	,, .	Middlesbrough	·96	49
,, .	Wells, Holkham Hall	1·15	56	,, .	Baldersdale, Hury Res.	2·51	...
,, .	Little Dunham	...	...	*Durh* .	Ushaw College	·86	34
Wilts .	Devizes, Highclere	·96	31	*Nor* .	Newcastle, Town Moor	·99	41
,, .	Bishops Cannings	·97	30	,, .	Bellingham, Highgreen	2·28	63
Dor .	Evershot, Melbury Ho.	1·94	38	,, .	Lilburn Tower Gdns.	1·85	70
,, .	Creech Grange	1·30	38	*Cumb* .	Geltsdale	2·33	...
,, .	Shaftesbury, Abbey Ho.	1·29	36	,, .	Carlisle, Scaleby Hall	2·52	78
Devon .	Plymouth, The Hoe	2·21	44	,, .	Borrowdale, Seathwaite	14·50	94
,, .	Polapit Tamar	...	...	,, .	Borrowdale, Rosthwaite	9·99	...
,, .	Holne, Church Pk. Cott.	4·22	50	,, .	Keswick, High Hill	4·42	...
,, .	Cullompton	1·92	44	*West* .	Appleby, Castle Bank	2·75	70
,, .	Sidmouth, Sidmount	1·80	46	*Glam* .	Cardiff, Ely P. Stn.	2·50	49
,, .	Filleigh, Castle Hill	3·06	...	,, .	Treherbert, Tynywaun	6·03	...
,, .	Barnstaple, N. Dev. Ath	2·32	52	*Carm* .	Carmarthen Friary	2·86	50
,, .	Dartm'r, Cranmere Pool	5·40	...	*Pemb* .	Haverfordwest, School	2·69	47
Corn .	Redruth, Trewirgie	2·17	35	*Card* .	Aberystwyth	3·44	...
,, .	Penzance, Morrab Gdn.	2·82	50	,, .	Cardigan, County Sch.	1·99	...
,, .	St. Austell, Trevarna	2·10	35	*Brec* .	Crickhowell, Talymaes	2·50	...
Soms .	Chewton Mendip	1·36	25	*Rad* .	Birm W. W. Tyrmynydd	4·26	52
,, .	Long Ashton	2·23	58	*Mont* .	Lake Vyrnwy	4·50	65
,, .	Street, Millfield	1·30	38	*Denb* .	Llangynhafal	1·98	60
Glos. .	Cirencester, Gwynfa	1·79	53	*Mer* .	Dolgelly, Bryntirion	5·49	80
Here .	Ross, Birchlea	1·35	45	*Carn* .	Llandudno	1·41	45
,, .	Ledbury, Underdown	1·07	38	,, .	Snowdon, L. Llydaw 9	14·90	...
Salop .	Church Stretton	1·49	44	*Ang* .	Holyhead, Salt Island	2·27	55
,, .	Shifnal, Hatton Grange	·97	53	,, .	Lligwy	3·70	93
Worc .	Ombersley, Holt Lock	·89	34	*Isle of Man*			
,, .	Blockley	1·15	...		Douglas, Boro' Cem.	3·57	72
War .	Birminghm, Edgbaston	·88	33	*Guernsey*			
Leics .	Thornton Reservoir	1·01	38		St. Peter P't. Grange Rd.	1·59	39

Rainfall : December, 1931 : Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per cent. of Av.
Wigt .	Pt. William, Monreith	...	...	*Suth* .	Melvich	4·21	...
,, .	New Luce School	4·72	85	,, .	Loch More, Achfary	15·05	163
Kirk .	Carsphairn, Shiel	8·12	87	*Caith* .	Wick	2·80	91
Dumf.	Dumfries, Crichton, R.I	3·56	...	*Ork* .	Pomona, Deerness	5·64	135
,, .	Eskdalemuir Obs.	5·29	76	*Shet* .	Lerwick	6·34	132
Roxb .	Branxholm	2·39	65	*Cork* .	Caheragh Rectory	4·29	...
Selk .	Ettrick Manse	5·34	86	,, .	Dunmany Rectory	3·94	49
Peeb .	West Linton	2·87	...	,, .	Ballinacurra	2·02	39
Berk .	Marchmont House	·75	27	,, .	Glanmire, Lota Lo.	2·38	43
Hadd .	North Berwick Res.	·57	26	*Kerry*.	Valentia Obsy.	5·04	76
Midl .	Edinburgh, Roy. Obs.	1·06	49	,, .	Gearahameen	7·00	...
Lan .	Auchtyfardle	4·03	...	,, .	Killarney Asylum	4·32	59
Ayr .	Kilmarnock, Kay Pk.	4·58	...	,, .	Darrynane Abbey	3·54	60
,, .	Girvan, Pinmore	5·36	90	*Wat* .	Waterford, Brook Lo.	...	...
Renf .	Glasgow, Queen's Pk.	3·92	93	*Tip* .	Nenagh, Cas. Lough	2·73	59
,, .	Greenock, Prospect H.	7·70	98	,, .	Roscrea, Timoney Park	2·41	...
Bute	Rothesay, Ardencraig.	6·77	124	,, .	Cashel, Ballinamona	2·23	51
,, .	Dougarie Lodge	4·21	...	*Lim* .	Foynes, Coolnanes	2·60	55
Arg .	Ardgour House	16·53	...	,, .	Castleconnel Rec.	4·08	...
,, .	Manse of Glenorchy	...	...	*Clare* .	Inagh, Mount Callan	6·26	...
,, .	Oban	6·62	98	,, .	Broadford, Hurdlest'n.	3·70	...
,, .	Poltalloch	5·70	89	*Wexf*.	Gorey, Courtown Ho.	2·53	66
,, .	Inveraray Castle	11·02	111	*Kilk* .	Kilkenny Castle	1·61	46
,, .	Islay, Eallabus	4·71	79	*Wic* .	Rathnew, Clonmannon	1·56	...
,, .	Mull, Benmore	17·80	...	*Carl* .	Hacketstown Rectory	2·58	63
,, .	Tiree	3·46	...	*Leix* .	Blandsfort House	2·41	65
Kinr .	Loch Leven Sluice	1·58	40	,, .	Mountmellick	2·92	...
Perth .	Loch Dhu	10·20	111	*Off'ly* .	Birr Castle	2·07	63
,, .	Balquhidder, Stronvar	6·19	...	*Kild'r*.	Monasterevin	1·76	...
,, .	Crieff, Strathearn Hyd.	2·79	57	*Dubl* .	Dublin, FitzWm. Sq.	·99	40
,, .	Blair Castle Gardens	2·84	74	,, .	Balbriggan, Ardgillan.	1·25	43
Angus.	Kettins School	1·21	40	*Me'th* .	Beauparc, St. Cloud	2·11	...
,, .	Dundee, E. Necropolis	·92	35	,, .	Kells, Headfort	2·74	72
,, .	Pearsie House	1·69	..	*W.M.*	Moate, Coolatore	2·60	...
,, .	Montrose, Sunnyside	1·03	37	,, .	Mullingar, Belvedere	3·07	83
Aber .	Braemar, Bank	2·88	81	*Long* .	Castle Forbes Gdns.	2·60	65
,, .	Logie Coldstone Sch.	...	.	*Gal* .	Ballynahinch Castle	7·19	96
,, .	Aberdeen, King's Coll.	1·39	43	,, .	Galway, Grammar Sch.	4·10	...
,, .	Fyvie Castle	1·77	52	*Mayo* .	Mallaranny	6·30	...
Moray.	Gordon Castle	1·74	65	,, .	Westport House	4·35	76
,, .	Grantown-on-Spey	1·57	58	,, .	Delphi Lodge	10·97	91
Nairn.	Nairn, Delnies	1·07	48	*Sligo* .	Markree Obsy.	3·49	74
Invs .	Ben Alder Lodge	7·44	...	*Cav'n* .	Belturbet, Cloverhill	2·33	63
,, .	Kingussie, The Birches	3·67	..	*Ferm* .	Enniskillen, Portora	...	...
,, .	Loch Quoich, Loan	20·55	...	*Arm* .	Armagh Obsy	2·58	82
,, .	Glenquoich	...	...	*Down*.	Fofanny Reservoir	5·60	...
,, .	Inverness, Culduthel R.	2·04	..	,, .	Seaforde	3·34	81
,, .	Arisaig, Faire-na-Squir	6·11	...	,, .	Donaghadee, C. Stn.	2·95	93
,, .	Fort William	11·32	...	,, .	Banbridge, Milltown	2·15	...
,, .	Skye, Dunvegan	6·14	...	*Antr* .	Belfast, Cavehill Rd.	3·23	...
R & C.	Alness, Ardross Cas.	4·30	104	,, .	Glenarm Castle	4·30	...
,, .	Ullapool	4·84	76	,, .	Ballymena, Harryville	3·32	75
,, .	Torridon, Bendamph	...	...	*Lon* .	Londonderry, Creggan	3·74	85
,, .	Achnashellach	13·98	...	*Tyr* .	Omagh, Edenfel	4·40	104
,, .	Stornoway	5·69	...	*D.n* .	Malin Head	2·81	...
Suth .	Lairg	5·99	148	,, .	Dunfanaghy	4·14	...
,, .	Tongue	4·41	89	,, .	Killybegs, Rockmount	4·19	57

Climatological Table for the British Empire, July, 1931.

STATIONS	PRESSURE: Mean of Day M.S.L.	PRESSURE: Diff. from Normal	TEMPERATURE: Absolute Max.	TEMPERATURE: Absolute Min.	TEMPERATURE: Mean Values Max.	TEMPERATURE: Mean Values Min.	TEMPERATURE: Mean Values ½ max. and min.	TEMPERATURE: Mean Values Diff. from Normal	TEMPERATURE: Mean Wet Bulb	Relative Humidity	Mean Cloud Am'nt	PRECIPITATION: Am'nt	PRECIPITATION: Diff. from Normal	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Per-cent-age of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F	°F.	%	0—10	in.	in.			
London, Kew Obsy.	1010·2	— 5·6	76	50	69·4	55·2	62·3	— 0·4	56·0	81	7·5	2·91	+ 0·74	12	4·9	30
Gibraltar	1015·4	— 1·4	95	63	83·4	66·8	75·1	+ 0·3	64·6	78	3·5	0·00	— 0·03	0	..	..
Malta	1014·6	— 0·1	103	67	87·3	74·3	80·8	+ 2·5	72·6	68	1·3	0·00	— 0·05	0	12·5	88
St. Helena	1017·2	+ 0·5	66	53	60·5	54·6	57·5	— 1·0	55·6	94	9·1	4·80	..	25	..	..
Sierra Leone	1014·4	+ 1·7	86	67	82·1	69·5	75·8	— 2·8	75·0	91	8·9	40·65	+ 5·07	30	..	..
Lagos, Nigeria	1013·2	— 0·6	85	72	81·6	74·3	77·9	— 0·1	74·6	87	9·3	17·81	+ 7·13	19	2·3	..
Kaduna, Nigeria	1013·8	— 1·1	90	..	87·4	..	..	..	71·6	87	9·0	12·20	+ 4·00	19	..	..
Zomba, Nyasaland	1015·8	— 2·7	81	47	72·1	54·2	63·1	+ 1·1	..	68	3·8	0·36	+ 0·01	3	..	..
Salisbury, Rhodesia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cape Town	1022·6	+ 1·3	81	33	62·7	47·6	55·1	+ 0·4	48·6	85	4·2	1·55	— 2·07	15	..	..
Johannesburg	1021·1	— 2·7	65	29	56·9	39·8	48·3	— 2·1	40·0	61	4·5	1·97	+ 1·64	12	7·4	69
Mauritius	1019·0	— 1·4	78	55	76·1	63·5	69·8	+ 1·5	66·2	74	4·6	1·86	— 0·63	15	8·1	74
Calcutta, Alipore Obsy.	999·9	+ 0·7	93	75	89·3	79·3	84·3	+ 0·6	80·0	90	9·2	13·70	+ 1·00	16*	..	..
Bombay	1003·4	— 0·5	89	73	85·4	76·1	80·7	— 0·7	78·0	89	9·3	47·50	+ 23·23	30*	..	..
Madras	1005·1	+ 0·6	101	70	94·3	78·4	86·3	— 1·3	75·8	70	7·9	5·73	+ 1·89	6*	..	..
Colombo, Ceylon	1010·0	+ 0·9	86	71	84·9	76·5	80·7	— 0·5	77·2	81	8·2	12·12	+ 7·69	23	5·8	46
Singapore	1009·8	+ 0·9	92	72	87·3	76·1	81·7	— 0·2	77·6	81	7·6	6·94	+ 0·17	15	5·9	49
Hongkong	1006·9	+ 2·2	90	76	87·4	79·0	83·2	+ 0·7	79·1	77	7·6	9·86	— 4·16	27	7·4	55
Sandakan	..	..	90	73	87·9	75·0	81·5	— 0·3	76·7	83	..	5·01	— 1·71	14	..	..
Sydney, N.S.W.	1016·1	— 2·2	77	38	63·5	45·5	54·5	+ 1·8	48·2	74	4·4	12·77	+ 7·97	9	6·7	66
Melbourne	1016·9	— 2·0	64	35	55·8	42·7	49·3	+ 0·6	45·3	83	6·5	2·09	+ 0·23	19	3·5	36
Adelaide	1019·3	— 1·0	66	38	57·9	45·0	51·5	— 0·3	46·9	80	8·6	3·73	+ 1·09	22	2·7	27
Perth, W. Australia	1017·1	— 1·9	69	39	62·4	50·2	56·3	+ 1·1	51·6	77	6·9	7·90	+ 1·34	21	4·3	42
Coolgardie	1019·8	0·0	69	32	60·3	43·3	51·8	+ 0·6	46·8	73	7·1	0·78	— 0·09	9	..	..
Brisbane	1018·0	— 0·4	81	42	69·1	50·4	59·7	+ 1·2	52·4	67	3·3	1·79	— 0·49	6	8·1	76
Hobart, Tasmania	1010·4	— 3·3	61	30	50·7	40·1	45·4	— 0·3	40·5	75	6·9	2·64	+ 0·46	19	3·6	38
Wellington, N.Z.	1009·8	— 4·1	59	34	51·5	42·0	46·7	— 1·3	44·4	80	7·4	5·39	— 0·24	19	3·9	41
Suva, Fiji	1015·0	+ 1·0	84	65	80·3	70·6	75·5	+ 2·1	71·2	80	6·5	8·70	+ 3·77	21	5·3	47
Apia, Samoa	1012·3	+ 0·4	87	66	84·1	73·0	78·5	+ 1·3	74·7	74	5·6	3·93	+ 0·95	9	8·4	74
Kingston, Jamaica	1012·9	— 1·8	92	71	88·1	73·7	80·9	— 0·8	73·2	83	6·6	7·80	+ 6·18	9	5·4	41
Grenada, W.I.	1012·9	— 0·4	89	72	86·5	73·8	80·1	+ 0·9	73·6	76	7·2	18·11	+ 8·68	31	..	..
Toronto	1012·3	— 2·1	98	54	82·7	64·5	73·6	+ 4·5	66·5	71	5·7	3·10	+ 0·26	10	8·6	57
Winnipeg	1010·6	— 1·7	98	48	79·4	57·4	68·4	+ 2·0	57·8	83	4·7	3·08	— 0·02	16	..	..
St. John, N.B.	1013·4	— 0·2	80	49	70·2	54·3	62·3	+ 1·9	58·6	87	7·0	5·07	+ 1·44	17	6·0	39
Victoria, B.C.	1016·5	— 0·8	86	49	69·7	53·3	61·5	+ 1·4	56·5	74	2·5	0·33	— 0·09	2	12·5	80