M.O. 313.

The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 64

Oct. 1929

No. 765

LONDON: PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

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

Conference of Empire Meteorologists, London, August, 1929

By F. ENTWISTLE, B.Sc.
Superintendent, Aviation Services Division.

It is a well recognised fact that the study and practice of meteorological science in any country depend for success on close and efficient co-operation between the meteorological services of the various countries of the world. The task of securing international agreement on such matters as methods of observations, forms of codes and times of issue of wireless weather reports is undertaken by the International Meteorological Committee and its various Commissions, and the progress which has been made in the different branches of meteorology, particularly since the war, is due in no small measure to the work of this Organization. There are, however, special meteorological problems which affect the British Empire as distinct from the wider international family and, while the directors of the various Empire meteorological services are represented on the International Meteorological Committee, there is no similar organization for the discussion of more intimate Imperial matters. It is for this reason that the Conference of Empire Meteorologists which met in London in August and which included representatives from India, the Dominions and more than twenty Colonies, marked an important step in the development of Imperial communications. Shortly after the war Sir

(86360) P.S. 1602/81 1050. 10/29 M. & S. *Gp. 303*

Napier Shaw, then Director of the Meteorological Office, arranged for a conference of the directors of the meteorological services of the Empire, but in addition to Great Britain, only Australia, Canada, Ceylon, India, New Zealand and South Africa were represented on that occasion. The 1929 Conference may be regarded as the first of its kind, in that it included representatives from practically every part of the Empire.

The delegates assembled on August 20th at the Air Ministry, where they were welcomed by Lord Thomson, Secretary of State for Air. Dr. G. C. Simpson, Director of the Meteorological Office, was unanimously elected President of the Conference, and after he had addressed the delegates and outlined the programme of work which had been drawn up, the meeting adjourned until the following day when the main work of the Conference began.

The first three days were devoted to the discussion of meteorology in relation to aviation and airship navigation in the British Empire. From the point of view of recent developments in aviation, particularly the inauguration of the first commercial Empire air route between England and India and of the projected experimental Empire airship flights, the choice of the present year for the Conference was particularly happy, in that it afforded an opportunity for full discussion of the various problems which had arisen in connexion with these developments in a way that would not otherwise have been possible. The procedure adopted was followed throughout the Conference. The Superintendent of the Division of the Meteorological Office responsible for the particular branch of the subject under discussion read a memorandum which he had prepared, and his address was then followed by a general discussion. In the case of aviation and airships, the first morning was devoted to placing the memoranda before the delegates. The first of these dealt with the development of Imperial air routes and the meteorological requirements of the Royal Air Force and of Dominion air services. The arrangements for the supply of weather information on the civil international air routes of western Europe were described together with an outline of the meteorological arrangements made in connexion with the recently inaugurated Air Mail to India. The requirements that would have to be met when other long-distance air routes for regular commercial flying came into operation were then dealt with. The second memorandum by Mr. M. A. Giblett, Superintendent of the Airships Services Division, dealt with the meteorological problems in relation to airship navigation. The reporting and forecasting organization which had been drawn up for Empire airship flights was described, together with the method of collecting meteorological information and statistics for the selection of airship routes and bases. An account was also given of the experimental investigations into wind structure and temperature conditions which had been carried out in this country and in Egypt, and which are of particular importance in the navigation and especially the mooring of airships.

The two papers were followed by a short address by Lieut.-Col. E. Gold, the President of the Meteorological Sub-Committee of the International Commission for Air Navigation, which is responsible for securing international agreement regarding the general organization on air routes. Col. Gold gave an account of the origin and development of the International Commission, and dealt with the question of the relationship of the meteorological services of the Empire with this organization. In the afternoon the delegates visited Croydon aerodrome, where they had an opportunity of inspecting the arrangements for the supply of meteorological information to pilots in addition to the general organization. By the courtesy of Imperial Airways Ltd. the delegates made a short flight in a three-engined "Argosy," one of the air liners used on the regular Continental services. The following day was devoted to a visit to the Royal Airship Works at Cardington. Here the delegates had an opportunity of inspecting the state airship R.101 now nearing completion, as well as the general arrangements for mooring and operating airships when flying operations begin. The third day was given up to a discussion on the application of the Empire's meteorological resources to aviation. A wide range of subjects was dealt with, including the collection of data to supplement the information already available for projected aeroplane and airship routes, the methods of observation and general organization. Sub-committees were appointed to consider in greater detail certain specific requirements, such as the meteorological organization on the projected air route between Cairo and Cape Town.

Three further days were devoted to marine meteorology, the outstanding problem of which is to reach agreement as to what observations should be collected from sea areas, how and when they should be made and how they should be collated. These problems were dealt with in memoranda presented to the delegates by Captain L. A. Brooke Smith, Marine Superintendent of the Meteorological Office. He described the organization of the Marine Division, which collates observations from a fleet of about 500 regular observing ships, the officers of which are, for the time being, the Corps of Voluntary Marine Observers. Their activities extend wherever the British Ensign is carried at sea, and they are so selected that their sailing schedules provide, as far as possible, a constant network of observations all over the oceans. Reference was also made to the International Conference for the Safety of Life at Sea which met in London in the spring of this year. Under a scheme put forward at this Conference 1,000 ships of all nationalities are to co-operate in a world-wide scheme for the transmission of weather reports by wireless, the number allotted to each country being proportional to its share of the world's tonnage. The discussions which followed dealt with the participation of the various parts of the Empire in the collection of data from different ocean areas, the adoption of a uniform ship's log in all parts of the Empire and the practicability of securing uniformity in the arrangements for transmitting messages by wireless telegraphy from ship to shore and from the shore to ships. The latter involved agreement as to the times at which observations should be taken and despatched, the codes used for transmitting the reports and the general organization which would enable a ship to obtain sufficient data for the construction of a synoptic weather chart on board. The question of gale warnings was also examined and the practicability of adopting a uniform system for visual warnings at coast stations was discussed.

Further subjects which came before the Conference included the meteorological requirements of the Royal Navy and of the Army and the question of the so-called "polar year." In connexion with the latter Dr. Simpson recalled that in the year 1882-3, twelve countries had co-operated in an intensive attack on the problems of polar meteorology by sending expeditions into the Arctic Circle, and that the data then collected still formed an invaluable source of information for all engaged in polar work. A proposal had been made recently to celebrate the Jubilee of this great scientific enterprise by organising special observations in high latitudes in the year 1932-3, and a small international sub-committee had been formed under the chairmanship of Dr. Simpson to consider these proposals. A discussion took place with regard to the co-operation of the British Empire in the forthcoming expedition in both the northern and southern hemispheres.

When it was known that the Conference of Empire Meteorologists was to be held in London, the Ministry of Agriculture asked for two days to be allotted for the discussion of questions relating to meteorology and agriculture, and an Agricultural Section was formed under the chairmanship of Sir Napier Shaw. This Section met on August 29th and 30th under arrangements made by the Ministry of Agriculture. The subjects dealt with included meteorology in relation to plant physiology, light and growth and fruit production; climate and animal distribution; weather and insects; weather and the fungus diseases of plants; and the use of meteorological data in the improvement of crop estimates. On August 31st the Section visited the Royal Horticultural Society's Gardens at Wisley and the Lord Wandsworth Agricultural College at Long Sutton to inspect agricultural meteorological work.

The last meeting of the Conference, which took place on the day before the meetings of the Agricultural Section, was a joint section of the latter and the general Conference. At this meeting the subject of General Climatology engaged the attention of the delegates during the morning. The discussion, which was opened by Mr. R. G. K. Lempfert, was directed to two main points, the contribution made by the Empire to the *Réseau Mondial*, an annual statistical summary of meteorological observations over the whole world, which is prepared in the Meteorological Office, and the arrangements for the distribution of reprints of the meteorological statistics which are contained in the Colonial Blue-books. Dr. C. E. P. Brooks, Superintendent of the General Climatology Division of the Meteorological Office, then opened a discussion on the collection, tabulation and publication of climatological data, in which attention was directed to the methods and hours of climatological observations and the standard form in which they should be published. The afternoon meeting was devoted to the important subject of seasonal forecasting. Dr. Simpson gave an account of a paper prepared at his request by Sir Gilbert Walker describing statistical methods of correlation which the latter had developed, and Dr. Normand, Director - General of Observatories, India Meteorological Department, spoke on the application of Sir Gilbert Walker's methods to forecasting the arrival of the monsoon in India.

Although the programme of work which had been drawn up for the Conference was very heavy, time was found for lighter social intercourse. On the evening of August 20th, Dr. and Mrs. Simpson received the delegates at a soirée held at the Meteorological Office, South Kensington, to which members of the staff of the Meteorological Office were invited to meet them. An interesting display of instruments, models and diagrams was arranged for the occasion. A week later Sir Henry Lyons held a reception for the delegates at the Science Museum, and on the evening of August 23rd the delegates were entertained by H.M. Government at a dinner at which Mr. F. Montague, Under Secretary of State for Air, presided. As time permitted during the course of the Conference, informal discussions of a very useful nature took place betwen certain of the delegates and representatives of the Meteorological Office. It is too early yet to appraise the full value of the work of the Conference, but the very close liaison between representatives of the various Empire meteorological services brought each one of them more closely in touch with the meteorological problems which are of fundamental importance to the Empire than would have been possible otherwise. From this restricted point of view alone, the Conference was well worth while.

OFFICIAL PUBLICATIONS

GEOPHYSICAL MEMOIRS—

No. 47. *Report on Thames Floods* By A. T. Doodson, D.Sc., Tidal Institute, University of Liverpool, and *Meteorological Conditions associated with High Tides in the Thames.* By J. S. Dines, M.A., Superintendent, Forecast Division, Meteorological Office. (M.O. 307g)

The Report on the Thames Floods of January 6-7th, 1928, gives details of the scientific investigations carried out at the Tidal Institute. The conclusions reached indicate that the land water played only a small part near London Bridge, and that the flooding was due to a surge propagated inwards from the North Sea. The progress of this surge is traced from Dunbar, round to Dover and north again, in the continental shores, as far as the Baltic. Several other instances of travelling surges are also discussed. It is also shown that local winds will not be very effective in raising high water, as their principal effects are experienced about two hours after low water. Floods can only occur when the surge arrives in the Thames coincidentally with normal high tide. The frequency of occurrence is discussed and the conclusion reached, that there is no evidence to show that floods are likely to be more frequent in the future than in the past.

In the second part of the memoir an account is given of the inquiry carried out in the Meteorological Office to determine the possibility of forecasting Thames floods. It was found that almost all cases where the water level at Southend was raised much above the height predicted from the astronomical tides were preceded by a strong wind from the NW. or N. over a considerable part of the North Sea. It is, however, only if such a raising of the water level occurs at a time of high tide that there is any danger of flooding. It is not possible to forecast the exact time at which the disturbance will occur and in practice it is found to coincide much more frequently with half tide than with high tide, thus passing without danger. The conclusion is reached that it is not in the present state of knowledge practicable to forecast a Thames flood in the London area with a sufficient degree of certainty to be of service.

Annual Report of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council, for the year ended 31*st March,* 1929.

This report describes the activities of the Meteorological Office during the seventy-fourth year of its existence and the ninth year in which its cost has been borne on Air Ministry votes. It is arranged in the same form as last year, the various practical applications of meteorology being discussed under separate headings. Under the heading "forecasting" is an account of an investigation into the advisability of giving warnings when meteorological conditions likely to cause high tides in the Thames occur. In the section on aviation is a description of the completed arrangements made for the supply of meteorological information to airships, at the Royal Airship Works at Cardington and also at the mooring towers in Egypt and India. The Office co-operated in the Air Defence Command Exercises carried out by the Royal Air Force in August, 1928.

Discussions at the Meteorological Office

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

October 28th.—*Fog and haze, their causes, distribution and forecasting.* By H. C. Willett (Monthly Weather Rev. 56, 1928, pp.435-68). *Opener*—Capt. F. Entwistle, B.Sc.

November 11th.—*On the exposure of thermometers in Ceylon.* By A. J. Bamford (Colombo, Ceylon, J.Sci. (Sec. E), Bull., I, 1928, pp. 153-67). *Opener*—Mr. J. E. Belasco, B.Sc.

Correspondence

To the Editor, *The Meteorological Magazine*

The Green Flash

It was my good fortune to witness this somewhat rare optical phenomenon on August 25th. At the time I was on a pleasure steamer in the Bristol Channel midway between Weston-super-Mare and Minehead. Looking down channel the sky was perfectly clear apart from a smoke haze which hung about two degrees above the horizon. Visibility was good, with a fresh NW. breeze going.

The setting sun was of a deep yellow colour, and when partly set was still trying to the sight. As the last segment of the sun disappeared it turned a whitish yellow tinged with a deep orange colour, followed immediately by the green flash of a beautiful emerald shade. This remained visible for a fraction of a second and in shape could best be described as bulbous.

E. D. Cooper.

Sunny Nook, Minehead, Somerset. September 2nd, 1929.

Halo into Circumzenithal Arc.

A very pretty sight was witnessed here by me yesterday morning, June 8th, details of which I thought would be worth sending in to you. The double sun rings I first saw at 6h. 35m. B.S.T. outer circle of colour disappeared at 6h. 40m. May have commenced 5 minutes before I first saw it. Cirrus from westsouthwest fast enough pace for rain. This covered the sky thinly to patchily. Surface wind south, light and variable. Parts of the inside ring remained after occurring off and on at intervals. I have sketched roughly what I saw (Fig. 1). Sunshine prevailed through cirrus, light ground mist or blue thunder mist was present. A little cirro-stratus to the southward. The sight I saw was lovely to look upon. At 6h. 55m. a piece of outside ring appeared on top nearest to zenith. (You will see this in Fig. 2 and Fig. 3.) This small part of ring changed to reverse later. Stratus and cumulus cloud came up later from south, also scud. At the time this part of ring changed reverse all other parts of the outside ring had disappeared. While I was watching the small part of coloured ring nearest zenith I suddenly saw a strange sight: I saw the part change to reverse or the other way about (Fig. 3). I am sure my eyes did not deceive me. May I ask you the cause of this sudden change. Was it due to the change of floating crystals in the upper atmosphere? There may have been a lot of volcanic dust at certain heights to the eastward from the recent eruption. This reverse part of ring in Fig. 3 lasted until 7h. 15m., then gradually faded away, no part of the outside ring was seen again after this time, but the two well and sharply coloured parts of the inside ring opposite the sun were seen until 7h. 38m. disappearing as cumulus clouds came up from south.

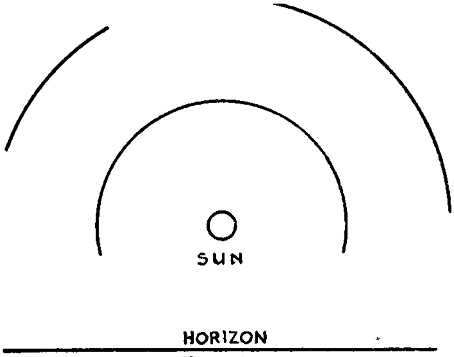

FIG 1.

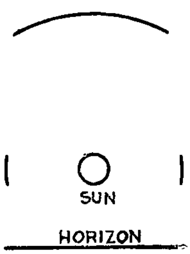

FIG. 2.

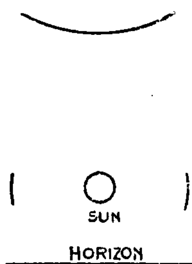

FIG. 3.

R. E. PARKER.

Dale Farm, Great Dalby, Melton Mowbray, Leicestershire, June 9th, 1929.

The phenomenon which Mr. Parker reports, the transformation of a 46° halo into a circumzenithal arc, is most striking. I do not know whether it has ever been put on record before. On the one occasion on which I saw it (I believe on March 15th. 1924, two days after a remarkable sun pillar), the 46° halo lasted but a minute or two before the curvature was reversed. The circumzenithal arc persisted for a quarter of an hour and the parhelia on either side of the sun a little longer. I judge by the distance I walked in the time.

The existence of the halo of 46° implies the presence of ice crystals with faces at right angles, the crystals being oriented at random. For the circumzenithal arc to be found the crystals must be in such a position that each has a horizontal face, the light is refracted through this horizontal face and a vertical face. If crystals of the same type are producing parhelia near the 22° halo, they may be presumed to be hexagonal prisms with their axes vertical.

Mr. Parker's observations (and mine) indicate that hexagonal prisms with flat ends can be floating for some time in the air without any marked tendency to assume the upright position, and that suddenly some force comes into play which pulls the crystals into this position. What the force is I do not know.

F. J. W. WHIPPLE.

Audibility of Thunder

Between 3 and 4 a.m. (B.S.T.), August 28th, I observed flashes of lightning from a southeast point and was somewhat surprised to notice that an interval of 110 seconds elapsed between flash and peal. The thunder, though soft and low, was distinct, and the bright moonlight played upon an anvil-shaped cumulo-nimbus cloud, the upper portion of which appeared above the southeast horizon. This cloud moved very quickly towards the northeast. A second storm following gave a time interval of 90 seconds between lightning and thunder. I have witnesed, or rather heard, long distance thunder in Macedonia (upwards of 20 miles away), but do not recall previously doing so in Great Britain. The night was unusually calm and still for a London suburb.

A. F. HARRISON.

36, *Rosemont Road, Richmond, Surrey. August 28th,* 1929.

[Some reports of very long intervals between lightning flash and thunder were quoted in the *Meteorological Magazine* for June, 1928, p. 113, but we cannot recall any reported intervals of so long as 110 seconds in this country.—ED., *M. M.*]

Winter Fog and Relative Humidity

In a recent issue of the *Meteorological Magazine* (February, 1929) I gave, in conjunction with Dr. R. C. Sutcliffe, statistics relating to winter fog and relative humidity at the three selected stations, Birmingham (town), Cranwell (rural) and Gorleston (seaside). In view of the somewhat surprising results obtained it has seemed worth while to repeat the work for three other stations: Kew (town), Ross-on-Wye (rural) and Scilly (seaside), In the present investigation the period brought under review for each station stretched from October 1st, 1923, to March 31st, 1927, and "winter" is defined as before as the months October to March (both inclusive). All the data used were extracted from the *Daily Weather Reports* issued by the Meteorological Office, London. The relative humidities were in every case measured by the use of wet and dry bulb thermometers, and the visibility observations at the sea stations, Scilly, are those taken looking landwards. Fog signifies a visibility of less than 1,100yds., and the observations were taken at 7h., 13h. and 18h. The table attached shows the results obtained. It needs to be noted that in that table the first of the three relative humidity columns contains all readings below 95 per cent. and the second all readings below 90 per cent. :—

	No. of cases of fog	Percentage of such cases when relative humidity was less than		
		95 per cent.	90 per cent.	80 per cent.
Kew	210	42·9	20·5	5·2
Ross-on-Wye	121	18·2	6·6	0·8
Scilly	51	0·0	0·0	0·0

The high percentages of fog at Kew, the town station, with air that is not saturated or even approximately saturated, support those previously obtained for Birmingham as indicative of smoke pollution: while the lower percentages for Ross-on-Wye show the results for a station fairly free from smoke vitiation. The results for Scilly—no fogs at all with relative humidities below 95 per cent.—seem very noteworthy and differ sharply from those obtained for Gorleston in the previous communication. The east coast and the south-west coast, perhaps by reason of shorter sea tracks in the former case for certain winds, appear greatly opposed in this matter of winter fog and accompanying relative humidity.

In view of the discrepancy so clearly shown, the investigation is being continued.

William H. Pick.

February 19th, 1929.

March Fogs and May Frosts

To compare with Mr. W. H. Bigg's table of March fogs and May frosts in the August magazine, I have obtained the corresponding figures for Grayshott in the years 1924-9, though six years cannot be regarded as sufficient to prove or disprove the existence of any connexion. There is nothing to decide the range of visibility corresponding with the layman's "fog," but his definition of "frost" is when the grass minimum is

32° or lower, and not 30·4° or lower. For this reason I have put two lines of "frost" figures.

Number of occasions of fog at 9h. G.M.T. during March :—

Visibility less than	1924	1925	1926	1927	1928	1929
110 yards	2	0	0	0	0	0
220 „	4	1	1	0	1	2
550 „	5	1	1	1	2	5
1,100 „	6	6	3	3	9	13

Number of ground frosts in May :—

Year	1924	1925	1926	1927	1928	1929
30·4° or less	4	1	3	9	7	4
32° or less	7	2	5	9	7	7

S. E. Ashmore.

Windwhistle Cottage, Grayshott, Hindhead, Surrey. September 1st, 1929.

Small Upper-Air Velocities at Colombo

A pilot balloon, released at Colombo about 7 a.m. on April 17th, during an international upper-air week, showed a remarkable lack of movement in the uper-air up to 10½ kilometres; at which altitude the balloon was lost into cloud. The mean velocities, in metres per second, and directions, of successive approximately homogenous layers of wind currents are shown in the table below.

Height in km.	0	0·4	0·9	2·2	3·0	3·6	4·1	4·5
Mean Velocity in m/s.	3·9	2·2	1·1	1·8	and light var.	4·6	1·5	
Direction	ENE	ESE	NNE	SE		NW	N	

Height in km.	4·5	5·0	5·4	6·2	7·2	7·4	8·1	9·2	10·5
Mean Velocity in m/s.	Calm	1·3	light and var.	2·5	1·1	2·7	3·9	2·2	
Direction		N		NE	ESE	SSW	SW	SSE	

Although the balloon was followed for 91 minutes, the greatest horizontal distance from the starting point was only 2 miles, while during the last hour of the flight the vertical angle was between 60° and 85°. Heights were computed from readings of a 20-metres tail. Altitudes deduced at such large vertical angles were naturally very irregular, but a straight line drawn as evenly as possibly through the time-altitude graph gave a rise of 115 metres per minute, from the 11th to the 91st minute, and the figures adopted were computed from this value. The theoretical value of the rise, deduced from the lift at the commencement of the flight, was 120 metres per minute.

Another balloon, released about 2.30 p.m. the same afternoon and followed till it burst at 4·0 kilometres, showed a gentle to moderate westerly sea-breeze up to 0·8 kilometre, but above that, the same lack of movement as in the morning persisted up to 3·7 kilometres, while between 3·7 and 4·0 kilometres a NNW. wind of 4 m/s was found, corresponding closely to the NW wind of average velocity 4·6 m/s found at about the same altitude in the morning.

Next morning, with a flight reaching 9·5 kilometres, the wind had increased appreciably, reaching a maximum of 7 to 8 m/s at about 9 kilometres.

The weather over Ceylon at that time was of the usual intermonsoon type, with flat or irregular barometric gradients.

H. JAMESON.

Colombo Observatory, Ceylon. July 30th, 1929.

Temperature and Sunspots

In a letter to the *Meteorological Magazine*, Monsieur H. Mémery raises the question as to whether the anomalies in the August ten-day mean temperature, pointed out in the note on "Ten-day period temperatures" in the June number of this magazine, p. 120, are not due to sunspots. He writes: "Other epochs of the year present similar anomalies, *e.g.*, the five-day mean temperature for June 10th-15th is lower than that for June 1st-5th. The mean annual temperature would only show a uniform variation in the course of the year if the influence of the seasons were the only cause for the variation of temperature. But there are other causes which appear to have a more important influence than the seasons; these causes are to be sought in the variations of solar phenomena. If the daily means of the sunspots are taken over a number of years, annual periodic variations similar to those of the temperature means will be seen. In August there is almost every year an abundance of sunspots during the first fortnight with a noticeable increase towards the 15th, and this increase of sunspots is generally followed by a rise of temperature, which explains the rising of the mean temperature for August 10th-20th. . . . This happened in August, 1929; from the 10th-20th there was an increase in the number of sunspots, which was followed by a rise of temperature towards the 15th. . . . In the same way an explanation of almost all the abnormal variations of the temperature in the countries of western Europe can be given by means of the variations of the sunspots.''

NOTES AND QUERIES

Official Course of Training for Observers

Twenty people attended this course at Kew Observatory on September 23rd and 24th. On Monday the ordinary meteorological instruments appropriate to a climatological station were explained, and also the system of classification of clouds, advantage being taken of a varied display of cloud forms that was visible in the morning during a change from early fog to fine and then dull weather. On Tuesday morning the filling up of returns and the use of hygrometric tables were dealt with. Some climatology was introduced when suitable opportunities arose, but the making of a synoptic chart from coded telegraphic reports, which was done last year, was not repeated. On Tuesday afternoon Mr. R. Corless, Superintendent of the British Climatology Division, explained the anemobiagraph and its management to crop-weather observers, and Mr. F. J. Scrase conducted a party on a tour round the Observatory which was greatly appreciated.

E. V. NEWNHAM.

A Problem of Convection

It is well known that when a deep current of polar air passes over a long stretch of warm sea, the addition of heat and moisture at the base of the current results in showers, generally known as "instability showers." Over the sea they are of course most frequent in autumn and winter, when the sea is relatively warm. In spring and summer they sometimes also develop over the sea, but at these seasons they are far more frequent and heavy over land in the daytime, when they are frequently accompanied by thunder. If the showers happen to be absent over the sea, they often take some hours to develop on land, though the cumulus clouds appear as soon as the air reaches the coast. If there is a fair wind velocity, say 30 miles per hour at 2,000 feet, the air may travel over 100 miles from the coast before the showers form, while the maximum intensity may not be reached for over 200 miles. When there is an old depression over our northwest districts, air of polar origin reaches England from southwest, and one frequently has heavy thundery showers in the Midlands, but fine weather in the southeast if there are no showers over the English Channel. A typical case of this occurred on July 5th, 1929, and the interesting point was that in London, which just escaped the showers, temperature was a few degrees higher than in the showery area further north. After a certain stage it is a question not so much of surface temperature as of the time required for showers to develop.

Where there are hills about 2,000 feet or more in height, the showers develop far more rapidly than over more or less flat countries, but thunder is rare in summer. (This of course only refers to our own hills in the conditions described above.)

Observers who watch the clouds must often have noticed the time which elapses between the first appearance of cumulus clouds and the development of a severe thunderstorm. It is rarely less than two hours and is often much longer, and this is a surprisingly long time when one considers the large vertical velocities known to exist within fully developed cumulo-nimbus clouds. If, for example, one sees thundery looking cumulus clouds gathering overhead, and the wind at the cloud level is 25 miles per hour, the chances of a thunderstorm are much better some 50 miles down this wind than at one's own locality. In London this is especially true for cloud movements from nearly due south or due east, where the sea is nearest. When a storm reaches London travelling at all quickly from the south, it has usually formed over France in the daytime and arrives in the late evening or night. A slow movement from the south (about 10 or 15 m.p.h.) is quite favourable for an afternoon storm in London (*e.g.*, June 16th, 1917, July 11th, 1927).

During the slow development of a thunderstorm, isolated cumulus heads towering upwards are apt to break away and dissolve. Once, however, a storm has formed, cumulus clouds at its boundary may grow rapidly into cumulo-nimbus, joining on to the main storm. In warm weather, the development of a storm may continue long after the surface temperature inversion has formed in the evening, and it is only in such weather that summer storms last far into the night.

The whole problem of instability and convection is difficult and is still only imperfectly understood.

C. K. M. DOUGLAS.

Correlation between the Maize Crop in the Argentine and the subsequent Grain Crops in the United States

Mr. S. S. Gampell calls attention to an apparent similarity in type between the Argentine summer and the ensuing summer in North America. He writes: "The best test of the heat and dryness of an Argentine summer might be the yield per acre of the maize crop. If this is arranged in order for the last

20 years, and the size of the United States crop of wheat for the same year is considered it is seen that the 10 best Argentine maize yields have preceded United States crops of an average of 874 million bushels, while the 10 worst Plate maize yields have preceded United States wheat crops of an average of only 725 million bushels, which is a very striking difference."

The figures for the years 1909 to 1924 for the maize crops of the Plate region and the corn crops of the United States arranged in order of magnitude of the Plate crop are as follows:—

Year	Yield per acre of		Year	Yield per acre of		Year	Yield per acre of	
	Plate maize crop	U.S.A. corn crop		Plate maize crop	U.S.A. corn crop		Plate maize crop	U.S.A. corn crop
	qrs.	bushels		qrs.			qrs.	bushels
1912	4·08	29·2	1921	3·33	29·6	1913	2·42	23·1
1924	3·81	22·9	1919	3·18	28·9	1925	2·38	28·8
1920	3·68	31·5	1926	3·07	27·0	1918	2·29	24·0
1915	3·67	28·2	1914	2·99	25·8	1916	1·89	24·4
1927	3·53	28·1	1922	2·81	28·3	1917	0·76	26·3
1928	3·33	28·2	1909	2·81	26·1	1911	0·41	23·9
			1910	2·76	27·7			
Average yield per acre of U.S.A. corn following 6 best Plate crop years.		28·0	1923	2·62	29·3	Average yield per acre of U.S.A. corn following 6 poorest Plate crop years.		25·1

The correlation coefficient between the two series given above is $+0{\cdot}46$, but Mr. Gampell considers that "the fact that the static correlation is low does not of course necessarily prove that the relationship is negligible; a correlation of first differences would possibly give a higher coefficient, if it were possible to remove the errors in both series of crop estimates, which is unfortunately not possible. The static correlation must be low because of the great changes in acreage in the period; when (say) 1909 is compared with 1927, one is comparing the yield on different land; the correlation of first differences removes at least some of this secular variation, and the number of instances given in Table I in which a rise or fall in Plate maize yield was accompanied by a change of similar sense in the total United States wheat crop appears striking.

"The United States wheat crop increased when the yield of Plate maize increased and *vice versa* in 12 out of the 16 cases listed above. The year 1917 can hardly be counted among the exceptions, since even with the negligible increase in the United States crop, it remains one of the worst years of the century for both crops. In fact, consideration of 1917, 1916, 1911 and 1925 shows well the tendency for failures in these two crops to coincide. At present, it appears that the yield of Plate maize will fall some 25% below last year, but this can hardly be taken to portend any shortage in the United States wheat crop, since

TABLE I.

Year	1911	1912	1913	1914	1915	1916	1917	1918	1919
Yield of Plate Maize in quarters per acre	0·41	4·08	2·42	2·99	3·67	1·89	0·76	2·29	3·18
Total United States Wheat crop in millions of bushels	621	730	763	891	1,026	636	637	921	967

Year	1920	1921	1922	1923	1924	1925	1926	1927
Yield of Plate Maize in quarters per acre	3·68	815	2·81	2·62	3·81	2·38	3·07	3·53
Total United States Wheat crop in millions of bushels	833	3·33	867	797	864	676	831	878

even if it is accepted that some reduction in the latter below the big figure of 903 of last year is likely, the increase in wheat carried into the new crop year will probably make the total supply of wheat greater than last year."

Review

Atmospheric Ozone: its relation to some solar and terrestrial phenomena. By Frederic E. Fowle. Smithsonian Miscellaneous Collections, Vol. 81, No. 11.

Interest has recently been aroused in the ozone in the earth's atmosphere, largely as a result of measurements made by Dr. G. M. B. Dobson and others from 1925 onwards, which have shown that there is a close relation between ozone and upper-air conditions. The method was indicated by Fabry and Buisson in 1921, and depends on the photographic measurement of the intensity of sunlight in the region of the very strong ultra-violet absorption band of ozone.

We now have a paper of great interest by Dr. F. E. Fowle, describing calculations of the amount of ozone based on spectro-bolometric measurements in the visible solar spectrum, in the region of the yellow "Chappuis" absorption band of ozone. The absorption here is very weak, and can hardly be detected in the intensity curves, but it is revealed when atmospheric transmission coefficients are obtained from observations at different altitudes of the sun. When the transmission coefficients are plotted against wave-length, the ozone band appears as a distinct dip in the otherwise smooth curve; from the size of the dip the amount of energy absorbed by the ozone, and hence the amount of ozone, is calculated. The close correspondence between the transmission coefficients thus found, and the ozone absorption curve found in the laboratory by Colange, proves the excellence of the Smithsonian observers' measurements.

This method, according to the author, gives the area of the "Chappuis" band with an accuracy of 1 in 30 at the best, assuming that the amount of ozone does not change during the observations, which extend over more than an hour. Dr. Dobson estimates that the "probable error" of an ozone value obtained from a single photograph by his method is not more than half of this.

The author proceeds to compare the two methods, to the disadvantage of Dr. Dobson. It must be said that the criticisms of Dobson's method show a failure to grasp the ideas which are set out in his original paper.* The fundamental formula underlying both methods is that which expresses the relation between the transmission coefficient of a layer of absorbing medium and the thickness of the layer. If the radiation is in a parallel pencil, the ratio of transmitted to incident intensity (the transmission coefficient) is—

$$I/I_0 = 10^{-ax}$$

$$\text{whence } \log_{10} I = \log_{10} I_0 - a x$$

where x is the length of path of the rays in the medium, and a is called the absorption coefficient of the medium. a is in general a function of wave-length, and it is obvious that the above equations are true only for monochromatic radiation, and do not hold for the total intensity of a number of wavelengths with differing values of a; only in the former case is the relation between log I and x a linear one. By what seems to me a quite mistaken application of this, the auther purports to prove that the "Chappuis" band, where a is about 0·04 for 1cm. of pure ozone at normal temperature and pressure, "is a more sensitive indicator of changes in atmospheric ozone than that employed by Dr. Dobson," where a is about 2·0 to 2·5. Now this is certainly not so; for although a given change in the amount of ozone might produce a larger absolute change of intensity in the yellow (on account of the much greater initial intensity in that region), the percentage change would be greater in the ultra-violet, in the proportion of the respective absorption coefficients. Dobson does not use, as Dr. Fowle seems to think he does, comparatively wide sections of spectrum, over which a may vary considerably, but very narrow sections over which the variation of a is negligible.

One or two other objections are raised, but they need not detain us, being already answered in the paper referred to.

I have dealt with this at some length because Dr. Fowle finds that his values of ozone at Table Mt., California, have a much greater range than those of Dr. Dobson for the same place and the same two months, and implies that here is additional proof of

* *London, Proc. R. Soc.*, A. 110 (1926), p. 660.

the greater sensitivity of his method. This is, however, open to a different interpretation, for a large " scatter " is not usually taken to indicate great accuracy.

Turning now to the author's results, monthly means of ozone (expressed as the area of the "Chappuis" band) are given for one or more of four stations, for the years 1921-8. These show an annual variation, with maximum in spring and minimum in autumn in both northern and southern hemispheres, in agreement with Dobson's results. The much larger range at the two stations in the northern hemisphere is probably due to the fact that one of the southern stations is in the tropics, while the data for the other are very scanty. The annual means show a connexion with sunspot numbers in the northern hemisphere, but not in the southern, and from this the author concludes that there are two layers of ozone, one formed by the sun's ultra violet light and not varying with the sunspot period, but having an annual variation, the other varying with sunspot period, and formed by positively charged particles emitted from the sun, which are collected in the northern hemisphere by the earth's magnetic field. It will be seen that the supposed positive ions must really be positive magnetic poles! The electrically charged particles which have been suggested as the origin of the aurora are collected equally towards both poles. The author suggests that some difference between the molecular states of the two layers may help to account for the discrepancy between his results and Dobson's, and also between those of Cabannes and Dufay and those of Dobson as regards the height of the ozone layer. He finds support for the theory of two ozone layers in the two ionized layers suggested by Dr. Chapman to account for the variation of the magnetic elements; this is a very interesting section of the paper, and I feel that it is a great pity that we have not more experimental knowledge of the formation of ozone on which to base our speculations.

In the concluding paragraphs the ozone data are compared with Lord Rayleigh's measurements of the intensity of the auroral green line in the light of the night sky.

There are one or two mistakes in the paper, but most of these will be easily detected. It is perhaps worth while to point out that (on p. 6) the energy absorbed by the ozone is $\left(1-\frac{a}{a_a}\right)e$, not $\frac{a}{a_a}e$. (e being the energy at the selected place in the sun's spectrum).

D. N. HARRISON.

Books Received

Meteorology. Extract from Statistics of New Zealand for the Year, 1927. Wellington, 1928.

Everfrozen of Soil in the Boundaries of U.S.S.R. By M. Soumgin. Vladivostok, 1927.

Obituary

We regret to learn of the death of Dr. H. C. Frankenfield, who was in charge of the river and flood service of the United States Weather Bureau, on July 31st.

News in Brief

We are informed that Dr. F. Lindholm has resigned from the Directorship of the Physical Meteorological Observatory at Davos in order to resume his former position in Sweden. He is succeeded at Davos by Dr. W. Mörikofer.

A Geophysical Discussion on "Cyclonic Disturbances of Sea Level" will be held in the rooms of the Royal Astronomical Society at Burlington House, London, W.1, on Friday, November 1st, at 4.30 p.m. Speakers: Dr. Doodson and Prof. Proudman, of the Liverpool Tidal Institute.

In connexion with their advertisement on page iii of this Magazine, Messrs. C. F. Casella & Co., Ltd., wish to call attention to their change of address to Fitzroy Square.

The Weather of September, 1929

Except in the Hebrides, the weather over the British Isles for September was dry, sunny and warm, especially so in the south-east. Mean pressure was high over the British Isles and conditions mainly anticyclonic in the south, with the track of the Atlantic depressions keeping so far to the northwest of this country that our northern and western seaboards were almost the only areas affected by them. On a few occasions, however, a trough of low pressure passing across the country or a depression over France caused local thunderstorms, as on the 3rd, 12th, 17th and 18th. At Jersey thunder and lightning were experienced for the most part of four days from the 15th-18th and the rainfall was heavy on the 17th, 2·77in. falling during the 24 hours ending 17h. on that day. Other heavy falls during the thunderstorms were 0·79in. at Falcondale (Cardigan) on the 3rd, 1·50in. at Molland (Devon) on the 12th, and 0·64in. at Tenterden (Kent) on the 18th. Strong winds and gales were general on the 20th and 21st, especially in the northern midlands of England, Spurn Head reporting force 9 (49m.p.h.) at 13h. on the 21st. The month was notable warm, particularly in the eastern and midland districts, maximum temperatures of over 80°F. being recorded on several days during the first fortnight southeast of a line from Scarborough to Devon, 89°F. was recorded at Greenwich on the 4th, and 88°F. at Cambridge and Norwich on the 4th and 8th. Even towards the end of the month 70°F. was frequently exceeded. During the first few days minimum temperatures did not fall below 60°F. at several places in the south, but later ground frosts were experienced locally. In the northwest of Scotland rainfall was considerably above normal, but elsewhere it was much below. Some places in southeast England and the midlands had practically no rain until the 28th, 29th or 30th, when rain became general over the whole country; 2·03in. falling at Penrhyn Quarry (Carnarvon) on the 28th, and 1·60in. at Tal-y-llyn (Merioneth) and 1·03in. at Brigg (Lincoln) on the 30th. At Kew Observatory the total rainfall constituted a record for September, at least since 1866, and with the dry spell during the latter part of August completed an exceptionally long period of drought (37 days). At Ross-on-Wye it was the driest September since 1865. Sunshine totals were considerably above normal in most places except the extreme northwest of Scotland; among the sunniest days of the month were the 2nd, 4th, 7th, 8th, 16th, 17th and 25th-28th; 12·4hrs. bright sunshine were recorded at Hastings and 12·1hrs. at Falmouth on the 8th, and 12·0hrs. at Brighton on the 2nd and at Jersey on the 4th. The distribution for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs).
Stornoway	85	—30	Valentia	139	+ 6
Aberdeen	157	+33	Liverpool	163	+35
Dublin	151	+12	Falmouth	223	+60
Birr Castle	184	+18	Kew	196	+51

Pressure was below normal over Spitsbergen, Iceland, the northwest coast of Norway, and Portugal, the greatest deficit being 7·7mb. at Jan Mayen, and above normal elsewhere over western Europe and over the North Atlantic, the greatest excess being 4·1mb. at the Scilly Isles. Temperature was above normal generally and rainfall except at Spitsbergen below normal.

Temperature continued high and the weather dry in France during the first ten days of the month and forest fires were frequent in the south. On the 2nd violent thunderstorms were experienced in various parts of Spain and also round Mons. On the 12th and again between the 18th and 20th severe storms passed over various parts of France, and these were in each case followed by floods. Between the 18th-20th severe storms occurred in the Rhineland, where the hailstones did much damage to the fruit trees. Considerable damage and some loss of life was reported from the Basilicata (south Italy) as a result of the thunderstorms and floods which occurred between the 21st and 23rd. Strong gales were experienced in Finland on the 7th. A waterspout occurred off Hospitalet, near Tarragona, Spain, on the 13th.

The Nile flood, which started 20 days early, was still rising at the beginning of this month (which is unusual) owing to the continuation of the rains in the Abyssinian plateau. At Rosaires, in the Sudan, the flood level was 58in. above the normal crest on the 7th and reached the danger limit at Roda on the 11th. Abundant rain fell in Kenya during the month.

On the 16th the worst of the Indus flood was over, but the flood water was still slowly penetrating into fresh tracts of country; by the 23rd, however, the flood was subsiding in parts of Sind. Later in the month heavy beneficial rain occurred in many parts of northern India, but there was a shortage in Gujerat and Kathiawar. Twenty-six people were killed by a typhoon which struck the southern part of the Luzon Islands (Philippines) at the beginning of the month.

Beneficial rains fell generally on the agricultural districts of South Australia.

Abnormally hot weather was experienced in Central Canada and the United States early in the month, but by the 10th conditions were cooler. Generally the weather was dry in Canada throughout the month, but heavy rain occurred in Alberta and Saskatchewan about the third week. About the same time there was heavy rain in the southwestern United States, and torrential rain occurred in Mexico, doing much damage. A hurricane swept over the Bahamas on the 25th and 26th, and the southeastern coast of Florida from Miami to Key West later on the 27th and all day on the 28th. It reached Tampa on the 29th, and passed to the east of Pensacola on the 30th. Several people were killed, many ships sunk, and much material damage done. The speed of the wind was said to be 90m.p.h. at times. Considerable beneficial rains fell in Argentina about the middle of the month. A southwesterly hurricane passed over Cape Verde Islands on the 21st and 23rd.

The special message from Brazil states that the distribution of rainfall was irregular in the northern and southern regions, with averages 0·16in. and 0·35in. above normal respectively, and scarce in the central regions with an average 0·28in. below normal. Seven anticyclones passed across the country. Crops were generally in good condition. At Rio de Janeiro pressure was 0·3mb. below normal and temperature 1·4°F. above normal.

Rainfall, September, 1929.—General Distribution

England and Wales	37	per cent. of the average 1881-1915.
Scotland	73	
Ireland	38	
British Isles	47	

Rainfall: September, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Lond .	Camden Square	·28	15	*Leics* .	Belvoir Castle	·66	35
Sur .	Reigate, Alvington	·15	...	*Rut* .	Ridlington	1·39	...
Kent .	Tenterden, Ashenden	1·21	57	*Linc* .	Boston, Skirbeck	·57	32
,, .	Folkestone, Boro. San.	·74	...	,, .	Lincoln	·43	28
,, .	Margate, Cliftonville	·40	22	,,	Skegness, Marine Gdns	·35	19
,, .	Sevenoaks, Speldhurst	·20	...	,, .	Louth, Westgate	51	25
Sus .	Patching Farm	·84	35	,, .	Brigg, Wrawby St.	1·21	...
,, .	Brighton, Old Steyne	·72	34	*Notts* .	Worksop, Hodsock	1·34	89
,,	Heathfield, Barklye	1·04	42	*Derby* .	Derby, L. M. & S. Rly.	·54	33
Hants .	Ventnor, Roy. Nat. Hos.	·69	28	,, .	Buxton, Devon Hos.	2·23	69
,, .	Fordingbridge, Oaklnds	·41	19	*Ches* .	Runcorn, Weston Pt.	1·38	52
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	1·90	...
,, .	Sherborne St. John	·37	18	*Lancs* .	Manchester, Whit. Pk.	2·06	87
Berks .	Wellington College	·18	6	,, .	Stonyhurst College	2·58	68
,, .	Newbury, Greenham	·51	25	,, .	Southport, Hesketh Pk	1·90	69
Herts .	Welwyn Garden City	·16	...	,, .	Lancaster, Strathspey	2·74	...
Bucks .	High Wycombe	·40	21	*Yorks* .	Wath-upon-Dearne	1·10	70
Oxf . .	Oxford, Mag. College	11	7	,, .	Bradford, Lister Pk.	·63	30
Nor .	Pitsford, Sedgebrook	·80	44	,, .	Oughtershaw Hall	2·85	...
,, .	Oundle	·54	...	,, .	Wetherby, Ribston H.	·62	34
Beds .	Woburn, Crawley Mill	·17	9	,, .	Hull, Pearson Park	·76	44
Cam .	Cambridge, Bot. Gdns.	·10	6	,, .	Holme-on-Spalding	·51	...
Essex .	Chelmsford, County Lab	·73	42	,, .	West Witton, Ivy Ho.	1·02	...
,, .	Lexden Hill House	1·19	...	,, .	Felixkirk, Mt. St. John	·77	42
Suff .	Hawkedon Rectory	98	51	,, .	Pickering, Hungate	·34	...
,, .	Haughley House	·44	...	,, .	Scarborough	·26	15
Norf .	Norwich, Eaton	·65	30	,, .	Middlesbrough	1·13	68
,, .	Wells, Holkham Hall	·75	39	,, .	Baldersdale, Hury Res.	1·76	...
,, .	Little Dunham	·43	19	*Durh* .	Ushaw College	1·07	53
Wilts .	Devizes, Highclere	·28	14	*Nor* .	Newcastle, Town Moor	·79	39
,, .	Bishops Cannings	·41	19	,, .	Bellingham, Highgreen	·83	...
Dor .	Evershot, Melbury Ho.	·44	17	,, .	Lilburn Tower Gdns.	·46	...
,, .	Creech Grange	40	...	*Cumb* .	Geltsdale	1·56	...
,, .	Shaftesbury, Abbey Ho.	·65	27	,, .	Carlisle, Scaleby Hall	1·26	47
Devon .	Plymouth, The Hoe	·38	15	,, .	Borrowdale, Seathwaite	4·68	47
,, .	Polapit Tamar	·71	25	,, .	Borrowdale, Rosthwaite	3·25	...
,, .	Ashburton, Druid Ho.	·83	27	,, .	Keswick, High Hill	1·72	...
,, .	Cullompton	·89	40	*Glam* .	Cardiff, Ely P. Stn.	·45	14
,, .	Sidmouth, Sidmount	·36	16	,, .	Treherbert, Tynywaun	3·02	...
,, .	Filleigh, Castle Hill	1·70	...	*Carm* .	Carmarthen Friary	1·14	33
,, .	Barnstaple, N. Dev. Ath.	·53	20	,, .	Llanwrda	1·53	38
Corn .	Redruth, Trewirgie	·76	24	*Pemb* .	Haverfordwest, School	1·32	37
,, .	Penzance, Morrab Gdn.	·48	16	*Card* .	Aberystwyth	2·31	...
,, .	St. Austell, Trevarna	·50	16	,, .	Cardigan, County Sch.	1·56	...
Soms .	Chewton Mendip	·65	21	*Brec* .	Crickhowell, Talymaes	1·90	...
,, .	Long Ashton	·74	...	*Rad* .	Birm W. W. Tyrmynydd	2·42	63
,, .	Street, Millfield	·35	...	*Mont* .	Lake Vyrnwy	·96	27
Glos. .	Cirencester, Gwynfa	·23	10	*Denb* .	Llangynhafal	1·79	...
Here .	Ross, Birchlea	·35	18	*Mer* .	Dolgelly, Bryntirion	4·01	94
,, .	Ledbury, Underdown	·55	29	*Carn* .	Llandudno	1·74	76
Salop .	Church Stretton	1·43	70	,, .	Snowdon, L. Llydaw 9	5·55	...
,, .	Shifnal, Hatton Grange	·93	48	*Ang* .	Holyhead, Salt Island	1·61	60
Worc .	Ombersley, Holt Lock	1·00	56	,, .	Lligwy	2·38	...
,, .	Blockley	·61	...	*Isle of Man*			
War .	Farnborough	·75	35		Douglas, Boro' Cem.	1·00	31
,, .	Birminghm, Edgbaston	·90	50	*Guernsey*			
Leics .	Thornton Reservoir	·83	46		St. Peter P't. Grange Rd.	1·82	70

Rainfall: September, 1929: Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	·94	34	*Suth* .	Loch More, Achfary...	11·80	205
,, .	Pt. William, Monreith	·74	...	*Caith* .	Wick......................	3·52	141
Kirk .	Carsphairn, Shiel.......	1·48	...	*Ork* .	Pomona, Deerness......	5·94	204
,, .	Dumfries, Cargen......	·76	26	*Shet* .	Lerwick..................	4·26	142
Dumf.	Eskdalemuir Obs.......	1·43	39	*Cork* .	Caheragh Rectory......	...	...
Roxb .	Branxholm	·50	22	,, .	Dunmanway Rectory...	1·25	30
Selk .	Ettrick Manse..........	...	...	,, .	Ballinacurra............	1·00	40
Peeb .	West Linton............	·91	...	,, .	Glanmire, Lota Lo......	·80	29
Berk .	Marchmont House......	·21	9	*Kerry*.	Valentia Obsy..........	1·53	37
Hadd.	North Berwick Res.....	·28	13	,, .	Gearahameen............	2·20	...
Midl .	Edinburgh, Roy. Obs.	·35	19	,, .	Killarney Asylum......	1·71	48
Ayr .	Kilmarnock, Agric. C.	1·70	56	,, .	Darrynane Abbey.......	1·20	34
,, .	Girvan, Pinmore..	1·46	38	*Wat* .	Waterford, Brook Lo...	1·50	54
Renf .	Glasgow, Queen's Pk. .	1·22	44	*Tip* .	Nenagh, Cas. Lough...	·89	32
,, .	Greenock, Prospect H.	1·86	39	,, .	Roscrea, Timoney Park	·62	...
Bute .	Rothesay, Ardencraig.	2·24	55	,, .	Cashel, Ballinamona...	1·13	46
,, .	Dougarie Lodge.........	2·13	...	*Lim* .	Foynes, Coolnanes......	·78	27
Arg .	Ardgour House	8·68	...	,, .	Castleconnel Rec.......	·99	...
,, .	Manse of Glenorchy...	5·47	...	*Clare* .	Inagh, Mount Callan...	2·11	...
,, .	Oban......................	3·48	...	,, .	Broadford, Hurdlest'n.	1·06	...
,, .	Poltalloch	3·45	75	*Wexf*.	Newtownbarry	1·11	...
,, .	Inveraray Castle...	4·27	66	,, .	Gorey, Courtown Ho...	1·29	52
,, .	Islay, Eallabus.........	2·68	64	*Kilk* .	Kilkenny Castle.........	·93	40
,, .	Mull, Benmore.........	15·70	...	*Wic* .	Rathnew, Clonmannon	·67	...
,, .	Tiree	3·56	...	*Carl* .	Hacketstown Rectory..	·98	35
Kinr .	Loch Leven Sluice......	·44	17	*Leix* .	Blandsfort House......	·64	24
Perth .	Loch Dhu..............	2·60	45	,, .	Mountmellick...........	·72	...
,, .	Balquhidder, Stronvar	...	...	*Off'ly* .	Birr Castle...............	·83	36
,, .	Crieff, Strathearn Hyd.	·82	29	*Dubl* .	Dublin, FitzWm. Sq...	·38	20
,, .	Blair Castle Gardens...	1·28	54	,, .	Balbriggan, Ardgillan.	·33	16
,, .	Dalnaspidal Lodge.....	2·99	64	*Me'th* .	Beauparc, St. Cloud...	·32	...
Angus.	Kettins School.	·54	27	,, .	Kells, Headfort.........	·97	36
,, .	Dundee, E. Necropolis	·65	31	*W.M* .	Moate, Coolatore......	1·24	...
,, .	Pearsie House...........	1·00	...	,, .	Mullingar, Belvedere..	·53	20
,, .	Montrose, Sunnyside...	·57	29	*Long* .	Castle Forbes Gdns......	1·18	40
Aber .	Braemar, Bank...	1·29	51	*Gal* .	Ballynahinch Castle...	2·31	49
,, .	Logie Coldstone Sch....	1·18	51	,, .	Galway, Grammar Sch.	1·70	...
,, .	Aberdeen, King's Coll.	1·28	58	*Mayo* .	Mallaranny..............	2·49	...
,, .	Fyvie Castle............	1·76	...	,, .	Westport House.........	1·08	30
Moray.	Gordon Castle...........	1·50	60	,, .	Delphi Lodge...........	3·40	...
,, .	Grantown-on-Spey......	1·37	55	*Sligo* .	Markree Obsy...........	1·13	33
Nairn.	Nairn, Delnies	1·79	81	*Cav'n* .	Belturbet, Cloverhill...	1·53	62
Inv .	Kingussie, The Birches	1·66	...	*Ferm* .	Enniskillen, Portora...	1·48	...
,, .	Loch Quoich, Loan.....	...	...	*Arm* .	Armagh Obsy...........	1·43	58
,, .	Glenquoich.............	10·07	117	*Down* .	Fofanny Reservoir......	·96	...
,, .	Inverness, Culduthel R.	1·93	...	,, .	Seaforde.................	·60	22
,, .	Arisaig, Faire-na-Squir	6·00	...	,, .	Donaghadee, C. Stn...	·80	33
,, .	Fort William...........	5·09	...	,, .	Banbridge, Milltown...	·69	...
,, .	Skye, Dunvegan........	7·66	...	*Antr* .	Belfast, Cavehill Rd...	1·10	...
R & C.	Alness, Ardross Cas ...	2·39	80	,, .	Glenarm Castle.........	1·16	...
,, .	Ullapool	5·35	...	,, .	Ballymena, Harryville	1·37	44
,, .	Torridon, Bendamph...	8·54	123	*Lon* .	Londonderry, Creggan	2·24	68
,, .	Achnashellach..........	9·23	...	*Tyr* .	Donaghmore............	1·32	...
,, .	Stornoway...............	6·19	156	,, .	Omagh, Edenfel.........	1·23	40
Suth .	Lairg.....................	3·75	...	*Don* .	Malin Head.............	1·78	...
,, .	Tongue	4·77	151	,, .	Dunfanaghy.............	2·25	...
,, .	Melvich..................	8·14	290	,, .	Killybegs, Rockmount.	2·58	56

Climatological Table for the British Empire, April, 1929.

STATIONS	Pressure: Mean of Day M.S.L. mb.	Pressure: Diff. from Normal mb.	Temp. Absolute Max. °F.	Temp. Absolute Min. °F.	Temp. Mean Values Max. °F.	Temp. Mean Values Min. °F.	Temp. Mean Values ½ max. and min. °F.	Temp. Mean Values Diff. from Normal °F.	Temp. Mean Wet Bulb °F.	Relative Humidity %	Mean Cloud Am'nt 0—10	Precipitation Am'nt in.	Precipitation Diff. from Normal in.	Precipitation Days	Bright Sunshine Hours per day	Bright Sunshine Percentage of possible
London, Kew Obsy.	1015·9	+ 1·5	69	29	52·3	36·9	44·6	− 2·7	38·3	83	7·2	1·07	− 0·38	12	4·9	35
Gibraltar	1013·2	− 3·3	75	49	68·3	56·7	62·5	+ 1·5	55·1	79	5·4	1·55	− 1·13	11	..	..
Malta	1013·9	− 0·1	79	47	64·6	54·0	59·3	− 1·6	53·8	73	3·9	0·50	− 0·36	5	9·6	73
St. Helena	1012·2	+ 2·0	78	58	67·0	60·4	63·7	− 2·1	61·1	92	7·9	1·11	− 2·76	11	..	..
Sierra Leone	1011·0	+ 0·2	92	70	89·1	74·9	82·0	− 0·4	76·5	75	4·0	0·63	− 3·43	3	..	..
Lagos, Nigeria	1011·7	+ 1·9	89	72	87·7	76·4	82·1	− 0·4	77·5	81	7·8	7·04	+ 1·29	9	..	..
Kaduna, Nigeria	1013·4	+ 2·7	99	63	95·0	69·5	82·3	+ 0·8	68·5	47	..	0·49	− 2·80	3	..	..
Zomba, Nyasaland	1013·4	+ 0·9	85	53	73·5	60·5	67·0	− 2·3	..	83	8·5	3·66	0·00	17	..	..
Salisbury, Rhodesia	1013·3	+ 0·4	84	43	76·6	51·8	64·2	− 1·5	57·2	59	1·8	0·08	− 0·91	2	9·9	85
Cape Town	1016·5	+ 0·2	87	46	70·9	54·2	62·5	− 0·7	56·0	84	5·8	3·24	+ 1·37	9	..	..
Johannesburg	1017·3	+ 0·2	76	35	70·2	49·6	59·9	+ 0·1	50·1	59	1·5	2·29	+ 0·55	5	9·8	85
Mauritius	1012·9	− 1·1	84	64	80·4	70·5	75·5	− 0·3	74·5	72	6·5	14·95	+ 10·48	26	5·3	46
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1007·3	+ 1·0	103	66	95·9	77·4	86·7	+ 1·0	77·6	80	4·9	2·05	+ 0·16	2*	..	..
Bombay	1009·0	+ 0·2	95	76	91·8	79·0	85·4	+ 2·3	76·5	73	3·7	0·04	− 0·01	0*	..	..
Madras	1008·8	+ 0·4	94	74	92·8	77·5	85·1	− 0·2	78·0	74	5·4	0·55	+ 0·02	1*	..	..
Colombo, Ceylon	1009·8	+ 0·7	89	72	87·3	74·5	80·9	− 1·7	77·6	77	6·8	18·66	+ 10·36	25	6·5	53
Hongkong	1014·2	+ 1·5	88	61	76·5	67·8	72·1	+ 1.3	66·0	71	6·7	1·54	− 3·76	6	5·7	45
Sandakan	..	..	90	73	87·7	74·9	81·3	− 1·0	77·9	77	..	2·38	− 1·69	10	..	..
Sydney, N.S.W.	1015·6	− 2·9	89	47	73·0	56·8	64·9	+ 0·2	58·3	69	4·3	5·42	− 0·15	7	6·9	61
Melbourne	1015·9	− 3·5	80	40	66·7	51·3	59·0	− 0·5	53·8	71	7·1	3·91	+ 1·66	13	4·8	42
Adelaide	1018·3	− 1·7	89	41	73·0	53·4	63·2	− 0·7	53·5	46	5·5	0·42	− 1·33	6	7·0	63
Perth, W. Australia	1017·7	− 0·8	92	45	73·6	54·9	64·3	− 2·3	57·3	57	4·2	1·20	− 0·38	9	7·7	68
Coolgardie	1017·0	− 1·5	98	41	79·4	50·8	65·1	0·0	53·6	46	2·1	0·00	− 0·95	0	..	..
Brisbane	1015·2	− 2·4	86	47	78·2	59·8	69·0	− 1·3	62·8	69	3·7	9·84	+ 6·25	11	8·1	72
Hobart, Tasmania	1011·2	− 3·3	84	39	63·0	49·2	56·1	+ 1·0	49·3	69	7·9	4·37	+ 2·48	16	3·6	33
Wellington, N.Z.	1014·3	− 3·8	71	41	60·1	50·1	55·1	− 1·8	52·9	82	8·3	6·77	+ 2·89	16	3·7	34
Suva, Fiji	1011·0	+ 0·4	87	69	84·1	72·8	78·5	− 0·2	74·5	79	6·0	13·64	+ 2·36	13	5·3	45
Apia, Samoa	1009·9	0·0	90	73	86·7	74·7	80·7	+ 1·8	78·4	76	2·7	2·03	− 8·21	7	9·1	77
Kingston, Jamaica	1014·6	+ 0·5	91	65	85·7	69·9	77·8	− 0·6	69·2	81	3·4	0·14	− 1·10	3	5·8	46
Grenada, W.I.	1010·3	− 2·1	89	72	86·4	73·8	80·1	+ 1·2	73·5	78	3·0	1·34	− 0·94	11	..	..
Toronto	1012·3	− 3·2	74	21	53·7	37·5	45·6	+ 4·2	39.2	72	6·5	6·21	+ 3·81	19	4·8	36
Winnipeg	1014·0	− 3·0	66	14	50·2	30·1	40·1	+ 2·3	..	..	5·3	1·13	− 0·36	5	6·9	50
St. John, N.B.	1012·9	− 0·7	57	20	44·7	30·8	37·7	− 1·3	33·1	67	6·9	4·66	+ 1·15	15	4·6	34
Victoria, B.C.	1014·8	− 2·5	61	33	51·9	40·0	45·9	− 1·8	43·2	77	6·0	1·13	− 0·60	14	7·2	53

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