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Halo Phenomena

THE following communications give eye-witnesses' accounts of recent solar halos and associated phenomena. The coincidence that all three observed the upper tangent arc adds an unusual feature of interest:—

Mrs. A. E. Moule, of Home Cottage, Bradfield, near Reading, sends us particulars of a solar halo, upper tangent arc and sun pillar observed at Bradfield, near Reading, on the early morning of May 3rd, 1931. The phenomena were first observed at 6.10 a.m. (B.S.T.) when the sun was partially obscured by misty clouds and the sun pillar was very bright. By 6.27 the light of the sun was much stronger and the sun pillar was fainter, especially towards the top. A very faint halo of 22° was visible with an exceedingly bright tangent arc showing prismatic colours. At 6.40 the sun pillar had vanished, the halo was faint and the tangent arc very bright but less coloured. The arc was still visible at 8.30 as a bright light but without its characteristic curved shape.

The altitude of the sun on May 3rd was 4° at 6.10 a.m., 7° at 6.27 and 26° at 8.30. Mrs. Moule's sketch is reproduced as the upper part of Fig. 1.

Mr. A. Moon, of 39, Clive Avenue, Clive Vale, Hastings, writes as follows:—

"On Saturday, the 18th of April, I observed a very intense

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arc of contact at 13h. 10m. (G.M.T.) together with a very faint halo of about 22°. At the same time a white arc curved towards the sun was seen to the north-east, which, if it had been complete would have passed through the sun. This fact was confirmed later (at about 13h. 25m.) by the appearance of a whitish arc passing through the sun towards the north and north-west, and was undoubtedly a portion of the parhelic circle. The arc of contact at the zenith of the halo of 22° was very intense, showing plainly the colouring from red to violet. The ends were curved downwards in a similar manner to the phenomenon observed here on October 19th, 1930, though in a less striking manner.

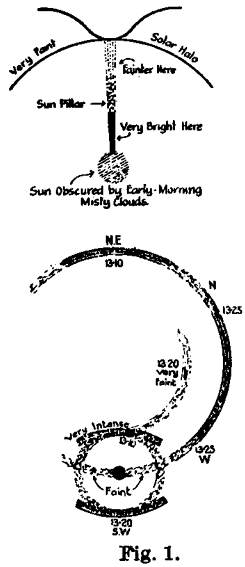

Fig. 1.

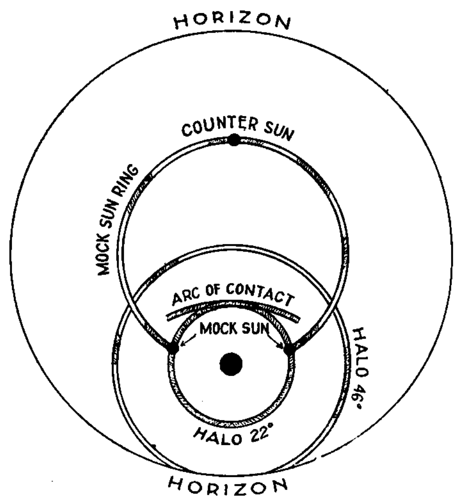

Fig. 2.

At 13h. 20m. another very faint part of a white circle appeared inside the large parhelic circle as shown in the accompanying rough diagram. This was of short duration. A bright arc similar to that at the zenith of the halo of 22° but in a reversed position made its appearance about 13h. 20m., at the "base" of the halo. These bright arcs remained visible some time after the white circle had vanished; the latter was only visible in one large patch of high cirriform cloud which moved from the east-north-east round towards the north-west and west.

Between 13h. 35m. and 13h. 40m. only the two bright arcs were visible with no trace of the halo, and no cloud was visible to the naked eye in the vicinity of the upper contact arc. The clouds were "false cirrus" and patches of cirro-nebula. Weather conditions were showery with large cumulo-nimbus and masses of "false cirrus." A considerable fall of snow and sleet occurred during the morning.

The lower diagram of Fig. 1 represents the complete phenomenon together with the times at which each portion made its appearance."

The altitude of the sun during Mr. Moon's observation was about 50°.

Mr. W. J. Fowler and Mr. R. T. Andrews, of the Meteorological Office, Larkhill, Salisbury Plain, write that "On March 20th at 2 p.m. the rather unusual halo phenomena, of which a drawing is enclosed (Fig. 2), were seen at Larkhill, Salisbury Plain.

The sky was almost covered with a thin veil of cirro-stratus and some cirrus and alto-cumulus. Round the sun was a 22° halo with an upper arc of contact, the ends of which turned down, and at the point of contact the colouring was very vivid. Mock suns were very brilliant at the junction of the mock sun ring with the 22° halo and a counter-sun 180° from the sun was visible for some time; large portions of a 46° halo were also seen. When the mock sun ring disappeared a band of cirrus cloud seemed to take the place of the ring itself.

The above conditions continued for about 15 minutes and towards the end the halos disappeared and gave place to a solar corona, but the mock suns were still visible for a short time."

During this observation the altitude of the sun was 34.°

Some Phenomena related to Halos

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

There are several interesting features in the groups of phenomena described in the three communications printed above. To use a word which I coined some time ago, all the phenomena are no doubt chionisms, being due to the reflection or refraction of light by ice crystals. In general from the occurrence of any particular chionism we can deduce the presence of ice crystals of particular types. Thus, on May 3rd when Mrs. Moule made her observations near Reading there were flat crystals, probably star-shaped, falling with their planes nearly horizontal and producing the sun pillar, whilst needle-like hexagonal prisms falling with their axes horizontal were revealed by the arc of contact. There were also prisms falling at random and causing the faint halo of 22°.

On March 20th and again on April 18th no sun pillars were seen. We may not deduce that the flat crystals were not present; the sun was in each case too high for the production of a sun pillar. Hexagonal prisms with axes horizontal account for the arcs of contact. The upper arcs were turned down like portions of an elliptic halo whereas on May 3rd the corresponding arc was turned upwards, this is accounted for by the different altitudes of the sun. The change of type occurs when the altitude is about 40°. The lower arc of contact seen on April 18th was cured upwards, the altitude of the sun being about 50°.

The mock sun ring seen on the two occasions indicates that light was being reflected from vertical planes, probably the faces of hexagonal prisms with vertical axes. The presence of prisms floating in that position was shown by the mock suns of March 20th. On April 18th the sun was too high for mock suns to be noticed. The halo of 46° is evidence for the existence of crystals with faces at right angles, probably composite crystals, hexagonal prisms attached to flat caps.

There are two more chionisms to mention. The counter-sun of Fig. 3 and the arc marked "very faint" in Fig. 2. A counter-sun, a luminous, colourless patch at the same elevation as the sun and on the opposite side of the sky indicates reflection of light from pairs of vertical surfaces at right angles. If crystals can grow together, four prisms with pointed ends making a rectangular cross, and if the side faces of the individual prisms are all perpendicular to the plane containing the crystal axes then these aggregates will fall with the crosses horizontal and the conditions for the formation of a counter-sun will be satisfied. This is Besson's theory of the phenomenon. The difficulty in accepting it is that composite crystals of the cross pattern have hardly ever been found; as far as I know the orientation of the facets of such crystals has not been investigated.

The explanation given by Humphreys for the formation of the counter-sun (or anthelion, as it is generally named) is that some of the hexagonal prisms with flat caps float with the axes of the prisms horizontal and that there is a tendency for two of the six facets of a prism to be vertical. This explanation is hard to accept, for the nicety of balance would surely be upset by the attachment of a flat end to the prism. (Cf. Humphreys, Physics of the Air, 1920, p. 520, Fig. 178.)

The observation of March 20th is perhaps favourable to Humphreys's explanation, for evidence for the flat-capped prisms and for prisms with horizontal axes has been mentioned.

The "very faint" arc of Fig. 2 may have been a part of an "oblique arc through the anthelion." No explanation of the oblique arcs is generally accepted.

There is a tendency for observers to suggest in their descriptions of chionisms that the phenomena are produced in the clouds. We are not in the habit of assuming that rainbows are produced in clouds, though it is rare to see a complete rainbow without a cloud background. The crystals which produce halos may occur in swarms, but it is misleading to refer to the swarms as if they were identical with clouds. There is an instructive account in Glaisher's "Travels through the Air" of a crystal-swarm encountered in a stratum of dry air with rain falling into the stratum from above and with ordinary cloud below. The ascent in which these observations were made started from

Wolverton on June 26th, 1863, and terminated, after 2½ hours, near Ely. It was on the downward journey that the swarm of ice crystals was encountered. Between 18,000 ft. and 16,000 ft. the aeronauts were in cloud and at the lower level heavy rain fell pattering on the balloon. Of the next stage of descent Glaisher writes: " On passing below 14,000 ft. and for a space of nearly 5,600 ft. we passed through a beautiful snowy scene. There were no flakes in the air—the snow was entirely composed of spiculæ of ice, of cross spiculæ at angles of 60°, and an innumerable number of snow crystals, small in size, but distinct and of well-known forms easily recognisable as they fell and remained on the coat. This unexpected meeting with snow on a summer afternoon was all that was needed on this occasion to complete the experience of the characteristics of extreme heat of summer with the cold of winter within the range of a few hours. On passing below the snow, which we did when about 10,000 ft. from the earth, we entered a murky atmosphere which continued until we reached the ground; indeed, so thick and misty was the lower atmosphere that although we passed over Ely Cathedral and not far from it, we were unable to see it."

Every meteorologist knows that large snow flakes are aggregates of small crystals, but not many have seen the process of aggregation. There is a good description by Tissandier in Glaisher's book. On November 8th, 1868, three aeronauts made an ascent in a snowstorm. By sacrificing much ballast they attained an altitude of 5,900 ft. to find themselves " present at the admirable spectacle of the formation of snow. Just now large flakes danced around the car in a thousand irregular curves and sported in the wind, now we have brilliant almost iridescent, crystalline plates, which are mutually attracted and increase in volume whilst we watch them, growing considerably larger before they are many hundred yards below the car." The balloon rose to 6,500 ft. when the particles were very fine—an endless number of microscopic crystalline needles. In descending Tissandier found the flakes of snow rather more numerous than before, though according to the psychrometer the air appeared nearly dry. We can but echo his questions: " How do these mysterious crystals form in air so mild? By what marvellous mechanism does Nature shape these angular forms that are constantly created before our eyes? Are the invisible atoms of vapour drawn together by the same force which causes planetary worlds to gravitate in space? Are we not witnessing the formation of an endless number of corpuscular worlds modelled by Divine art? "

By way of postcript to this article I should like to mention another lesson which I have learned from the same volume, namely, that the hypothesis which was put forward a few years ago by certain meteorologists that all considerable rain-drops are melted snowflakes or hail, is not valid. On July 21st, 1863, when it was raining steadily on the ground the drops being " as large as a fourpenny piece," Glaisher passed through clouds with a minimum temperature of 59° F. into clear air above. On the same occasion he came down to the bottom of the cloud layer and heard the rain pattering on the trees of Epping Forest, rain which seems to have been produced between the clouds and the ground " that which we saw had its origin within 800 ft. of the ground."

Glaisher's observations during the 28 ascents which he made in the years 1862 to 1866 are printed in the Reports of the British Association. Only the descriptive matter is reproduced in " Travels in the Air." The original observations and especially those made in the clouds would repay careful study now that the question how clouds form in non-saturated air is receiving so much attention.

Alto-cumulus Castellatus Clouds and Thunderstorms

THIS note is based on a fairly complete series of observations of alto-cumulus castellatus cloud in the London area during the years 1923 to 1930. For many years past Mr. Spencer Russell has kept continuous cloud records, and during the period under review the writer has also noted examples of castellatus cloud. In general the same cases were noted by both observers, but Mr. Russell's list is more complete, and the observations used were really his examples supplemented by a few others. The criteria used by both observers in identifying the type were not only the turreted tops but also the existence of a layer of alto-cumulus structure. Various forms of cloud, including cirrus and alto-stratus, occasionally develop cumuliform tops, and the new detailed International Cloud Classification denotes these by the adjective " cumuliformis." Sometimes large towering cumulus or cumulo-nimbus clouds with anvils develop with their base at alto-cumulus levels, and in my private records I have found it necessary to use the terms " high-level cumulus " and " high-level cumulo-nimbus." One of the examples of alto-cumulus castellatus in the large International Cloud Atlas* shows a large heap of cloud. On days when the large type develops, the small type with real alto-cumulus structure can usually be seen sometime during the day. Sometimes the large masses develop upwards from an alto-cumulus layer, and if the layer is low (say 6,000 feet) it may eventually form the base of a thunderstorm. In such cases the layer is often rather thick

* A brief additional note on this subject will be given after the publication of the large atlas.

at an early stage, and might more accurately be described as "strato-cumulus castellatus"; this is a very thundery cloud form.

A more typical sequence of developments, when the life history of the clouds can be followed, is somewhat as follows. A delicate layer of small-grained alto-cumulus first appears, becoming thicker with larger cloudlets, some of which develop turreted tops. Subsequently the cloudlets assume an appearance resembling fracto-cumulus and then dissolve. (This sequence was first described to me in detail by M. A. Giblett and J. Bjerknes, who observed it while on the Thames in the late summer of 1926.)

The total number of examples observed in the eight years was 107. Every month from February to October was represented, the maximum frequency being 26 in July and 25 in August; 95 of the cases occurred in the period May to September, and the subsequent discussion will be entirely limited to these. On 66 out of the 95 occasions, or 69 per cent., there was thunder within 100 miles either on the day of observation or on the following day.

The observations fall into two groups. A small group of 11 cases occurred in polar air, and the upper air temperature, when observed, was low. When there is much large cumulus or cumulo-nimbus cloud, there is often alto-cumulus cloud formed as a sort of residue, perhaps persisting for long afterwards, at levels lower than that of the tops of the cumulonimbus. In a few cases the castellatus form appears, though good examples are rare in cool weather. Observers are likely to differ in their treatment of the less well-defined types.

The larger group comprises 84 observations in warm weather, and includes all the really good displays. Observations of upper air temperatures up to about 15,000 feet or more were obtained at Duxford or Farnborough on 52 of these occasions, and a comparison with the monthly means shows that on the average there was an excess of 10°F. at 5,000 feet and of 5°F. at 15,000 feet. The average lapse rate was thus above the normal, with warm air below and less warm air above, giving a condition favourable for thunderstorm development. The other condition required for thunder is an adequate moisture supply at lower levels. In some cases in the rear of anticyclones, alto-cumulus castellatus clouds appear when the air lower down is dry, so that there is no immediate prospect of thunder. Although the thundery conditions often follow in about 24 hours or less, the clouds are not an infallible sign of thunder.

In every instance there was some information as regards the upper wind, either from nephoscope observations of the alto-cumulus clouds, or from pilot balloon ascents up to fully 10,000 feet. Among the 84 examples in the warm weather group, the upper wind at about 10,000 to 15,000 feet (or at the cloud level) was in 74 cases from a direction between south and west, inclusive, the velocity being often considerable; in seven of the remaining cases it was from a point in the south-east quadrant. Observations of changes of upper air temperature up to about 15,000 feet in a period of about 24 hours preceding an observation of castellatus clouds were available on 38 occasions in the warm weather group. At the height of 5,000 feet, temperature rose on 25 occasions, fell on 10, and remained steady on three. On the average of all cases there was a rise of 4°F., and there were seven cases of a rise of 10°F. or more, the largest rise being 21°F. At the height of 15,000 feet, temperature rose on nine occasions, fell on 22, and remained steady on seven. On the average of all cases the fall was barely 1°F., the largest fall being 7°F.

Thus the main feature of the change was a rise of temperature at about 5,000 feet, and the same is true if we consider only those cases definitely associated with thunder. This rise of temperature is normally accompanied by a wind which veers with height, as theoretically it should if the wind is geostrophic and the rise of temperature is due to the horizontal motion. The slight fall of temperature which often takes place high up cannot be easily interpreted in terms of purely geostrophic motion. These falls are usually associated with an approaching cold front, but seem to have no very definite relation to the front. The falls are small and probably gradual rather than sudden; larger falls often occur behind the front. A strong west component in the upper wind does not in itself imply a fall of temperature, and over-running cold air should not be put forward in explanation of a thunderstorm unless this can be proved by means of a suitable series of observations of upper air temperature.

Many of the thunderstorms associated with castellatus cloud occur at night. It has been suggested by R. W. Green* that all nocturnal summer thunderstorms are of turret cloud type, except for a few which develop in polar air. I think this is justified, especially if the term "turret cloud" is given a liberal interpretation. Certainly nearly all the night storms in the London area have been of this type. An important point in connexion with such storms is the trigger action required to start off the disturbance. As a rule this is supplied by a front, most frequently a cold front but sometimes a warm front. In some cases, however, there is no front at the earth's surface and no definite indication of a front up above. One obvious way of starting the disturbance would be a super-adiabatic lapse rate of temperature, but this is somewhat rare and should not be put forward as an explanation without definite evidence. Accord-

* *London, Meteorological Magazine* 64, 1929, *p.* 186.

ing to L. F. Richardson,* stability in the atmosphere depends not only on the lapse rate but also on wind shearing, *i.e.*, on the rate of change of wind with height. This rate is usually high when castellatus clouds are present. Indeed if the lapse rate is increased by the horizontal motion, a change of wind with height is automatically involved. The problem of small disturbances of the dimensions of turret clouds is rather different from that of the larger disturbances giving thunderstorms.

The detailed investigation of castellatus clouds could be carried out from aeroplanes, preferably with the aid of autographic instruments. As a rule a layer of alto-cumulus cloud has a high lapse-rate below and in it, but an inversion or stable layer above it. In the case of alto-cumulus castellatus it is clear that when there is such a stable layer it must be a very thin one, easily broken through. The fact that usually only some of the cloudlets develop turrets suggests that the thin stable layer is often present. A small inversion was noted above a layer containing clouds of this type at Berck on July 16th, 1918, in thundery weather.

C. K. M. Douglas.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, May 20th, 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.

Sir Gilbert Walker, C.S.I., F.R.S.—Recent work by S. Mal on the forms of stratified clouds.

The paper contains an account of work done partly at the Imperial College of Science and partly at Berlin and Lindenberg where Professor Hergesell had been generous in the provision of facilities. Two years ago it had been suggested that the breaking up of a stratum of cloud into polygons or long strips was often due to instability accompanied in the latter case by shear parallel to the strips. But there was no direct evidence regarding the conditions prevailing in the sky and the production of rectangular arrays of cloudlets had still to be effected experimentally. Mal showed that a rectangular pattern was caused when the unstable stratum was subjected to a less rapid shear than is needed for strips; and verified the measurements made in the sky that cloud strata break up or persist according as their temperature gradient is unstable or stable; and that when they break up the pattern assumed is polygonal, rectangular or in strips according as the shear is zero, moderate or large. The author describes some new types of cloud and

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* The Supply of Energy from and to Atmospheric Eddies. *London, Proc. R. Soc. A.*, 97, 1920, *pp.* 354-73.

suggests an application to the conditions prevailing in the sun.

C. K. M. Douglas, B.A.—A problem of the general circulation.
It is shown that, so far as can be judged from present data, there is no appreciable net flow of polar air in the lower troposphere (*i.e.*, between about 1 and 4km.) towards the subtropical anticyclone. This supports the view of Dr. Jeffreys, namely, that the exchange of air between different latitudes, required to maintain the angular momentum of the zone of west winds against friction, is carried out entirely by currents lying side by side, and not one above the other. It is shown that if this exchange of air could be treated by the methods developed in the classical theory of turbulence, cyclones and anticyclones being regarded as eddies in the general circulation, then the supply of angular momentum into the westerly zone would be enormously greater than what is required. It is thought the angular momentum does not diffuse in this way, owing to the large size of cyclones and anticyclones (this is probably to some extent true also of the diffusion of heat and moisture). The fundamental problem is the relation of the individual cyclone to the general circulation, and this has not yet been solved. Some empirical facts are mentioned which may prove useful to future investigators of the subject.

G. S. P. Heywood, B.Sc.—Wind structure near the ground, and its relation to temperature gradient.
The wind velocities in this paper were obtained by two anemometers at heights of 12.7m. and 94.5m. above the ground. Though the diurnal variation of wind velocity at different heights has been worked out by numerous observers, there are not many results from anemometers as high as 95m.; for this reason the ordinary diurnal variation at this height in summer and winter is shown together with that at 13m. for comparison. The vertical gradient of temperature up to 87m. is also recorded. Wind gradient must depend largely on temperature gradient, and in the paper the relation between the difference in wind velocity and the difference in temperature over approximately the same height interval, is worked out for various wind strengths. The various factors controlling the wind gradient are investigated, and the results are found to agree with Taylor's theory of turbulence. The gustiness of the wind is also studied in its relation to vertical temperature gradient and to wind direction.

Correspondence

To the Editor, *The Meteorological Magazine.*

Mammato-cumulus Clouds and Thunderstorms

W. J. Humphreys, in his " Physics of the Air " (Second Edition, p. 294. New York, 1929), says, categorically, that " mammato-cumulus, sometimes called pocky-cloud, festoon cloud, 'rain balls,' sack-cloud, or other similar name . . . occurs . . . seldom except in connection with a severe thunderstorm."

Humphreys is an American and his statement can therefore be taken as being based on American observations. There is a danger, however, that the English reader may take it is being applicable to the British Isles as well and it is the aim of this note to show that, so far as the British Isles are concerned, mammato-cumulus cloud occurs frequently without any thunderstorm, severe or otherwise, occurring at or near the place of observation of the cloud either at, or within four or five hours on either side of, the time of observation.

This I have already shown in conjunction with Mr. G. A. Wright in a note* dealing with observations at one station only. But in this present contribution I have examined the matter over a far more extended range of stations in the British Isles. That more extended survey was made possible by the courtesy of the members of the Meteorological Office Staff at the various stations set out in the table below, who supplied me with details of the observations of mammato-cumulus made at their stations over the years 1926-9, both inclusive. Examination of the *Daily Weather Reports* (issued by the Meteorological Office, London) then enabled it to be determined whether or no thunderstorms had occurred at or about the time of observation of the mammato-cumulus or within the four or five hours preceding or following that time of observation. In this connexion it needs to be noted that either thunder alone, or lightning alone, or thunder and lightning together without precipitation, was taken to mean a thunderstorm in addition to what may be termed the complete thunderstorm, thunder, lightning and precipitation together. The results of the survey are set out in the table below :—

Station	No. of occurrences of mammato-cumulus	No. of such occurrences with thunderstorms either at, or within 4 or 5 hours of, the observation
South Farnborough ...	21	3
Calshot	9	1
Holyhead	7	0
Croydon	6	0
Sealand	7	2
Cranwell	22	1
Felixstowe	23	1
Renfrew	4	0

In short, therefore, taking the aggregate, there were 99 occur-

* Mammato-Cumulus Cloud at Cranwell, Lincolnshire. By W. H. Pick and G. A. Wright. *London : Q.J.R. Meteor. Soc.* 53, 1927, p. 185.

rences of mammato-cumulus cloud, and of these only 8 were connected with thunderstoms either at the time of observation or within four or five hours on either side of the time of observation. This is a striking result and one that shows that the statement of Humphreys that mammato-cumulus occurs " seldom except in connexion with a severe thunderstorm " is not justified for conditions in the British Isles.

It remains to add that, being personally responsible for many of the Cranwell observations, I can testify that they were examples of mammillated low cloud (below 4,000 feet) and not examples of mammillated alto-stratus.

WILLIAM H. PICK.

December 4th, 1930.

NOTES AND QUERIES

Winds up to 1,500 ft. at Mount Batten, Plymouth

A NOTE giving comparisons of winds at the surface and at 1,500ft. at Mount Batten, Plymouth, was sent recently to the Meteorological Office, and it included diagrams showing for each month of the year mean wind speeds and percentage frequency of direction at the two heights. These diagrams revealed several points of interest. Two points are of particular interest; one, south-west winds occur most often in July and August and least so in December; two, east winds are most frequent in October and rarest in January.

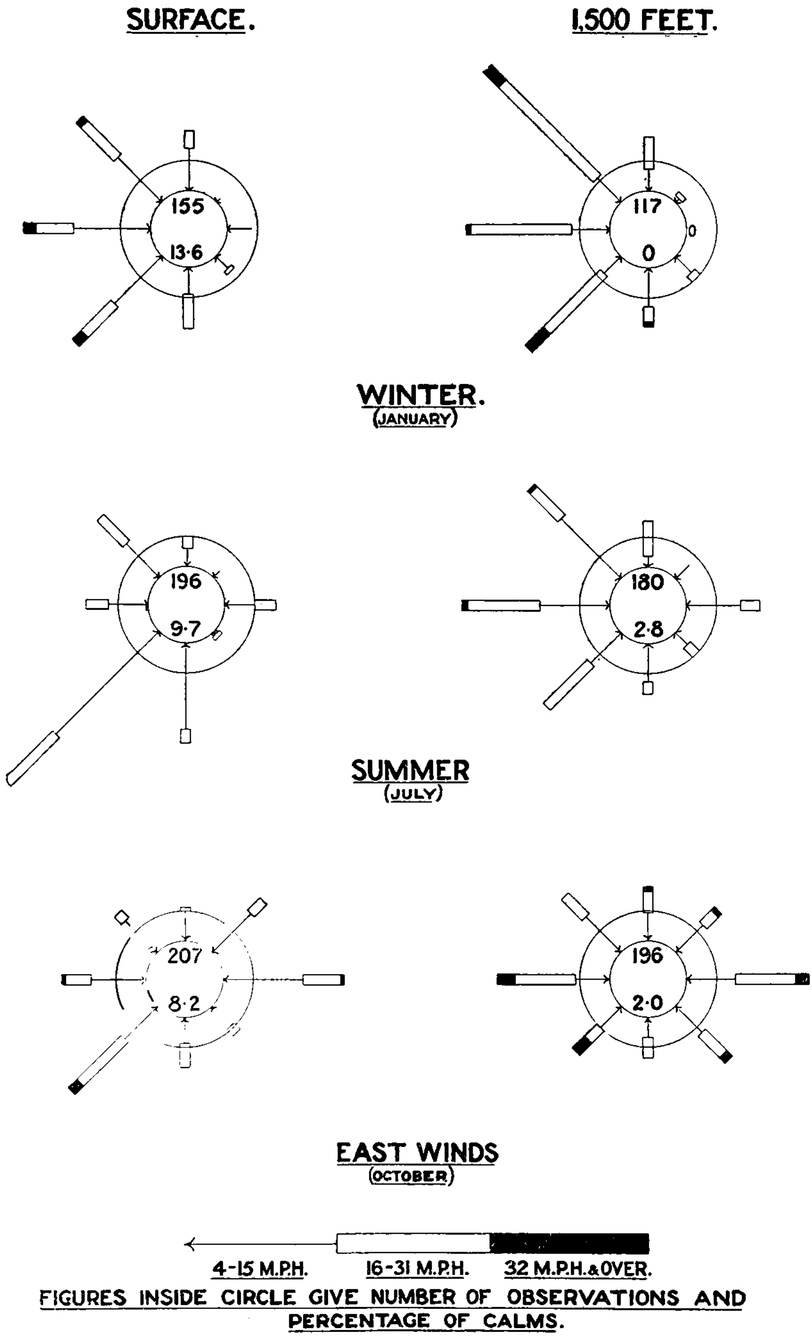
The following tables show the prevailing wind directions and the strongest mean wind for each month of the year :—

	Prevailing Wind		Strongest Wind	
Month	Surface	1,500 feet	Surface	1,500 feet
January ...	W—NW	W—NW	SW	SW
February ...	SW	SW—NW	SW*	†
March	E	NW	NW*	S
April	SW, NW, N	NW	†	NW and NE
May	SW	W and E	NW	S
June	SW and NW	NW	SW—NW	SW*
July	SW	W	SW	SW
August ...	SW	W	SW—W	SW
September ...	SW	W—NW	W—NW	†
October ...	E and SW	E	SW—W	SW
November ...	E	NW—N	SW—W	NW
December ...	NW	W	S—SW	W—NW

* Fairly constant in all directions. † Constant in all directions.

The accompanying diagrams show the distribution of wind force and direction in winter (January), summer (July), and during October when east winds predominate. It will be noted that an increase of force occurs at 1,500ft., and except in the case of east winds a veer takes place between the surface and the higher level.

H. APPLEGATE.



PERCENTAGE FREQUENCY OF WINDS AT MOUNT BATTEN, PLYMOUTH.

Amazing Rainfall in the Bahamas

Capt. C. J. P. Cave has kindly sent us the following paragraph from "The West India Committee Circular" for May 14th, 1931 :—

" There was an amazing cloudburst at West End, Grand Bahama, on April 15th, when, according to the Collector of Revenue, no fewer than 24in. of rain (equivalent to London's annual rainfall) fell in less than 5 minutes. The downpour was accompanied by a mighty rushing wind of 70 to 80 miles an hour, which did much damage to small craft and wrecked an aeroplane."

The record is more than amazing, and before commenting upon it, we should like to have fuller details.

Reviews

The Cyclone Season 1928-1929 *at Mauritius.* By R. A. Watson, B.A. Misc. Publ. Royal Alfred Observatory, No. 10.

An interesting analysis of 8 cyclones which occurred in the south Indian Ocean. Daily synoptic charts are included for the periods during which the cyclones lasted. They enable the tracks of the storms to be followed readily. In addition, the tracks of these cyclones are shown together on a general chart.

Autographic records of pressure and wind are given to illustrate the passage of two of these cyclones at Rodrigues. The publication includes a table showing the number of cyclones that have occurred on any particular date during the last 78 years, and also a table of directions of movement of cyclones as they cross various parallels of latitude.

The analogy suggested between the effect of the land mass of Madagascar and that of the Alps and Norway is very interesting. Other similar examples might be quoted, namely, (*a*) India where several cyclones have passed across the country from the Bay of Bengal into the Arabian Sea, and (*b*) the Philippines where typhoons regularly cross from mid-Pacific into the China Sea. One of these latter has actually continued across the Malayan Peninsula into the Bay of Bengal. T. R. BEATTY.

Atlas Pluviomètric de Catalunya. By Joaquim Febrer. Memòries Patzot. Volume 1. Size 11 x 8½ in., pp. 523, *Illus.*, Barcelona. Institució Patxot. 1930.

This publication gives details of the monthly rainfall and number of rain-days of all available records in Catalonia from their commencement until 1925. The longest record is that maintained at the Observatory of the University at Barcelona since 1861. Records for 306 stations have been collected from various sources. The monthly means have been evaluated for 17 stations with more than 30 years' records, and the means of shorter records adjusted by reference to the nearest long-period station. Computed monthly means are also given for each station, together with a note of the long-period station used in the computation. The positions of the 306 stations are shown on a map of Catalonia (the north-east of Spain, extending for about 100 miles round Barcelona), on the scale of 22 miles to 1 inch. A series of maps show the mean monthly and annual rainfall, the rainfall of the driest and wettest year, the proportion of the annual rainfall in each month and the mean number of days with rain.

The general practice adopted in Catalonian climatological statistics, of using the seasonal year December to November, is adhered to. Thus, in the tables and maps December is taken as the initial month. Another departure from the routine adopted in the British Isles is that the rainfall maps are drawn without reference to the configuration.

This work on the rainfall of Catalonia by the head of the Climatological Section of the Meteorological Service of Catalonia, was awarded first prize in the Patxot competition of 1925. This competition was instituted some four years previously by Mr. Raphaël Patxot i Jubert in order to stimulate research in the physical sciences and in mathematics, especially in Catalonia. In this connexion it may be mentioned that the subject of the ninth competition is " The Meteorology of the Western Mediterranean, especially of the coast of Catalonia and preferably from the dynamical aspect of the problem." Entries should be submitted before December 31st, 1931, and the prize is 5,000 pesetas (about £25).

J. GLASSPOOLE.

Barometers (List 565) *and Meteorological Thermometers (List* 567), pp. 34 and pp. 24, *Illus.* C. F. Casella & Co. Ltd. London.

No apology, it is felt, is needed, in bringing these two excellently illustrated catalogues of this well-known firm to the notice of our readers. Where it is felt that an explanation of the mode of operation of an instrument is needed, it is given in a short but clear descriptive article.

In the barometer catalogue are listed aneroids and barographs as well as mercury barometers. Examples of the Kew (Station and Marine), Fortin and Newman type of mercury barometer for observatory work are given, while barometers for ornament as well are not forgotten. Graduations to meet the needs of purchasers whether in inches, millimetres or millibars, can be engraved as desired. Of aneroids, there is a large selection ranging from instruments designed to be carried in the pocket to those 4½ inches in diameter. These aneroids can be graduated to read heights or pressure or both. There are also listed, an aneroid for the dashboard of a car, altimeters for use on aeroplanes, and a small altimeter which can be strapped on to the arm. Pendant aneroids for the home in the ornamental mounts of various designs are also included.

The thermometer catalogue is almost entirely devoted to thermometers for general meteorological use, and so includes such theromemeters as maximum, minimum, grass and earth, though right-angled soil thermometers are not shown. Also listed are such allied instruments as a bimetallic thermograph, hair hygrograph and a combination of these two, a Mason hygrometer, an Assmann psychrometer with a clock or motor-driven fan and a whirling psychrometer. A standard Stevenson screen is also included. It is interesting to notice that such thermometers as the black bulb *in vacuo*, solar radiation, and Six's maximum and minimum are still listed. Mention should also be made of a variety of evaporimeters and recorder drums for various speeds of rotation which are given in the catalogue.

Many of the more important instruments can be supplied with a certificate from the National Physical Laboratory.

J. E. Belasco.

Books Received

Bulletin de l'Observatoire de Talence (Gironde). 2nd Series, Nos. 10-14. Talence, 1930 and 1931.

Royal Botanic Society of London. Quarterly summary and meteorological readings, Nos. 43, 44, 45.

Deutsches Meteorologisches Jahrbuch für 1921-1922. Freistaat Sachsen. Edited by Prof. Dr. E. Alt. Jahrgang xxxix to xl. Dresden, 1930.

Gulf Stream daily thermograms across the Straits of Florida. By Charles F. Brooks. Reprinted from Washington, Monthly Weather Rev. 58, 1930, pp. 148-54.

Summary of meteorological observations made at the meteorological stations in the Netherlands West Indies during the years 1919-1928. Compiled by the Royal Dutch Meteor. Inst. The Hague, 1930.

Obituary

Professor Alfred Wegener.—We learn with deep regret of the death of Professor Alfred Wegener, leader of the German expedition to Greenland. This expedition, the fourth in which he has taken part, set out on April 1st, 1930, for Kamarujuk in latitude 71°N. on the west coast, and in spite of difficulties caused by an unusually severe season, succeeded on July 31st in establishing a station on the central part of the inland ice, about 250 miles from both east and west coasts, where observations were to be maintained throughout the year. On September 22nd last year Professor Wegener set out with Dr. Loewe and a party of thirteen Greenlanders for the purpose of taking supplies and instruments to Dr. J. Georgi and Dr. E. Sorge, who were observing at the central station. He sent back twelve of the Greenlanders in October, and continued with Dr. Loewe and the remaining Greenlander, Rasmus, to the central station. Here Loewe remained, while Wegener and Rasmus commenced the return journey on November 1st. They failed to arrive at Kamarujuk, but their comrades, supposing that they had remained at the ice camp, did not send out a relief party until April 23rd. Wegener's body was found buried in the snow, but there is no trace of Rasmus, nor of Wegener's diaries and other notes, and the search is being continued.

Alfred Wegener was born on November 1st, 1880, and studied at Berlin, Heidelberg and Innsbruck, obtaining the degree of Doctor at Berlin with an astronomical thesis. From 1906 to 1908 he took part in a Danish expedition to Greenland under Mylius-Ericksen, having charge of the meteorological work, including upper air observations with kites and captive balloons; on his return he summarised the observations for publication. He returned to Greenland in 1911 to 1913, in association with Colonel Koch, one of his companions in 1906-1908. In 1916 he was appointed to the meteorological service of the German army, and took part as meteorological adviser on a number of Zeppelin flights. After the war he joined the Deutsche Seewarte at Hamburg, remaining until 1925, when he was appointed Professor of Geophysics and Meteorology at the University of Graz. His third expedition to Greenland in 1929 was by way of preparation for the fourth, which was his most ambitious attempt, but which has ended so sadly. He leaves a wife and two daughters.

Besides his explorations, Wegener's work has ranged over a very wide field. In 1911 he published his well-known book, "Thermodynamik der Atmosphäre," which reached its third edition in 1928, and is a standard meteorological text-book. Other papers deal with the investigation of the outermost layers of the atmosphere, atmospheric optics and the theory of halos, the resistance of the air to the passage of meteors, abnormal audibility of explosions, and the problems of dynamical meteorology. He is most generally known however for his theory of "continental drift," as set out in his book "The Origin of Continents and Oceans." The first German edition of this work appeared in 1915, the second in 1920, the third in 1922 and the fourth in 1929. An English translation of the third edition was issued in 1924, and the book has also appeared in French, Russian, Swedish and Spanish. It marshals with great skill all the arguments which go to show that the continents are rafts of granitic rock floating in a heavier basaltic magma, and have repeatedly changed their positions during geological time, both relative to each other as the great primeval continent broke up into smaller masses, and relative to the poles. The theory is important to meteorologists because the author adduced the movements of the poles to explain the great apparent variations of geological climates, and especially the glaciation of regions now within the tropics. The climatological part of the theory was set out in greater detail in "Die Klimate der Geologischen Vorzeit," by W. Köppen and A. Wegener. In the last decade the question of continental drift has been a subject of great argument in scientific circles; no general agreement has yet been reached, but the theory has already resulted in several advances of geophysical knowledge, and it is given to few men to inspire research as Wegener has done.

News in Brief

Mr. Seton Gordon reports that "at Duntulm, Skye, on April 29th, from about 1½ hours before sunset onward, there was an unusually brilliant ring round the sun, and a shadow or faint second ring outside it. This brought a change of weather as usual. I do not ever remember having seen two rings before."

Major Goldie who sends this report, remarks that the rings observed by Mr. Seton Gordon are no doubt the common 22° and the less frequent 46°.

Dr. H. R. Mill has been appointed President of the Geographical Association for 1932.

We regret to learn that in February Dr. Joaquim de Sampaio Ferraz resigned for reasons of health from his post as Director of the Brazilian Meteorological Institute, which he initiated in 1921. He has been succeeded by M. Paul Pires Xavier.

The Weather of ~~April~~ May, 1931

Pressure was below normal in a belt extending from south-west Scandinavia, Germany and Austria across the Atlantic to eastern Canada and the eastern United States, over the western coasts of the United States and of Canada and Alaska and also over the Caspian and Black Seas, the greatest deficit being 8·1mb. at Valentia (Ireland). Pressure was above normal in a wedge over the middle western districts of Canada and of the United States, over the Atlantic to the south of Bermuda and the Azores, from Iceland to Spitsbergen and over most of Scandinavia, Russia, southern Europe, and north Africa, the greatest excesses being 5·6mb. at lat. 50°, long. 100° and 5·4mb. at Jan Mayen. Temperature was above normal over Spitsbergen and western Europe except the Iberian Peninsula, and rainfall was in excess over most of western Europe though deficient in northern Scandinavia and at Spitsbergen. In eastern Gothaland (Sweden) the rainfall was between twice and three times the normal.

The weather of May over the British Isles was generally unsettled with some long bright periods and heavy rain. Pressure continued high to the north-west and north of the British Isles during the greater part of the month, causing depressions to move across the country instead of skirting the north-west coasts. For the first few days a complex low pressure system extended from the Faroes to the western Mediterranean. Slight rain fell at most places on the 1st and 2nd, except in north-east England and south Scotland, where sunshine was abundant; 13.4hrs. were measured at Scarboro' on the 1st. This fine weather spread over the rest of the north and west during the next day or two. Aberdeen had 14.7hrs. bright sunshine on the 3rd, but in the south the 3rd was dull, wet and cold. On the 4th and 5th there was a general rise of temperature over the country as the winds backed to SW., and the weather became brighter though thunderstorms occurred locally on the 5th, 7th and 8th. A belt of high pressure moved across the British Isles on the 8th and 9th accompanied by bright warm sunny weather. From then to the 16th, however, a depression was situated off the north-western coasts, temperature was about normal with slight rain at times, but some bright periods. The 11th was a sunny day in Ireland. From the 16th-20th depressions again moved across the country and the weather was dull and cold with rain at times in the east but sunny in the west. After an extension of the high-pressure system over Greenland and Scandinavia had passed across the country on the 20th and 21st, during which the weather was cold and sunny, temperature rose generally above normal and continued warm until the end of the month. The 27th was the warmest day, when 70°F. was exceeded even as far north as Morecambe and Ilkley and 76°F. was reached at Cambridge and Southampton. Rain occurred in almost all districts on the Saturday and Sunday of the Whitsun holidays, but on Whit Monday there was brilliant sunshine at most places, 14.7hrs. at Norwich and 14.5hrs. at Margate. After this conditions continued unsettled with thunderstorms locally from the 26th-29th and heavy rain alternating with bright intervals, 4.18in. fell at Cardiff and 2.90in. at Wheddon Cross, Somerset, on the 27th. On this day severe thunderstorms were also recorded in the Isle of Wight (Shanklin 1·72in.) and Hereford-

(*Continued on p.* 124)

Rainfall: May, 1931: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Lond .	Camden Square.........	2·67	152	*Rut* .	Ridlington...............	2·58	128
Sur .	Reigate, Alvington.....	3·12	172	*Linc* .	Boston, Skirbeck........	2·61	148
Kent .	Tenterden, Ashenden...	1·90	121	,, .	Cranwell Aerodrome...	2·70	149
,, .	Folkestone, Boro. San..	1·87	...	,, .	Skegness, Marine Gdns	2·02	119
,, .	Margate, Cliftonville...	1·98	125	,, .	Louth, Westgate........	2·15	106
,, .	Sevenoaks, Speldhurst	2·84	...	,, .	Brigg, Wrawby St.....	2·51	...
Sus .	Patching Farm.........	3·65	197	*Notts* .	Worksop, Hodsock.....	2·26	114
,, .	Brighton, Old Steyne..	2·19	135	*Derby* .	Derby, L. M. & S. Rly.	2·65	139
,, .	Heathfield, Barklye....	2·34	130	,, .	Buxton, Devon Hos....	3·02	97
Hants .	Ventnor, Roy. Nat. Hos.	3·69	217	*Ches* .	Runcorn, Weston Pt...	2·43	105
,, .	Fordingbridge, Oaklnds	2·48	119	,, .	Nantwich, Dorfold Hall	3·96	...
,, .	Ovington Rectory.......	3·17	146	*Lancs* .	Manchester, Whit. Pk.	2·68	126
,, .	Sherborne St. John.....	3·26	168	,, .	Stonyhurst College.....	2·06	72
Berks .	Wellington College.....	3·24	174	,, .	Southport, Hesketh Pk	2·06	98
,, .	Newbury, Greenham...	2·61	139	,, .	Lancaster, Strathspey	2·05	...
Herts .	Welwyn Garden City...	2·52	...	*Yorks* .	Wath-upon-Dearne.....	2·76	136
Bucks .	H. Wycombe, Flackwell	2·65	...	,, .	Bradford, Lister Pk....	2·32	111
Oxf .	Oxford, Mag. College..	2·75	157	,, .	Oughtershaw Hall......	3·84	...
Nor .	Pitsford, Sedgebrook...	2·53	132	,, .	Wetherby, Ribston H.	2·96	143
,, .	Oundle..................	1·98	...	,, .	Hull, Pearson Park.....	3·00	155
Beds .	Woburn, Crawley Mill	2·81	145	,, .	Holme-on-Spalding.....	2·44	...
Cam .	Cambridge, Bot. Gdns.	2·85	162	,, .	West Witton, Ivy Ho.	3·06	136
Essex .	Chelmsford, County Lab	2·67	185	,, .	Felixkirk, Mt. St. John	2·93	156
,, .	Lexden Hill House....	2·09	...	,, .	Pickering, Hungate....	2·73	139
Suff .	Hawkedon Rectory.....	2·77	150	,, .	Scarborough............	2·02	106
,, .	Haughley House........	2·20	...	,, .	Middlesbrough..........	2·30	120
Norf .	Norwich, Eaton...... ...	3·57	185	,, .	Baldersdale, Hury Res.	3·31	...
,, .	Wells, Holkham Hall	3·18	198	*Durh* .	Ushaw College..........	2·93	136
,, .	Little Dunham..........	3·68	190	*Nor* .	Newcastle, Town Moor	2·45	121
Wilts .	Devizes, Highclere......	2·73	151	,, .	Bellingham, Highgreen	2·94	122
,, .	Bishops Cannings.......	3·36	172	,, .	Lilburn Tower Gdns....	2·42	105
Dor .	Evershot, Melbury Ho.	3·42	168	*Cumb* .	Geltsdale...............	2·10	...
,, .	Creech Grange..........	3·70	181	,, .	Carlisle, Scaleby Hall	2·60	109
,, .	Shaftesbury, Abbey Ho.	2·60	126	,, .	Borrowdale, Seathwaite	6·95	94
Devon .	Plymouth, The Hoe....	3·84	185	,, .	Borrowdale, Rosthwaite	7·63	...
,, .	Polapit Tamar..........	...	...	,, .	Keswick, High Hill.....	3·95	...
,, .	Ashburton, Druid Ho.	..	...	*West* .	Appleby, Castle Bank..	3·02	137
,, .	Cullompton.......	3·25	150	*Glam* .	Cardiff, Ely P. Stn.....	7·29	291
,, .	Sidmouth, Sidmount...	2·95	151	,, .	Treherbert, Tynywaun	6·28	...
,, .	Filleigh, Castle Hill....	3·21	...	*Carm* .	Carmarthen Friary.....	3·84	139
,, .	Barnstable. N. Dev. Ath	3·40	164	,, .	Llanwrda............	...	...
Corn .	Redruth, Trewirgie.....	4·01	174	*Pemb* .	Haverfordwest, School	4·16	166
,, .	Penzance, Morrab Gdn.	3·26	147	*Card* .	Aberystwyth............	3·64	...
,, .	St. Austell, Trevarna...	3·44	142	,, .	Cardigan, County Sch.	2·69	...
Soms .	Chewton Mendip........	4·12	149	*Brec* .	Crickhowell, Talymaes	...	...
,, .	Long Ashton............	3·47	164	*Rad* .	Birm W. W. Tyrmynydd	6·17	180
,, .	Street, Millfield	3·21	168	*Mont* .	Lake Vyrnwy...........	6·48	205
Glos. .	Cirencester, Gwynfa....	4·21	205	*Denb* .	Llangynhafal............	3·63	164
Here .	Ross, Birchlea...........	3·43	161	*Mer* .	Dolgelly, Bryntirion...	4·05	122
,, .	Ledbury, Underdown..	3·80	186	*Carn* .	Llandudno...............	2·15	113
Salop .	Church Stretton.........	5·46	212	,, .	Snowdon, L. Llydaw 9	11·35	...
,, .	Shifnal, Hatton Grange	4·36	212	*Ang* .	Holyhead, Salt Island	3·39	173
Worc .	Ombersley, Holt Lock	4·35	212	,, .	Lligwy..................	2·23	104
,, .	Blockley..............	4·38	...	*Isle of Man*			
War .	Birminghm, Edgbaston	3·94	184		Douglas, Boro' Cem....	3·75	150
Leics .	Thornton Reservoir....	2·92	145	*Guernsey*			
,, .	Belvoir Castle...........	3·07	145		St. Peter P't. Grange Rd.	2·51	148

Rainfall: May, 1931: Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per cent. of Av.
Wigt .	Pt. William, Monreith	2·24	95	*Suth* .	Loch More, Achfary ...	5·51	125
,, .	New Luce School......	2·88	101	*Caith* .	Wick........................	4·91	237
Kirk .	Carsphairn, Shiel	5·33	126	*Ork* .	Pomona, Deerness......	4·74	238
Dumf.	Dumfries, Crichton, R.I	3·41	...	*Shet* .	Lerwick	2·75	131
,, .	Eskdalemuir Obs.......	4·59	139	*Cork* .	Caheragh Rectory......	3·43	...
Roxb .	Branxholm.........	3·43	152	,, .	Dunmanway Rectory...	4·80	141
Selk .	Ettrick Manse	4·91	134	,, .	Ballinacurra.............	4·27	180
Peeb .	West Linton	3·64	...	,, .	Glanmire, Lota Lo......	4·35	177
Berk .	Marchmont House......	2·68	108	*Kerry*.	Valentia Obsy...........	4·69	148
Hadd.	North Berwick Res....	3·00	151	,, .	Gearahameen............	8·10	...
Midl .	Edinburgh, Roy. Obs.	2·77	148	,, .	Killarney Asylum.......	4·33	142
Lan .	Auchtyfardle	3·11	..	,, .	Darrynane Abbey......	4·01	135
Ayr .	Kilmarnock, Agric. C.	2·63	114	*Wat* .	Waterford, Brook Lo...	4·81	207
,, .	Girvan, Pinmore	2·17	73	*Tip* .	Nenagh, Cas. Lough ...	4·23	171
Renf .	Glasgow, Queen's Pk. .	4·08	167	,, .	Roscrea, Timoney Park	4·63	...
,, .	Greenock, Prospect H.	5·83	169	,, .	Cashel, Ballinamona ...	6·10	254
Bute .	Rothesay, Ardencraig.	4·97	164	*Lim* .	Foynes, Coolnanes	2·79	120
,, .	Dougarie Lodge.........	3·28	...	,, .	Castleconnel Rec........	4·24	...
Arg .	Ardgour House	7·58	...	*Clare* .	Inagh, Mount Callan...	4·41	...
,, .	Manse of Glenorchy...	3·88	...	,, .	Broadford, Hurdlest'n.	4·16	...
,, .	Oban......................	3·24	107	*Wexf*.	Gorey, Courtown Ho...	4·89	220
,, .	Poltalloch	...	...	*Kilk* .	Kilkenny Castle	4·56	206
,, .	Inveraray Castle........	6·32	161	*Wic* .	Rathnew, Clonmannon	5·27	...
,, .	Islay, Eallabus	3·23	122	*Carl* .	Hacketstown Rectory..	5·35	206
,, .	Mull, Benmore	11.40	...	*Leix* .	Blandsfort House.......	4·36	179
,, .	Tiree......................	3·44	..	,, .	Mountmellick...........	3·42	...
Kinr .	Loch Leven Sluice......	3·63	149	*Off'ly* .	Birr Castle	2·81	126
Perth .	Loch Dhu................	8·55	191	*Kild'r*.	Monasterevin	3·35	...
,, .	Balquhidder, Stronvar	5·93	...	*Dubl* .	Dublin, FitzWm. Sq....	3·60	175
,, .	Crieff, Strathearn Hyd.	4·74	190	,, .	Balbriggan, Ardgillan.	2·93	141
,, .	Blair Castle Gardens...	4·32	213	*Me'th* .	Beauparc, St. Cloud...	3·78	...
Angus.	Kettins School..........	4·44	182	,, .	Kells, Headfort.........	4·33	160
,, .	Dundee, E. Necropolis	3·42	163	*W.M.* .	Moate, Coolatore......	3·46	...
,, .	Pearsie House...........	3·96	...	,, .	Mullingar, Belvedere...	3·47	141
,, .	Montrose, Sunnyside...	2·86	140	*Long* .	Castle Forbes Gdns......	4·41	171
Aber .	Braemar, Bank.........	3·21	135	*Gal* .	Ballynahinch Castle...	5·67	158
,, .	Logie Coldstone Sch....	3·12	125	,, .	Galway, Grammar Sch.	4·51	...
,, .	Aberdeen, King's Coll.	4·59	197	*Mayo* .	Mallaranny...............	5·90	...
,, .	Fyvie Castle	...	...	,, .	Westport House........	4·65	163
Moray.	Gordon Castle...........	2·58	122	,, .	Delphi Lodge............	8·26	139
,, .	Grantown-on-Spey......	4·02	172	*Sligo* .	Markree Obsy...........	4·73	187
Nairn.	Nairn, Delnies	2·48	138	*Cav'n* .	Belturbet, Cloverhill...	3·98	160
Inv .	Kingussie, The Birches	2·98	...	*Ferm* .	Enniskillen, Portora...	4·33	...
,, .	Loch Quoich, Loan......	10·89	...	*Arm* .	Armagh Obsy	3·61	152
,, .	Glenquoich	8·22	150	*Down* .	Fofanny Reservoir	8·75	...
,, .	Inverness, Culduhtel R.	2·68	...	,, .	Seaforde	3·85	146
,, .	Arisaig, Faire-na-Squir	...	...	,, .	Donaghadee, C. Stn....	3·58	158
,, .	Fort William...........	6·27	...	,, .	Banbridge, Milltown...	2·67	...
,, .	Skye, Dunvegan.........	4·31	...	*Antr* .	Belfast, Cavehill Rd...	4·54	...
R.& C.	Alness, Ardross Cas....	2·99	115	,, .	Glenarm Castle.........	5·05	...
,, .	Ullapool	2·02	79	,, .	Ballymena, Harryville	5·34	187
,, .	Torridon, Bendamph...	2·83	62	*Lon* .	Londonderry, Creggan	3·12	119
,, .	Achnashellach	5·94	...	*Tyr* .	Donaghmore	...	...
,, .	Stornoway	3·68	...	,, .	Omagh, Edenfel.........	3·92	151
Suth .	Lairg......................	2·95	118	*D.n* .	Malin Head..............	2·36	...
,, .	Tongue	3·71	156	,, .	Dunfanaghy..............	2·71	...
,, .	Melvich	4·38	...	,, .	Killybegs, Rockmount .	4·38	123

Climatological Table for the British Empire, December, 1930.

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 Clou'd 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.	1012·8	— 0·9	52	28	45·0	36·0	40·5	+ 0·2	38·1	91	8·1	1·82	— 0·47	14	0·7	9
Gibraltar	1019·5	— 0·6	67	43	62·6	50·8	56·7	+ 0·7	50·7	83	4·8	2·95	— 2·66	10	..	..
Malta	1014·0	— 2·6	70	48	62·5	54·3	58·4	+ 0·5	54·4	78	7·1	6·36	+ 2·65	16	4·9	51
St. Helena	1014·0	+ 0·5	69	55	66·5	57·5	62·0	— 0·2	58·7	92	8·8	0·74	— 1·22	9	..	..
Sierra Leone	1011·8	+ 0·9	89	69	87·3	73·4	80·3	— 1·1	76·8	82	3·8	0·10	— 1·32	2	..	..
Lagos, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kaduna, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zomba, Nyasaland	1007·9	— 0·4	94	63	84·9	68·0	76·5	+ 3·4	..	67	6·4	4·58	— 6·29	18	..	..
Salisbury, Rhodesia	1008·9	+ 0·1	85	58	77·8	61·6	69·7	+ 0·1	63·6	72	7·5	12·00	+ 6·22	25	5·2	39
Cape Town	1014·2	— 0·1	98	48	78·5	59·1	68·8	+ 0·9	62·6	72	4·6	0·44	— 0·37	6	..	..
Johannesburg	1010·2	+ 0·9	87	43	79·8	57·2	68·5	+ 3·4	58·6	62	4·5	4·32	— 1·11	13	8·7	64
Mauritius	1015·1	+ 1·1	88	67	85·6	70·9	78·3	0·0	72·5	61	5·8	2·56	— 2·17	21	9·6	72
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	1·19	— 1·26	..	..	..
Calcutta, Alipore Obsy.	1015·7	0·0	81	51	77·6	55·6	66·6	+ 0·1	56·6	82	1·4	0·00	— 0·20	0*	..	..
Bombay	1013·2	— 1·3	94	65	87·9	69·8	78·9	+ 1·4	67·0	69	0·7	0·00	— 0·05	0*	..	..
Madras	1013·5	0·0	85	64	83·0	70·6	76·8	+ 0·1	72·5	85	4·9	4·76	— 1·05	9*	..	..
Colombo, Ceylon	1012·0	+ 1·3	89	64	86·8	72·5	79·7	+ 0·7	74·3	72	5·3	0·27	— 5·10	3	8·3	71
Hongkong	1019·3	— 0·4	77	49	68·2	60·6	64·4	+ 1·4	59·4	74	7·5	0·89	— 0·24	8	3·9	36
Sandakan	..	..	89	73	86·8	74·5	80·7	+ 0·6	77·1	83	..	15·44	— 2·22	16	..	..
Sydney, N.S.W.	1012·8	+ 0·9	96	57	76·2	63·6	69·9	— 0·2	64·8	67	6·0	5·31	+ 2·40	14	8·1	56
Melbourne	1013·5	+ 1·0	93	50	74·9	56·5	65·7	+ 1·4	60·6	66	7·3	5·06	+ 2·72	17	5·8	39
Adelaide	1013·2	0·0	102	52	85·6	62·3	73·9	+ 2·8	60·7	37	5·8	0·91	— 0·09	7	9 0	63
Perth, W. Australia	1012·9	— 0·3	101	49	79·7	60·5	70·1	— 0·6	61·9	53	4·0	0·90	+ 0·32	5	10·8	76
Coolgardie	1011·2	0·0	100	50	89·2	60·6	74·9	— 0·9	61·3	42	3·2	3·50	+ 2·80	5	..	..
Brisbane	1014·1	+ 2·1	92	58	84·6	65·4	75·0	— 1·4	67·3	52	5·5	1·94	— 2·90	7	9·9	71
Hobart, Tasmania	1013·0	+ 3·3	87	45	68·8	52·1	60·5	+ 0·1	54·7	59	6·1	2·53	+ 0·57	12	7·5	49
Wellington, N.Z.	1015·9	+ 3·7	74	42	62·1	49·8	55·9	— 1·5	53·1	77	8·2	2·99	— 0·23	9	6·1	40
Suva, Fiji	1009·9	+ 1·3	87	70	83·8	73·5	78·7	— 0·2	73·7	75	7·2	7·01	— 5·10	24	6·6	50
Apia, Samoa	1006·8	— 1·6	87	71	84·4	76·2	80·3	+ 1·0	76·8	80	7·1	15·63	+ 2·01	16	5·1	40
Kingston, Jamaica	1013·6	— 0·4	90	67	87·0	70·2	78·6	+ 0·9	68·1	83	3·7	0·04	— 1·55	1	..	..
Grenada, W.I.	1012·8	+ 1·3	89	71	86·5	72·9	79·7	+ 1·6	73·6	77	6·6	4·55	— 2·72	18	..	..
Toronto	1017·5	+ 0·1	45	1	33·7	23·8	28·7	+ 2·5	26·1	82	8·3	1·16	— 1·67	11	1·8	20
Winnipeg	1017·5	— 0·4	38	—20	19·7	7·0	13·3	+ 7·6	..	..	5·9	0·59	— 0·39	9	3·1	38
St. John, N.B.	1015·0	+ 0·8	45	— 4	30·8	18·5	24·7	+ 0·3	20·2	70	7·0	3·42	— 0·75	12	3·0	34
Victoria, B.C.	1021·5	+ 4·7	52	33	46·7	39·6	43·1	+ 1·6	40·6	87	7·9	0·78	— 5·13	16	2·1	25

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

Climatological Table for the British Empire, Year 1930.

STATIONS	PRESSURE		TEMPERATURE										PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values.				Mean								
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb	Relative Humidity.	Mean Cloud Am'nt	Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	in.	in.			
London, Kew Obsy.	1012·7	− 2·7	89	25	57·0	44·5	50·8	+ 1·0	45·9	86	7·2	25·34	+ 1·54	166	3.8	29
Gibraltar	1017·2	− 0·6	93	40	72·1	56·9	64·5	+ 0·2	56·6	83	4·8	36·30	+ 0·48	89	..	..
Malta	1015·6	− 0·3	93	45	70·3	60·3	65·3	− 0·8	60·0	76	4·6	26·27	+ 6·41	86	8·7	70
St. Helena	1015·3	+ 1·0	..	51	..	57·0	..	..	58·0	94	8·9	29·55	− 10·57	203	..	..
Sierra Leone	1013·4	+ 1·9	95	67	85·1	72·5	78·8	− 1·9	75·1	83	5·9	114·47	− 42·76	158	..	..
Lagos, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kaduna, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zomba, Nyasaland	1012·5	− 0·2	94	46	78·1	60·4	69·2	− 0·2	..	73	5·5	36·29	− 18·25	103	..	..
Salisbury, Rhodesia	1012·7	− 0·1	91	35	76·3	53·8	65·1	− 0·3	56·2	53	3·8	23·75	− 8·19	82	7·9	66
Cape Town	1018·1	+ 1·2	104	36	73·0	54·4	63·7	+ 1·4	55·9	79	4·3	16·47	− 8·57	91	..	..
Johannesburg	1016·9	+ 0·4	89	28	70·7	49·4	60·1	+ 0·4	49·4	54	3·0	22·49	− 10·73	86	9·0	75
Mauritius	1016·0	− 0·1	89	55	80·2	67·4	73·8	− 0·2	69·6	69	5·6	35·99	− 13·67	202	8·0	66
Bloemfontein	..	..	..	...	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1008·0	+ 0·4	107	49	88·1	71·5	79·8	+ 1·1	71·8	84	5·0	59·88	− 2·66	84*	..	..
Bombay	1009·2	0·0	96	59	87·5	74·2	80·9	+ 0·4	72·9	76	3·8	89·98	+ 17·79	73*	..	..
Madras	1008·7	− 0·1	107	63	90·3	74·9	82·6	− 0·4	75·1	77	5·9	78·69	+ 27·95	78*	..	..
Colombo, Ceylon	1010·6	+ 0·7	93	64	86·2	74·8	80·5	− 0·3	76·4	77	6·7	116·51	+ 31·26	186	7·3	60
Hongkong	1012·8	+ 0·2	93	41	77·0	68·9	72·9	+ 0·7	68·1	77	7·1	96·10	+ 12·28	128	5·7	47
Sandakan	..	..	94	70	88·3	74·7	81·5	+ 0·2	77·1	81	..	103·14	− 16·58	131	..	..
Sydney, N.S.W.	1017·5	+ 1·6	106	41	70·5	56·8	63·7	+ 0·5	58·4	71	5·5	44·47	− 3·43	141	6·9	57
Melbourne	1018·1	+ 1·7	103	34	68·7	50·3	59·5	+ 1·1	53·4	64	6·0	25·41	− 0·14	145	5·8	47
Adelaide	1018·4	+ 1·3	112	37	74·9	54·7	64·8	+ 1·9	55·1	51	5·4	18·65	− 2·55	116	7·5	62
Perth, W. Australia	1016·1	− 0·3	108	41	74·3	56·6	65·4	+ 1·3	58·1	63	4·7	39·80	+ 5·77	129	7·9	64
Coolgardie	1016·1	+ 0·1	115	33	78·7	52·8	65·7	+ 1·2	55·4	52	3·6	13·87	+ 3·71	56	..	..
Brisbane	1017·6	+ 1·7	97	41	77·3	60·1	68·7	− 0·2	62·4	65	5·1	41·22	− 3·44	142	7·5	62
Hobart, Tasmania	1015·0	+ 2·5	93	32	62·7	47·2	55·0	+ 0·6	49·1	66	6·2	19·38	+ 4·36	152	6·1	50
Wellington, N.Z.	1014·9	+ 0·2	77	32	58·3	46·7	52·5	− 2·8	49·8	77	6·8	38·21	− 9·83	147	5·8	48
Suva, Fiji	1011·9	+ 0·5	92	58	81·7	71·2	76·4	− 0·6	71·9	76	6·9	102·92	− 9·46	235	5·3	43
Apia, Samoa	1009·6	− 0·7	89	69	84·8	75·0	79·9	+ 1·4	77·1	78	5·3	89·48	− 17·37	160	6·7	55
Kingston, Jamaica	1013·6	− 0·1	95	64	87·3	71·8	79·6	+ 0·2	70·1	82	3·9	15·48	− 18·11	72	..	..
Grenada, W.I.	1013·5	+ 1·2	90	70	86·9	73·4	80·2	+ 1·4	73·9	77	4·8	54·11	− 21·97	213	..	..
Toronto	1016·1	− 0·3	95	− 6	55·4	39·3	47·4	+ 3·0	41·2	72	5·8	25·74	− 7·73	139	5·6	44
Winnipeg	1015·5	− 0·8	94	−35	47·0	28·8	37·9	+ 3·6	..	..	5·3	22·63	+ 1·56	114	6·0	47
St. John, N.B.	1014·4	− 0·3	87	− 8	50·6	35·1	42·9	+ 1·7	38·5	75	6·2	40·29	− 7·79	149	5·5	44
Victoria, B.C.	1017·6	+ 1·1	87	15	55·1	43·7	49·4	− 0·1	46·0	80	5·9	18·80	− 13·69	119	6·3	49

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

(*Continued from p.* 119)

shire (Dorstone 1·75in.). The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	171	— 20	Liverpool	166	—33
Aberdeen	187	0	Ross-on-Wye	152	—51
Dublin	177	— 28	Falmouth	171	—60
Birr Castle	172	— 10	Gorleston	176	—49
Valentia	189	— 14	Kew	160	—41

The special message from Brazil states that for May the rainfall was scarce in the northern regions with an average 1·38in. below normal, irregular in distribution in the central regions with 0·16in. above normal and in excess in the southern regions with 0·71in. above normal. Six anticyclones passed across the country and the continental depression was active during the later part of the month. The cereal crops and vegetables were in normally good condition. At Rio de Janeiro pressure was 0·7mb. above normal and temperature 0·2°F. above normal.

Miscellaneous notes on weather abroad culled from various sources.

Owing to heavy rain and an unusually rapid thaw this spring the rivers in various parts of the central and northern provinces of Sweden overflowed their banks early in the month. Serious floods were also reported later from the country to the north of Lake Vener, Sweden, where Klarälven had overflowed and submerged 200 farms. Torrential rains flooded large parts of south Germany early in the month. Navigation re-opened at Riga and Uleaborg between the 18th and 25th. Thunderstorms damaged vineyards and fruit trees in the Rhine Valley, particularly near Assmannshausen and Lorch, and in the Eifel hills about the 27th (*The Times*, May 8th-28th).

Owing to the rainfall for April and May in Manitoba, Saskatchewan and Alberta being less than half the normal the prospects of the wheat crop are becoming endangered (*The Times*, June 6th). Temperature was below normal generally in the eastern United States, and above normal along the Pacific coasts. In the Missouri and Upper Mississippi valleys and the Mountain Region it was variable. Rainfall was irregular in distribution. Temperature in the Argentine was mainly below normal, and especially so during the week ended the 19th, when it was as much as 9-10°F. below. Precipitation was also deficient (*Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*). The first heat wave of the year occurred in New York State on the 28th-30th when 94°F. was registered at Albany, N.Y., on the 29th.

Rainfall, May, 1931—General Distribution

England and Wales	150	per cent of the average 1881-1915.
Scotland	145	
Ireland	162	
British Isles	151	