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A Beautiful Reflected Rainbow

The following account of an unusually complete reflected rainbow is translated from *Onweders, optische verschijnselen, enz. in Nederland*, vol. 51, 1930, pp. 74-7, by kind permission of the Director of the Koninklijk Nederlandsch Meteorologisch Instituut.

"On November 29th, 1930, Heer M. D. Dijt, of Eierland, Texel Island, observed a reflected rainbow, of which he gave so accurate a description that every phase of this unusual phenomenon can be followed.

To quote Heer Dijt:—

'The rainbow was observed at Eierland, Texel Island. I was at the point marked 1 on my diagram (Fig. 2). At about 13h. it began to rain, whilst there was practically no wind. To the south-west the sky was clearing and the 'clearing line,' which extended all along the horizon, appeared very slowly. Behind the clearing line the sky was clear. When the sun appeared at 14h., just below the clearing line, I went out of doors to have a look at the rainbow I expected to see, and was astonished to see three bows, one above the other, as shown in Fig. 1. At first bow C was even brighter than bow A and bow B was very faint. The reds of A and C were on the outer edge of the bows and the red of B was on the inner edge. Bows A and B slowly grew brighter so that the effect, especially of A was brilliant at

(1725) 107/27 1,125 5/33 M. & S. *Gp.303*

14h. 10m. and after. At the time in question I could differentiate the following sequences of colours: in A, from the outer to the inner edge; red, orange, yellow, green, blue, violet, green, violet, green, violet; in B, from the outer to the inner edge, violet, green, yellow, red: and in C, red, yellow, green. After this C disappeared.

'I was unable at first to understand the appearance of bow C, as I knew there were no expanses of water within 2 kilometres, but I think the phenomenon may be explained by the sheets of water at Waal and Burg, 2 to 4 kilometres distant. Thanks to the absolutely still air these sheets of water, which at that time, owing to the floods, extended over a wide area (shaded parts of Fig. 2) constituted giant mirrors and reflected the sunlight on the rainclouds and falling rain over the Eierland polder about 3 to 5 Km. distant from the sheets of water. As the sun was relatively low, the diffusion of light over such a great distance is explicable. At 14h. the centre of the highest part of bow A, indicated by 'a' in Fig. 1, was about 31° above the horizon, the highest part of bow B, indicated by b in Fig. 1 was about 39°, and the highest part of bow C, indicated by c, about 50° above the horizon. I had only a post and a couple of sticks wherewith to measure these heights. If I am not mistaken in my measurements and my assumption that bow C was caused by the sun reflected by the water is correct, the height of the sun must have been approximately 10°, *i.e.*, $\frac{50-31}{2}$. The sudden fading away of bow C at 14h. 10m., whilst the brilliance of bows A and B was increasing is, in my opinion, due to the fact that an easterly wind set in at that moment and ruffled the smooth surface of the water.

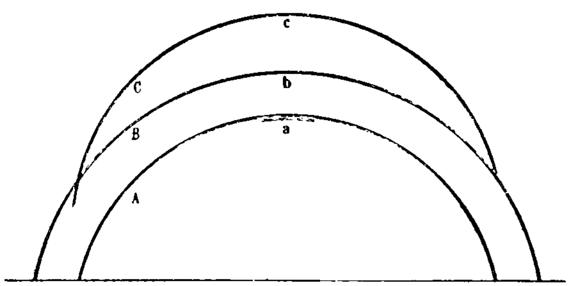

FIG. 1. REFLECTED RAINBOW SEEN FROM EIERLAND ON NOVEMBER 29th, 1930.

I was informed that this phenomenon was likewise observed at the place marked 2 on Fig. 2. I think it probable that all three rainbows may have been observed at other places north-east of the expanses of water.'

Heer Dijt's explanation is undoubtedly correct, and he is to be congratulated on the fact that he was able to take such accurate measurements with the rough-and-ready means at his disposal. At 14h. 5m. the sun was 9° 48′ above the horizon. The radius of the normal rainbow A must have been 42°, that of bow B 50°, hence theoretically, a must have been 32° 12′, b, 40° 12′, and c, 51° 48′ above the horizon.

It is possible that the wind referred to by Heer Dijt actually was the cause of the sudden fading of the reflected bow. The higher bow should have faded first with the passage of the rain squall, but it would have faded slowly and not suddenly. It is impossible from the data to determine the height of the cloud base at the time of observation, but it must have been at least 1,000 metres.

If we consider the path of the reflected rays when the sun is 10° above the horizon, it is obvious that the pencil of rays was more than wide enough for a complete reflected bow to be visible from Heer Dijt's point of observation. To explain that C could be followed at a height of 25° to 30°, we must assume that the southerly expanses of water were also a contributory cause. The completeness of the reflected bow with a relatively small reflecting surface may be explained by the unusually favourable point of observation. This was confirmed by a number of other observations received by Heer Dijt subsequent to an appeal for observations published in the *Texelsche Courant*. The points of observation are given in Fig. 2. 1 represents that of Heer Dijt. The observers at 2 and 3 close by, saw the same phenomenon as Heer Dijt, those at 4 and 5 saw the ordinary bow perfectly but only a part of the reflected bow to the left, and those at 6 saw it only to the right. 7 and 8 are in the direction of the sun's rays in relation t a few smaller expanses of water; 7 saw the highest middle section of the reflected bow, 8 described a third bow on the ground; this,

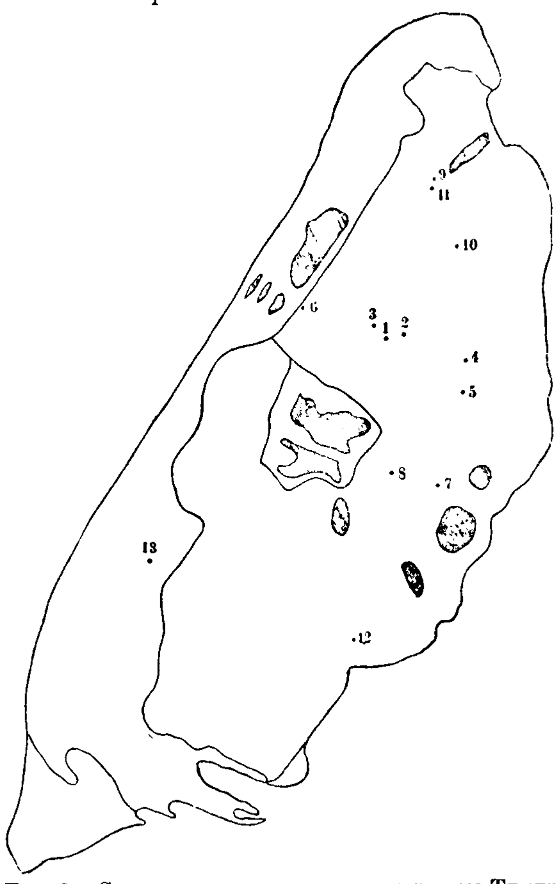

FIG. 2. SKETCH OF AREAS UNDER WATER ON TEXEL

however, was probably due to his imagination. It is more difficult to explain 9-11 and 12. In the case of 9 and 11 the expanses of water along the west coast may possibly have contributed. Both 9, 11 and 12 state that they only saw a portion of a reflected bow on the left edge. 10, however, describes a completely reflected bow. This might be due to the stretches of water at Waal and Burg; in that case the rays descending with the inclination 50° must have been reflected by drops at a height of about 1,000 metres. 12 was probably due to some small local expanse of water, Heer Dijt was not certain that he knew every spot under water. Observation 13 was sent to us direct by the observer, Heer A. Koopman. If we understand his diagram aright he saw the right lower end of the three bows, and the reflected bow between the other two ended slightly higher and was steeper. This portion may actually have been caused by the rays reflected by the expanses of water between observation points 7 and 12.

The 14th observation from Wieringen can naturally not be ascribed to the expanses of water on Texel Island, but probably to the parts of the Wieringermeerpolder which, owing to the constant rain, were again flooded. The whole phenomenon would, therefore, appear to be due to the excessive rainfall in November."

Remarkable Sunshine Record of Tiree

By J. Crichton, M.A., B.Sc., F.R.S.E.

At Cornaigmore School, Tiree, a telegraphic station has been maintained by the Meteorological Office for several years, sunshine values being available for the period 1927-1932. A study of the sunshine maps given in the "Book of Normals of Meteorological Elements of the British Isles" for periods ending 1915 would lead one to expect that Tiree on the average would experience very little sunshine throughout the year. An examination of the annual summaries of sunshine duration at various stations throughout the British Isles, issued by the Meteorological Office, indicates, however, that Tiree enjoys during at least the months of April, May and June as much sunshine as any part of the British Isles.

In Table I we have for a few stations the mean daily values of sunshine duration for each month and for the year over the period 1927-1932, the stations selected, with the exception of Stornoway, Castlebay and Tiree, comprising all those with 25 or more years' record which have been used in compiling the maps in the "Book of Normals" and for which data were given in the annual sunshine duration summaries. Stornoway and Castlebay were included for purpose of comparison, as

TABLE I

Mean monthly and annual sunshine daily averages covering period 1927-1932, with annual normal daily values for standard period 1881-1915.

	Eastbourne	Scilly	Brighton	Southampton	Plymouth	Douglas	Dublin	Greenwich	Kew	Valentia	Aberdeen	Stornoway	Castlebay*	Tiree
January ..	2·00	2·19	1·98	1·82	1·97	1·92	1·96	1·18	1·48	1·43	1·89	0·98	0·89	1·18
February ..	3·26	3·21	3·43	2·63	3·01	2·74	2·52	1·69	1·92	2·60	2·46	2·27	1·90	2·48
March ..	5·09	4·74	5·02	4·22	4·59	4·17	3·79	3·80	3·89	4·04	3·28	3·70	3·69	4·06
April ..	5·68	6·07	5·47	4·67	5·47	5·45	4·99	3·96	4·34	4·71	4·41	5·24	5·64	6·44
May ..	7·12	6·75	6·82	5·99	6·01	7·09	5·77	5·40	5·77	**6·28**	4·87	**6·23**	**6·34**	**7·78**
June ..	**8·14**	**7·62**	**7·65**	**7·15**	**7·30**	**7·10**	**6·38**	**6·40**	**6·63**	5·81	**6·05**	6·09	6·06	7·46
July ..	7·62	6·75	7·17	6·39	6·32	5·46	4·59	5·99	6·11	4·02	4·45	3·88	5·43	4·79
August ..	7·23	6·64	6·72	6·01	6·00	5·36	4·67	6·07	5·98	4·58	4·42	4·49	4·50	5·14
September ..	5·50	5·49	5·61	5·19	5·33	4·89	4·22	4·61	4·64	4·32	3·95	3·20	3·76	4·02
October ..	4·03	4·13	4·00	3·61	3·80	3·60	3·72	3·01	3·18	2·79	3·22	2·44	2·57	2·79
November ..	2·36	2·58	2·32	2·15	2·24	2·09	2·36	1·40	1·72	1·97	2·15	1·62	1·45	1·70
December ..	1·80	1·76	1·81	1·49	1·56	1·26	1·41	0·98	1·29	1·14	1·26	0·77	0·77	0·99
Year ..	5·00	4·84	4·84	4·28	4·47	4·27	3·87	3·72	3·93	3·64	3·54	3·41	3·59	4·07
35 year normal	4·88	4·84	4·81	4·57	4·56	4·41	4·13	4·05	4·04	3·96	3·80	3·45	—	—

Maximum values are indicated by heavy type.

* Values refer to period 1908-1926.

TABLE II

Mean monthly and annual sunshine daily averages covering period 1927-1932, with mean normal daily values for year for period 1881-1915 expressed as a percentage of mean length of day, allowance having been made in length of day for periods when sun had an elevation of 3° or less.

	East-bourne	Scilly	Brigh-ton	South-ampton	Ply-mouth	Douglas	Dublin	Green-wich	Kew	Valen-tia	Aber-deen	Storn-oway	Castle-bay	Tiree
January ..	26	26	26	24	26	27	27	16	20	19	30	16	13	18
February ..	35	35	37	29	33	31	28	18	21	28	29	27	22	29
March ..	46	43	45	38	41	38	34	34	35	36	30	34	34	37
April ..	43	47	42	36	42	41	38	30	33	36	33	39	**42**	48
May ..	48	46	46	41	41	**48**	38	36	39	**42**	31	**40**	41	**50**
June ..	52	**49**	**49**	**46**	**47**	44	**40**	41	42	37	**36**	36	36	45
July ..	50	45	47	41	42	35	30	39	40	26	28	24	34	30
August ..	**53**	48	**49**	44	44	38	33	**44**	**43**	33	31	31	31	36
September ..	46	46	47	44	45	41	35	39	39	36	33	27	31	33
October ..	40	41	40	36	38	37	38	30	32	28	34	26	27	29
November ..	29	31	29	26	29	27	30	17	21	25	31	24	21	24
December ..	26	25	26	21	22	20	22	14	19	17	23	15	14	18
Year ..	44	42	42	37	39	37	34	32	34	32	31	30	32	36
35 year normal	43	42	42	40	40	39	36	35	35	35	34	30	—	—

Maximum values are indicated by heavy type.

they, like Tiree, are in the Hebrides; the Stornoway record was available over the period 1927-1932 and that for Castlebay over the period 1908-1926. We see that in April and May Tiree had the largest average daily value and that in June only at Eastbourne, Brighton and Scilly was the Tiree figure exceeded. Even in March we note that the Tiree average was greater than that for any of the Irish or Scottish stations quoted in the table and also greater than that for either Kew or Greenwich. The mean daily figures for the year portray the same characteristics as those for March. The excess of the daily average for the year at Tiree over that for Kew, Greenwich, Valentia, Dublin and Aberdeen is in each case quite appreciable and, indeed, rather surprising in its amount in the cases of Kew, Greenwich and Valentia; Tiree's excess over Castlebay and Stornoway is perhaps somewhat greater than might have been anticipated.

We have in Table II expressed the figures, given in Table I, as a percentage of the mean length of the day at each station, allowance being made for the period when the sun has an elevation of 3 degrees or less above the horizon; no other allowances for obstructions were made. Here again we see that during April and May the greatest percentage of possible sunshine was registered at Tiree; in April the percentage at Scilly closely approximated to that for Tiree, while in May the nearest was Eastbourne, which was closely followed by Douglas. Table II brings out another important feature, namely, that May at Tiree, Douglas, Valentia and Stornoway had the greatest monthly percentage of possible sunshine, while at the remaining stations, with the exception of Castlebay, the greatest percentage occurred in either June or August, this seeming to indicate that in extreme western districts the month registering the greatest percentage of possible sunshine is May. Returning to Table I, we note, however, that only at Tiree, Castlebay, Stornoway and Valentia was the daily sunshine duration actually greatest in May; at the remaining stations the largest average daily figures were registered in June, there being little difference between the May and June figures for Douglas.

At the bottom of Table II the normal daily sunshine for the year for the standard period 1881-1915 is expressed as a percentage similar to that for the period 1927-1932. We note that the percentages for the two periods, 1881-1915 and 1927-1932, are in very good agreement, the latter period being slightly the less sunny of the two, so that we may assume that the period 1927-1932 was not in any way exceptional as regards the distribution of sunshine. The setting up of a sunshine recorder at Tiree has thus probably enabled us to locate the sunniest region in the British Isles during the months of April and May—and that a somewhat unexpected region.

OFFICIAL PUBLICATION

The following publication has recently been issued.

PROFESSIONAL NOTES.

No. 64. *The vertical extent of north-westerly winds over Iraq in summer.* By S. P. Peters, B.Sc. (M.O. 336d.)

The north-westerly winds, which occur almost continuously in Iraq during the months June to September, are frequently of such strength as to constitute a serious hindrance to aircraft engaged in making a return passage from India to Egypt. Hence it is a matter of practical interest and importance to know that frequently these winds do not extend above about 7,000 feet, a marked change in speed and direction being experienced above that height, and that in some cases this change takes the form of a complete reversal of direction from north-westerly in the lower layers to south-easterly above.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, April 26th, in the Society's Rooms, at 49, Cromwell Road, South Kensington, Prof. S. Chapman, F.R.S., President, in the Chair.

C. S. Durst, B.A.—The intrusion of air into anticyclones.

An examination of the dynamical equations of rotating fluid on a rotating globe shows that the descent of air in an anticyclone will cause an inflow towards the centre of the right order of magnitude to balance the outflow of air due to friction near the surface. An explanation is given of the empirical forecasting rule that warm-cored anticyclones are likely to endure.

H. M. Vernon, M.A., M.D.—The estimation of solar radiation in relation to its warming effect on the human body.

The globe thermometers described consist of globes of copper, glass or pasteboard, painted black or covered with cloth, and with an ordinary thermometer fixed so as to have its bulb in the centre. Up to a certain point the larger the size of such globes the higher the temperature indicated on exposure to solar radiation, but the limit is practically reached with globes 6 to 9 inches in diameter. The temperature then indicated corresponds with the warming effect of the solar radiation on the human body, as was proved by indoor tests on artificial radiant heat as well as by outdoor tests on solar radiation.

Globe thermometers are considerably influenced by wind velocity. For instance, a light breeze (eight miles an hour) reduced the globe temperature—in excess of air temperature—to 44 per cent. of its excess in nearly calm air, whilst it reduced the excess temperature of a clear glass solar radiation thermometer (black bulb in vacuo) only 7 per cent.

J. Glasspoole, Ph.D.—The rainfall over the British Isles of each of the eleven decades during the period 1820 *to* 1929.

It is obviously desirable to review, from time to time, the rainfall recorded during recent years, in comparison with that experienced during as long a period as possible. Maps are given showing the rainfall experienced over the British Isles during each of the eleven decades, 1820-29 to 1920-29. The rainfall of each locality is given as a percentage of that for the standard period 1881 to 1915, so that each map presents a fairly simple distribution. The main feature of the distribution of rainfall during the decade 1920-29 was that excesses were most marked in the west of Great Britain, while during the decade 1910-19 (covering the war years) the excesses were most marked in the south of England.

Correspondence

To the Editor, *The Meteorological Magazine.*

Summer Thunderstorms

In his very interesting and suggestive article on "Summer Thunderstorms," Captain Douglas refers to the "misleading notion that thermal instability is developed between a warm south-east current and an over-running colder south-west current, even at considerable heights." The first time the "notion" came to my knowledge was in France during the War, when Major Goldie drew attention to the fact which he had noted in the Somme area, viz., that there was a tendency for thunderstorms to develop with a wind at 4,000 or 5,000 feet from a south-westerly direction over a surface wind from a southerly or south-easterly direction.

Captain Douglas advances, as a reason against the "notion," the fact that in a layer in which the gradient wind veers with increasing height, the horizontal transport of air is from warm to cold; and this temperature factor would indeed be a "complete preventive" of thunderstorms with a veering upper gradient wind, if the gradient wind went on veering right up to the stratosphere; but the factor ceases to be effective when the veering ceases. The upper wind may then be transporting relatively cold air, instead of relatively warm air, across the surface isobars (from low to high). It is practically certain that in individual cases this does happen, and if the surface air has been warmed substantially as continental air may be warmed substantially in summer, then there may also be instability.

I think statistical investigations are extremely useful, especially to give some indication of the weight to be attached to any empirical rule. While I am satisfied from Captain Douglas's results that the suggestion "that a south-west wind at 5,000 feet over a south-east surface wind is favourable to thunderstorms" must be used with a good deal of caution, and taken in conjunction with other factors, I do not feel convinced that his statistical investigation has proved that the factor is of no use. (Why even to-day there was a veering upper wind over an easterly surface wind in front of thunderstorms.)

As I mentioned above, if a cold south-west upper wind over a warmer lower current from south-east or south is a source of instability and thunderstorms, then the wind certainly cannot go on veering with height indefinitely, and Captain Douglas's earlier remark, that a veer above 10,000 feet was unfavourable for thunderstorms, is quite in accordance with this view. Thus a condition, which must be necessary in addition to the veer in the lower levels, is a cessation of the veer or a backing at higher levels. It would be interesting to know what was the character of the curve showing the relation between wind direction and height for those cases of a veering wind which gave thunderstorms and for similar cases which did not.

Some thunderstorms appear to be due to diurnal heating of air more or less *in situ*. Those which are not will usually be due either to the intrusion of warm air beneath cold air, or to the over-running of cold air over warm air. In north-east France in summer, that usually meant a wind veering with height. The veer may not have been as much as 90° ; a smaller veer would be sufficient. It is quite likely that southern England is different from north-east France in this respect, because the Channel and the North Sea are not meteorologically insignificant.

A further factor which cannot be neglected in a consideration of thunderstorm problems is humidity. No amount of cold upper air can produce a thunderstorm if the air is dry, nor can diurnal heating.

The main point, in my view, in support of the idea that a veer of the wind at 4,000 or 5,000 feet from the surface isobars is a factor in connexion with the thunderstorm question, is that such a veer indicates an appreciable horizontal gradient of temperature; (so, of course, does a backing): a horizontal gradient of temperature is almost an essential for instability: thus, if there is such a veer up to 4,000 or 5,000 feet, one of the essentials for instability is present—and thunderstorms are instability phenomena.

E. GOLD.

8, *Hurst Close, London, N.W.*11. *May* 3*rd*, 1933.

In my article in the April number of this *Magazine*, there is an accidental omission near the middle of p. 59, where it should have been stated that the computation was based on a gradient wind of 10 metres per second and an angle of 20° between the surface wind and the isobars. In the sentence at the foot of p. 56, there is a possibility of some misunderstanding due to over-condensation, but it is fairly obvious from the context that the 156 cases represent the sum of the south-west and south-east upper currents, and that cases with northerly components at high levels were not considered. The latter are fairly numerous in anticyclones. South-east winds at high levels are rare in anticyclones, but it must be remembered that days with no high or medium clouds are automatically excluded from consideration unless a pilot balloon is followed to a sufficient height. Nevertheless I think the evidence is sufficient to show that south-easterly winds at high levels are normally associated with shallow depressions or troughs, or the intermediate regions between anticyclones and depressions, and that they are very favourable for thunderstorms. Many of the storms are of diurnal convectional type and affect the Midlands rather than the extreme south-east, but late in the day continental storms sometimes cross the Straits of Dover.

C. K. M. DOUGLAS.

April 25th, 1933.

A Thunderstorm Phenomenon

Observations have occasionally been recorded in this publication of a sharp " vit " or " click " accompanying lightning flashes. It has been described as occurring simultaneously with the lightning and preceding the thunder. The undersigned is collecting records of such occurrences, and would be glad to receive from readers, especially those connected with the Thunderstorm Census Organization, details such as the following :—

(1) Approximate distance of the lightning flash.
(2) Direction of the " vit " with respect to that of the lightning.
(3) Number of people who observed simultaneously the " vit."
(4) Whether only the most severe flashes were accompanied by the " vit."
(5) Whether observed indoors or in the open.

S. E. ASHMORE.

22, *Soho Road, Handsworth, Birmingham*, 21. *April 30th*, 1933.

Spells of Sunshine

In the April number of this *Magazine* Mr. Dunbar raises the question of classifying sunshine records under headings such as " sunny period," " dull period," etc., and tentatively suggests certain definitions. As opinions are invited, I venture to offer the following remarks :—

In the first place, when one sets out to invent a term to which a precise meaning is to be ascribed, it is very desirable to avoid words or expressions which are in daily use. From this point of view I would suggest that it is preferable to use the word " spell " rather than " period." The term " sunny spell " is not so likely to be employed in general descriptions of sequences of weather as the term " sunny period," and is, therefore, in my submission, a more appropriate term to use in a specialised sense. Perhaps Mr. Dunbar will agree, therefore, to allow me to speak of "sunny spells," "bright spells," "dull spells" and "sunless spells" in the subsequent discussion.

To see how Mr. Dunbar's proposals would work out I looked through the Kew Observatory records for 1931, with the following results :—

Sunny Spells (30 successive days with recordable sunshine).

Nil.

Bright Spells (15 successive days with 1 hour or more of sunshine.

March 7th—23rd = 17 days.
May 24th—June 8th = 20 days.
June 25th—July 14th = 20 days.

Dull Spells (15 successive days not having 1 hour or more of sunshine).

Dec. 11th-26th = 17 days.

Sunless Spells (10 successive days with no recordable sunshine).

Dec. 11th—25th = 16 days.

1931 was a dull year in south-east England. At Kew sunshine was substantially below normal in every month from April to September. I find, however, that from February 1st to November 30th there were only 42 days without sunshine. Of the 261 days in that period with some sunshine, only 49 had less than one hour. In the summer months June, July and August (in each of which sunshine was very deficient) there were only 16 days with less than one hour of sunshine, and only five with none at all. Except for breaks of single days on June 10th, June 24th, July 15th, August 14th and August 24th, the entire period from May 18th to September 4th would have been a "sunny spell" as defined by Mr. Dunbar. As it turned out, however, there was no spell quite reaching 30 days without interruption. There were, however, no fewer than three "bright spells." My general impression is that in framing definitions of the kind required one would have to take account of the following facts :—

1. Days with less than one hour of sunshine are infrequent in the summer.
2. Spells of as many as fifteen days each with less than one hour of sunshine are practically confined to the winter months.
3. Spells of fifteen or more days each with one hour or more of sunshine are too frequent to call for special comment.

(These remarks apply to all except the least sunny districts of the British Isles.)

In view of the large seasonal variation of sunshine, I very much doubt the possibility of framing really satisfactory definitions. To cut out all but the really noteworthy sequences in summer, I think it would be necessary to raise the limit for a "bright spell" from one hour to three hours, but that would be too high a limit for the winter months. Possibly the best course would be to make the criterion "one-fourth of the possible mean daily duration," both for "bright spells" and "dull spells," leaving the definitions as they stand in other respects.

E. G. BILHAM.

April 28th, 1933.

Halo System seen from Hastings

I beg to submit some notes on a halo system which was observed here on April 14th last. The phenomenon was by no means an unusual one and did not rival that seen here on December 19th, 1932, but is of interest from the fact that the sky appeared to be absolutely free from cloud in its vicinity though a little cirrus lay to the south. This cloud had moved from due north and, when passing over the sun some time previously, did not produce even a trace of a halo. The sky did not present even the milky appearance produced by the lofty cirro-nebula, but was of the clear blue often seen on those days with settled weather and a dry easterly wind. A little fracto-cumulus was seen inland.

At 12h. 5m. G.M.T. the system consisted of an upper and lower portion of the ordinary halo, both brightly coloured and the upper having the circumscribed arc of contact. To the south-east a coloured arc of the 46° halo was seen, while the white parhelic circle extended from the ordinary halo round by east to about north-east and was most pronounced nearest the halo. The circle did not pass through the sun as I observed on a previous occasion. The phenomenon gradually faded. The above may have been due to fine ice dust, and it is worthy of note that some of the most perfect haloes seem to occur in the thinnest of high cloud, especially cirro-nebula.

A. E. MOON.

39, Olive Avenue, Clive Vale, Hastings. April 18th, 1933.

Local Fog

It was interesting on the morning of March 3rd, 1933, during the period when persistent fog over the snowbound area of north Yorkshire held up for several days aerial communication between England and Scotland, to observe near Cranwell an illuminating example of the effectiveness of snow in producing local fog.

The air was moist after continuous light rain during the night, and there had been mist earlier; but at the time of observation (8h. 20m.) visibility was about 6 miles generally. The humidity measured immediately afterwards at the Meteorological Office a mile away was 97 per cent and the temperature 49°F. A south-easterly wind of 12 m.p.h. was blowing across the heath, and the sky was overcast with alto-stratus and scud.

Small patches of snow still persisted here and there. Over one of these, measuring about 15 yards by 5 yards, and lying in the lee of a small plantation, a patch of fog was seen. The fog extended upwards from the snow to a height of about six feet in the slowly eddying and drifting air of this sheltered spot, and in the air drifting away it dissolved four or five yards beyond the edge of the snow.

The observation suggests that, given facilities, it would not be impossible to bring into the laboratory the study of advection fog formed in free air.

W. A. HARWOOD.

R.A.F. Station, Cranwell, Lincs. April 13th, 1933.

Snowdrifts in Warwickshire

Whilst staying at Chipping Norton over Easter I was informed that, on the exposed ridge, about 700 feet high, which forms an outlying spar of the Cotswolds along the border of Oxfordshire and Warwickshire, and contains the prehistoric stone circle of Rollright above the village of Long Compton, the drifting during the blizzard of February was so severe that a couple of cottages within a few hundred yards of the Rollright Stones were snowed up to bedroom windows. Since this district was well removed from the zone of greatest intensity of the blizzard, I think it is an instructive illustration of the influence of fairly high ground in extending the area of heavy snow. This is confirmed by conditions in the Chilterns, for at Whipsnade on the Dunstable Downs the depth of undrifted snow appears to have been about 2 feet as compared with London's 2 inches only some 40 miles away.

L. C. W. BONACINA.

35, *Parliament Hill, London, N.W.*3. *April 27th*, 1933.

NOTES AND QUERIES

International Photography of the State of the Sky

As part of the programme of the second International Polar Year, at present in progress, the International Commission for the Study of Clouds organised a special "International Cloud Year" for the study of the state of the sky and its variations. In connexion with this investigation General Delcambre, President of the Commission, selected two periods for the special study of clouds in great detail, in France and neighbouring countries. The first of these was April 12th and 13th, and the second is arranged for July 12th and 13th, 1933, and to help in extending the latter beyond the borders of France, General Delcambre has appealed for the assistance of all photographers, whether professional or amateur, who are interested in meteorology.

At least three photographs should be taken each day, as near as possible to the hours of 8 a.m., 2 p.m. and 7 p.m. Summer Time, and additional photographs at intermediate hours are desirable whenever the general character of the sky changes. The purpose of the photographs is to represent, without any serious gap, the evolution of the cloud systems regarded as a whole. For example, in the course of a fine calm summer day, isolated cumulus clouds form, with growing white " cauliflower " heads. Each isolated cloud is constantly changing, but the evolution of the sky as a whole is much slower, and three photographs during the day would suffice to follow it completely: one taken at the moment when the fine weather clouds form, the second generally in the afternoon when they are most numerous and have reached their full development, and the third in the evening when they are degrading and tend to disappear.

The photographs are for scientific purposes, and their artistic value is a secondary consideration. Groups of clouds should be photographed rather than individual clouds, and if choice is available a wide-angle lens should be employed. If the clouds are thin, a yellow filter should be used to distinguish them from the blue of the sky; on the other hand, if the clouds have heavy shadows, it may be necessary to use a light blue filter to introduce sufficient contrast with the clear sky. The prints should be made to show as much detail as possible, but must not be retouched.

It is essential that on the back of each print should be written the name and address of the photographer, the place where taken, date and time. The following additional information would be of value: amount of sky covered, description of the part of the sky not included in the photograph, direction in which the camera was pointing, and approximate elevation above the horizon. Prints, suitably packed, should be addressed to M. le Ministre de l'Air, Office National Météorologique, 196 rue de l'Université, Paris 7, and in the corner should be written " Année des Nuages."

On Readings of a 4-ft. Earth Thermometer in vulcanite and iron Tubes

In the *Meteorological Magazine* for February, 1932, on page 13 there is a note on a comparison between readings of two 4-ft. earth thermometers. These were the Angstrom-Petri thermometer, designed for use in a vulcanite tube, and the Symons thermometer, with its paraffin lagging and large iron tube. It was mentioned in the article that the result of the comparison, which had extended over a year, was that the difference between the readings of thermometers of the two types was quite negligible for any practical purpose. Any regular law obeyed by the temperatures in the two tubes was likely to be masked by the effects of small errors in the calibration of thermometers.

Accordingly it was decided to use one thermometer on alternate days in the two tubes. In the following table the differences are set out between the means obtained from the readings in one tube or the other at 9h. and at 13h. The routine of alter-

Average readings of the thermometer in the vulcanite tube *minus* average readings in the iron tube.					
Month.	9h.	13h.	Month.	9h.	13h.
	°F	°F		°F	°F
October ...	+·16	+·29	April	+·10	—·01
November ...	+·23	—·14	May	+·42	—·31
December ...	+·23	+·08	June	—·21	+·35
January ...	+·11	+·12	July	—·08	+·06
February ...	+·14	+·06	August ...	+·05	—·12
March ...	+·17	·00	September ...	—·07	+·09
Means... ...	+·17	+·07		+·035	+·01
Means for 12 months				+·10	+·04
Mean for all readings +·07°F					

nate observations in the two tubes was usually interrupted on Sundays, but the thermometer spent as many days in one tube as in the other.

It will be noticed that on the average the vulcanite tube gave the higher readings during the winter months, the season of falling temperature at 4 feet; fluctuations in the computed means for the summer months, the season of rising temperature, are quite irregular and may be attributed to the fact that the temperatures were not taken on the same days in the two tubes.

The general average for the difference in temperature in the two tubes is ·07°F., the vulcanite tube yielding the higher readings. The explanation may be that in winter cold air falls down the large iron tube to mix with the air at 4 feet. In summer at 13h. the stratification in the iron tube is stable and the iron and vulcanite give consistent readings. The 13h. observation in winter and the 9h. observation in summer are intermediate in character. According to this explanation the defect of the Symons thermometer is the use of a large tube, not the use of an iron tube. The introduction of the tube with the smaller bore seems to be a real, though very slight, improvement.

F. J. W. Whipple.

The "Greenhouse Effect"

Prof. R. W. Wood published many years ago* a paper in which it was shown that the theory generally advanced to explain the high temperature reached inside a greenhouse in sunny weather is erroneous. Although the matter is of obvious interest for meteorology, it is doubtful whether many meteorologists are aware of the existence of this paper, and a brief summary of it may, therefore, not be out of place. In Prof. Wood's own words "there appears to be a widespread belief that the comparatively high temperature produced within a closed space covered with glass, and exposed to solar radiation, results from a transformation of wave-length, that is, that the heat waves from the sun, which are able to penetrate the glass, fall upon the walls of the enclosure and raise its temperature: the heat energy is re-emitted by the walls in the form of much longer waves, which are unable to penetrate the glass, the greenhouse acting as a radiation trap. I have always felt some doubt as to whether this action played any very large part in the elevation of temperature. It appeared much more probable that the part played by the glass was the prevention of the escape of the warm air heated by the ground within the enclosure."

To test this view Prof. Wood constructed two enclosures of black cardboard, one covered with a glass plate, the other with a plate of rock-salt of the same thickness. On exposing these to the sun, and placing a thermometer in each, it was observed that the reading of the thermometer under the rock-salt rose slightly faster than that of the thermometer under glass, a result which he attributed to the fact that practically all the wave-lengths in the solar radiation passed through the rock-salt, but only the short wave-lengths through the glass. To eliminate this the sunlight was first passed through a glass plate so that those long waves that were unable to pass through the glass did not fall upon either enclosure, and the amount of radiation received was practically the same in each case. It was found that there was then a difference of temperature of less than a degree centigrade between the two, the maximum reached being about 55°C. He concludes from this that the loss of temperature from the ground by radiation is very small in comparison with the loss by convection, and that the action of the greenhouse depends almost entirely upon the elimination of convectional loss. A small point worth noting is that the word convection is used to describe a process of replacement of warmed by unwarmed air, which in windy weather might be caused largely by turbulence due to obstruction of the wind by obstacles and to friction between the moving air and the stationary ground, but this does not affect the important conclusion that trapping

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*See *Phil. Mag. London* 17, 1909, p. 319.

of radiation plays a negligible part in the so-called " greenhouse effect."

Measurement of Evaporation

The measurement of evaporation has not received so much attention by meteorologists as some other meteorological factors, partly, no doubt, because the rate of evaporation from a water surface, in this country at least, is so small that an instrument of considerable precision is needed to measure it accurately and such instruments are not always well adapted for use at meteorological stations, but chiefly because the readings of evaporimeters do not necessarily accord with the loss by evaporation from a large water surface, such as a river, lake or ocean, or with the loss from damp ground, the evaporation which is of practical importance in meteorology. The subject is, however, of considerable interest and we welcome a paper " On Evaporation and its Measurement," by Dr. S. K. Banerji and Mr. H. M. Wadia, which has recently appeared among the Memoirs of the Indian Meteorological Department. This paper describes work done at Bombay Observatory both with an evaporation tank in the open and with a small tank used for laboratory experiments.

For the outdoor experiments a tank measuring 4 by 3 by 2½ feet was used, this being surrounded by a channel 7½ inches wide, which was also filled with water to diminish the " edge effect " in the tank proper. It was desired to obtain a continuous record of the loss of water by evaporation, and much thought was given to the recording mechanism in order to avoid unnecessary friction and errors due to capillarity and change of temperature. In the method adopted, a glass float was protected by a fixed cylindrical casing placed in the tank, the water connexion being made by means of a hole near the bottom of the casing. The movement of the float was recorded on a smoked sheet by means of a simple lever giving a magnification in one instrument of 21 to 1 and in another of 14 to 1. It was found that with a float 14 cm. in diameter a record free from frictional effects could be obtained and the authors are of opinion that previous workers in this field have erred by the use of too small a float. The expansion and contraction of the water in the tank with change of temperature naturally led to some disturbance in the record, but calculation showed that the error introduced into any individual hourly reading might be neglected as the change in volume between the hour of minimum water temperature in the morning and that of maximum temperature in the afternoon was less than 7 per cent of the loss by evaporation over the same period and the readings cannot attain to this degree of accuracy. The steady movement of the float was dis-

* *Calcutta, Ind. Meteor. Dept. Memoirs Vol. xxv, Part ix.*

turbed by the action of ripples on the water surface, so that on all occasions when there was wind the pointer gave a record somewhat resembling that of a pressure tube anemometer. In these cases a middle line through the ribbon trace was used for the determination of evaporation. This " gustiness " of the trace was regarded by the authors as being advantageous since the movements showed directly the size of the ripples and, therefore, the strength of the wind blowing over the water surface. It is clearly this wind which is effective in accelerating the rate of evaporation rather than the wind measured by an anemometer at a considerable height above the ground and at some distance away and, therefore, for purposes of correlating evaporation with the strength of the wind, the " gustiness " of the trace is useful.

After discussing the several sources of error the authors proceed to a consideration of the records obtained. The two recorders were both used in the same tank and the water level read off at hourly intervals throughout the day. Evaporation for each hour was thus obtained. The two records were not in entire agreement for the individual hours, differences amounting to 50 per cent or more being occasionally met with. Over a longer period, such as a whole day, however, the records were in good agreement and there can be little doubt that the readings were sufficiently accurate to show both the changes in the evaporation from day to day and the trend of the rate of evaporation through the 24 hours.

Measurements were made both with fresh water and sea water in the tank, though a single tank only being available, it was not possible to obtain simultaneous measurements to compare the two rates of evaporation. No attempt was made to measure the evaporation on days of rainfall. The mean rate of evaporation from fresh water over 30 days in April and May, 1930, for which satisfactory records were obtained with one recorder, was 0·25 mm. per hour, the average daily maximum rate of 0·47 mm. per hour occurring just before 5 p.m. and the average minimum rate of 0·09 mm. per hour occurring between 7 and 8 o'clock in the morning. The mean rate of evaporation from sea water on 5 days on which measurements were taken amounted to 0·32 mm. per hour. As has already been pointed out, owing to the different weather conditions prevailing, no direct comparison between this figure and the figure for fresh water is possible.

The records obtained do not throw much light upon the effect which the individual meteorological elements, wind velocity, air temperature and relative humidity, have on evaporation, owing to the close inter-relation of the variations of these elements throughout the 24 hours at Bombay. Thus, in the afternoon, temperature and wind velocity reach their maximum values and the relative humidity its minimum value, each factor playing its part in increasing the rate of evaporation. It is noteworthy that in this part of their work, the authors have paid little attention to the temperature of the water in the evaporation tank. There is little doubt that this is a factor which affects the rate of evaporation to a marked degree, and it is partly because the temperature of the water in an evaporation tank may differ so widely from that of natural waters that the readings of evaporation tanks are believed by many meteorologists to bear little relation to the actual rate of evaporation from a natural sheet of water.

The laboratory experiments, which were made in a somewhat smaller tank, were taken in hand with a view to determining the effect of the different meteorological elements on evaporation and these are discussed in the second part of the paper. Arrangements were made to blow a stream of air over the tank by an electric fan and also to apply artificial heat by electric radiators. The strength of the air current and the supply of heat could both be varied. The conclusion reached was that evaporation varies as the square root of the wind velocity except at very low speeds, a conclusion which is in agreement with some theoretical work of Jeffreys published in 1918. Certain other conclusions reached by Jeffreys regarding the effect of tanks of different sizes and shapes were also confirmed. The laboratory tests on the effect of varying temperature were less satisfactory owing to the fact that no attempt seems to have been made to vary the temperature of the water and the air independently. The electric radiators heated both air and water and the curves given in the paper show that the rate of evaporation increased with increasing temperature as would be expected, but do not permit any separation of the effects of air and water temperature. Jeffreys's formula for evaporation contains K, the co-efficient of eddy diffusion, and an attempt has been made by the authors of the present paper to determine the value of K by this means.

Another paper on the theoretical aspects is promised by Dr. Banerji later, and it may be hoped that in this an attempt will be made to elucidate the effect of water temperature in more detail. The hope may also be expressed that when the authors have obtained further observations in the field covering a complete period of 12 months or more, they will again publish the readings. The apparatus which has been evolved is of sufficient precision to justify the discussion of a more extensive series of observations than those which are recorded in the present paper.

J. S. DINES.

Congress of the Royal Institute of Public Health at Eastbourne, May 30th to June 4th, 1933

The annual congress of the Royal Institute of Public Health will be held in Eastbourne from Tuesday, May 30th, to Whit-Sunday, June 4th, under the presidency of the Right Hon. the Viscount Leverhulme. In addition to the usual purely medical sections, a section on Hydrology and Climatology will be included for the first time, the President of this section being Professor Sir Gilbert T. Walker, while the Vice-Presidents include Dr. G. C. Simpson and Dr. F. J. W. Whipple.

The Presidential Address to this section will be on "Airs, waters and places, their importance in medicine," and the following papers will also be read:—

"Records of humidity and what they teach us about the atmosphere outside and indoors," by Dr. F. J. W. Whipple.

"The effect on climatic factors of the nature of soil and of soil drainage," by D. Brunt.

"Soil and climate in relation to the rheumatic diseases," by Dr. E. C. Warner.

"Sea bathing: some medical aspects of a complete scheme," by Dr. G. R. Bruce.

"Smoke pollution of the atmosphere," by Dr. J. S. Owens.

"Health and holidays," by Dr. Robert Marshall.

"The medical profession and the health resort," by Col. R. H. Elliott.

"The sea breeze as a climatic factor," by E. G. Bilham.

"Medical indications for the sea coast," by Dr. N. E. Chadwick.

The programme also includes visits to hospitals and other institutions, a banquet and various evening receptions. Membership of the Congress is open, the fee being one guinea. The membership ticket and full particulars will be forwarded on application to the Secretary, Royal Institute of Public Health, 23, Queen Square, London, W.C.1.

The Halley Stewart Laboratory

In *The Times* of May 5th appears an interesting announcement of the opening of the new Halley Stewart Laboratory at 30, Chesterford Gardens, Hampstead. In this laboratory will be carried on Professor Appleton's researches into the electrical properties of the upper atmosphere, the researches which were previously carried on in the laboratories of King's College having suffered from the disturbances set up by local electrical machinery.

The formal opening was performed by Lord Rutherford, who in his speech alluded to the remarkable progress which has been achieved in recent years by the use of electric waves in the exploration of the upper atmosphere. The methods introduced by Professor Appleton led to the discovery of a second ionised layer at a greater height than the layer of which the existence was inferred many years ago by Balfour Stewart and other investigators and which is usually called the Kennelly-Heaviside layer. This second layer is known as the Appleton layer, in honour of its discoverer. The problems of the propagation of radio signals are of great practical importance, and the new laboratory will provide opportunities for carrying on valuable research work.

S. T. A. MIRRLEES.

Films on our Book-shelves

An unusual addition has recently been made to the Meteorological Office library in the form of a small tin containing a tiny roll of film about 1⅜ in. in height and 1¼ in. in diameter. Apart from a few pages of printed text and three diagrams, this roll constitutes the *Jahrbuch des Meteorologischen Observatoriums auf dem Donnersberge (Böhmen) für* 1929.

In an article which appeared in the previous issue of this year-book, Dr. L. W. Pollak discussed at some length the question of reproducing meteorological year-books on cinema films. Taking the 1927 year-book as a basis for calculation, he showed that the tabular part could thus be reproduced at less than half the usual cost by lithographic process while if the original manuscript tables instead of typescript copies were used the costs would be reduced by more than three-quarters. A further economy would be effected in postage, especially in the case of copies sent to foreign countries. In addition to these financial advantages, Dr. Pollak stressed the value of "filmed" year-books as a means of saving space. Any one who has been confronted with the problem of housing indefinitely within a strictly limited space the ever-increasing masses of statistical data, etc., will realise the attraction of any promising means of economy in this respect. According to calculations published in Germany a roll of film scarcely requires one-fortieth of the space occupied by a corresponding book. There is also a similar reduction in weight. A further advantage would be that additional copies of the whole or any part of the film could be made from the original negative as and when required at no higher rate of expense and therefore it would be unnecessary in the first instance to prepare more copies than were actually needed for distribution.

The speedy adoption of this method of publication by the Geophysikalisches Institut der Deutschen Universität in Prague was due in part to the unavoidable necessity of covering expenses out of reduced funds as stated in the introduction to the 1929 year-book. This introduction also contains an important note to the effect that it can be used without risk of fire as the copies have been made on non-inflammable Agfa films.

Against the advantages to which Dr. Pollak draws attention, certain obvious disadvantages must be off-set, such as the necessity of providing film reading or projecting apparatus. It may perhaps be possible to read the tables with no further equipment beyond a powerful magnifying glass, but the time taken in unrolling a little reel several yards long, containing hundreds of tables which may have to be scrutinised in search of the one required would seem very long compared with that used in turning to a given page in a book. In an institution where very frequent reference is made to the tables the usual style of reproduction in book form would seem desirable and it is understood that a typescript copy has been provided for the "Staatsanstalt für Meteorologie" in Prague.

The ingenuity displayed in this experiment calls forth admiration. It remains for time to show how far the fashion will spread.

Books Received

Anales del Observatorio Nacional de San Bartolomé en los Andes Colombianos. Observaciones meteorologicas de 1929. Bogotá, 1931.

The lunar atmospheric tide at Bombay (1873-1922), by S. K. Pramanik, M.Sc. Memoirs of the Indian Meteor. Dept., vol. xxv, Part viii. Calcutta, 1931.

The Weather of April, 1933

Pressure was below normal over Russia, western Siberia, most of Scandinavia, most of the North Atlantic, the United States and the part of Canada between the Great Lakes and Hudson Bay, the greatest deficits being 6·6 mb. at Moscow, 7·0 mb. at 50°N., 30°W., and 4·3 mb. at 40°N. 90°W. Pressure was above normal elsewhere in Canada and over Bermuda, Newfoundland, Greenland, Spitsbergen, Iceland and western, central and southern Europe, including south Scandinavia and the Balkan States, the greatest excesses being 7·8 mb. at Julianehaab and 5·7 mb. at London and Scilly. In Sweden temperature was unusually normal, the greatest deficit being about 4°F. in northernmost Lapland, while rainfall was mostly about half the normal amount or less, with the exception of Gothaland and northern Lapland. In north-western Gothaland only about $\frac{1}{6}$ of the normal amount occurred.

Mainly anticyclonic conditions prevailed over the British Isles during April, with rainfall and sunshine (except in the Midlands) generally deficient over the whole country and temperature above normal. Absolute droughts beginning on the 1st were experienced at numerous places in the Midlands—in some cases the drought lasted to the 22nd inclusive. From the 1st to 10th the southern half of the country was covered by an anticyclone, which from the 4th to 7th extended over the whole country, but depressions moving north-eastwards to the north of the country and low pressure to the east brought slight rain locally in the north and west on several days, with heavy rain in Scotland and north-west England on the 2nd and 8th, and snow or sleet showers in north-east Scotland on the 1st; 6·50 in. of rain fell at Dunhulladale, Loch Carron, Ross-shire, and 4·14 in. at Kinlochquoich, Inverness-shire, on the 2nd. Over most of England during this time the weather was sunny and warm, the warmest, sunniest day being the 8th, when 73°F. was registered at Greenwich and 71°F. at Tottenham, S. Farnborough, Tunbridge Wells, Dovercourt and London, and 12·3 hrs. bright sunshine occurred at Bath, 12·2 hrs. at Bournemouth, and 12·0 hrs. at Littlehampton. Temperature fell somewhat the following day but rose again over 70°F. in the south-east on the 11th as a depression approached the British Isles; 72°F. was registered at South Farnborough, Shoeburyness and London on the 11th, but sunshine records were small in that area. Slight rain fell locally on the 12th, though sunshine records were good in Scotland, reaching 11·3 hrs. at Dunbar and 11·1 hrs. at Aberdeen. On the 13th the country came again under the influence of an anticyclone and sunny weather prevailed generally, but cold north-westerly winds were experienced in the north and east. A small depression passed to the north of Scotland on the 15th, bringing rain only to the north, but in its rear the cold winds in the north spread southward reaching southern England by the 17th and causing a marked fall in temperature. These cold winds continued until the 22nd with variable amounts of sunshine, though daily values at a number of places exceeded 10 hrs.; St. Ives had 13·0 hrs. on the 16th. Slight rain occurred locally on many days and snow and sleet showers over the country generally on the 19th and 20th. On the 22nd a complex depression approached from the Atlantic and spread gradually across the country, giving mild unsettled conditions with rain at times, heavy locally, but also considerable periods of bright sunshine, 12·3 hrs. at Kirkwall (Orkneys) on the 23rd, and 12·4 hrs. at Pembroke on the 29th and Calshot on the 30th. The rainfall was heaviest in Ireland, where 1·88 in. fell at Fofanny (Co. Down) on the 24th, and 1·38 in. at Dunmanway (Co. Cork) on the 22nd. Thunderstorms were experienced at many places on the 28th, 29th and 30th. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	111	—43	Liverpool	146	—12
Aberdeen	113	—45	Ross-on-Wye	164	+14
Dublin	146	—19	Falmouth	162	—22
Birr Castle	129	—25	Gorleston	155	—29
Valentia	112	—48	Kew	175	+18

The special message from Brazil states that the rainfall in the northern and central regions was plentiful with 4·69 in. and 1·02 in. above normal respectively, but generally scarce in the southern regions with 1·18 in. below normal. Four anticyclones passed across the country and frosts were experienced towards the end of the month. The crops were generally in good condition owing to favourable weather. At Rio de Janeiro pressure was 2·8 mb. above normal and temperature 2·7°F. below normal.

Miscellaneous notes on weather abroad culled from various sources. On the 6th the river and bar were reported free of ice at Parnu (Gulf of Riga). No rain fell in Switzerland for the first three weeks of the month; water became scarce in some districts and forest fires were numerous. The temperature also was low round about the 20th, when 18°F. was recorded in the lower regions causing much damage to fruit trees in blossom. Snow fell to a level of 3,000 ft. but in small quantities, and the lower Alpine passes were open to motor traffic on the 22nd. (*The Times*, April 6th-22nd.)

Strong winds were reported over the Himalayas during the greater part of the month, but the lulls were of sufficient length to allow the Houston Mount Everest expedition to accomplish their object of flying over the mountain. A hurricane passed over the northern end of the central islands of the New Hebrides on the western Pacific on the 8th and 9th doing serious damage to property and crops. (*The Times*, April 3rd-21st.)

A hurricane struck Bermuda on the morning of the 26th doing much damage. (*The Times*, April 27th.)

The United States naval airship *Akron* crashed into the sea off the New Jersey coast during a severe thunderstorm accompanied by fog on the 4th. After fine weather during the first week of the month, rain fell in the maize areas of the Argentine interfering with picking operations. Dense fog and then a gale at Tristan da Cunha on the 26th and 27th prevented the landing of stores. Temperature was above normal over the United States generally at the beginning of the month, but later cold spells passed across the country from west to east. Rainfall was variable, but mainly above normal in the Atlantic Coast States and below normal in the Mountain Region and along the Pacific coast, though some moderate falls occurred locally at Lander and Cheyenne during the week ending the 25th. (*The Times*, April 8th-29th, and *Washington D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*.)

General Rainfall for April, 1933

England and Wales ...	70	per cent of the average 1881-1915.
Scotland	95	
Ireland	65	
British Isles	75	

Rainfall: April, 1933: England and Wales.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	·83	54	*Leis.* .	Thornton Reservoir	1·32	78
Kent .	Tenterden, Ashenden	1·18	73	,, .	Belvoir Castle	·96	63
,, .	Folkestone, Boro. San.	1·22	...	*Rut* .	Ridlington	·79	50
,, .	St. Peter's, Hildersham	...	...	*Lincs* .	Boston, Skirbeck	1·22	90
,, .	Eden'bdg., Falconhurst	·67	36	,, .	Cranwell Aerodrome	1·44	109
,, .	Sevenoaks, Speldhurst	·82	...	,, .	Skegness, Marine Gdns	1·00	75
Sus .	Compton, Compton Ho.	1·45	72	,, .	Louth, Westgate	·75	45
,, .	Patching Farm	1·04	59	,, .	Brigg, Wrawby St.	·97	...
,, .	Eastbourne, Wil. Sq.	1·04	57	*Notts* .	Worksop, Hodsock	·68	46
,, .	Heathfield, Barklye	1·31	71	*Derby* .	Derby, L. M. & S. Rly.	1·27	78
Hants.	Ventnor, Roy. Nat. Hos.	1·78	106	,, .	Buxton, Terr. Slopes	1·71	58
,, .	Fordingbridge, Oaklnds	1·68	92	*Ches* .	Runcorn, Weston Pt.	·81	47
,, .	Ovington Rectory	1·33	70	*Lancs*.	Manchester, Whit Pk.	·98	51
,, .	Sherborne St. John	1·15	65	,, .	Stonyhurst College	1·70	63
Herts .	Welwyn Garden City	·85	...	,, .	Southport, Hesketh Pk	1·48	80
Bucks.	Slough, Upton	·99	69	,, .	Lancaster, Greg Obsy.	2·08	93
,, .	H. Wycombe, Flackwell	1·07	...	*Yorks*.	Wath-upon-Dearne	1·41	89
Oxf .	Oxford, Mag. College	1·13	73	,, .	Wakefield, Clarence Pk.	1·56	93
Nor .	Pitsford, Sedgebrook	·59	39	,, .	Oughtershaw Hall	1·80	...
,, .	Oundle	·81	...	,, .	Wetherby, Ribston H.	1·49	85
Beds .	Woburn, Crawley Mill	1·05	70	,, .	Hull, Pearson Park	1·11	71
Cam .	Cambridge, Bot. Gdns.	1·20	88	,, .	Holme-on-Spalding	1·26	...
Essex .	Chelmsford, County Lab	·76	59	,, .	West Witton, Ivy Ho.	1·41	66
,, .	Lexden Hill House	·61	...	,, .	Felixkirk, Mt. St. John	1·44	86
Suff .	Haughley House	·98	...	,, .	York, Museum Gdns.	1·09	68
,, .	Campsea Ashe	1·66	118	,, .	Pickering, Hungate	1·94	116
,, .	Lowestoft Sec. School	·96	65	,, .	Scarborough	·93	60
,, .	Bury St. Ed., Westley H.	1·16	76	,, .	Middlesbrough	·94	69
Norf .	Wells, Holkham Hall	1·00	78	,, .	Balderdale, Hury Res.	2·50	103
Wilts.	Devizes, Highclere	1·54	81	*Durh* .	Ushaw College	1·25	66
,, .	Calne, Castleway	1·29	69	*Nor* .	Newcastle, Town Moor	1·21	74
Dor .	Evershot, Melbury Ho.	1·69	72	,, .	Bellingham, Highgreen	1·47	68
,, .	Weymouth, Westham	1·57	95	,, .	Lilburn Tower Gdns.	1·59	80
,, .	Shaftesbury, Abbey Ho.	1·31	62	*Cumb* .	Carlisle, Scaleby Hall	1·55	79
Devon.	Plymouth, The Hoe	2·96	130	,, .	Borrowdale, Seathwaite	5·00	72
,, .	Holne, Church Pk. Cott.	3·12	86	,, .	Borrowdale, Moraine	3·11	...
,, .	Teignmouth, Den Gdns.	1·78	89	,, .	Keswick, High Hill	1·71	56
,, .	Cullompton	2·16	95	*West* .	Appleby, Castle Bank	1·29	66
,, .	Sidmouth, Sidmount	1·91	90	*Mon* .	Abergavenny, Larch	1·05	42
,, .	Barnstaple, N. Dev. Ath	1·55	73	*Glam* .	Ystalyfera, Wern Ho.	3·73	98
,, .	Dartm'r, Cranmere Pool	4·10	...	,, .	Cardiff, Ely P. Stn.	1·72	68
,, .	Okehampton, Uplands	1·42	45	,, .	Treherbert, Tynywaun	3·42	...
Corn .	Redruth, Trewirgie	2·66	92	*Carm*.	Carmarthen Friary	2·20	80
,, .	Penzance, Morrab Gdn.	2·72	112	*Pemb* .	Haverfordwest, School	1·32	50
,, .	St. Austell, Trevarna	2·69	95	*Card* .	Aberystwyth	·75	...
Soms .	Chewton Mendip	2·09	70	*Rad* .	Birm W.W. Tyrmynydd	1·18	32
,, .	Long Ashton	1·18	54	*Mont* .	Lake Vyrnwy	1·71	57
,, .	Street, Millfield	1·43	72	*Flint* .	Sealand Aerodrome	·86	58
Glos .	Blockley	·86	...	*Mer* .	Dolgelley, Bontddu	·88	24
,, .	Cirencester, Gwynfa	1·28	68	*Carn* .	Llandudno	·62	34
Here .	Ross, Birchlea	1·02	54	,, .	Snowdon, L. Llydaw 9	6·05	...
Salop .	Church Stretton	1·00	46	*Ang* .	Holyhead, Salt Island	·90	43
,, .	Shifnal, Hatton Grange	1·04	62	,, .	Lligwy	1·38	...
Staffs .	Market Drayt'n, Old Sp.	·86	50	*Isle of Man*			
Worc .	Ombersley, Holt Lock	·80	53		Douglas, Boro' Cem.	2·04	83
War .	Alcester, Ragley Hall	1·04	62	*Guernsey*			
,, .	Birminghm, Edgbaston	·73	42		St. Peter P't. Grange Rd	1·32	65

Rainfall: April, 1933: Scotland and Ireland.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent of Av.
Wigt .	Pt. William, Monreith	1·48	67	*Suth* .	Melvich	1·59	69
,, .	New Luce School	2·11	79	,, .	Loch More, Achfary	7·06	145
Kirk .	Dalry, Glendarroch	2·28	75	*Caith* .	Wick	1·35	68
,, .	Carsphairn, Shiel	3·32	81	*Ork* .	Deerness	2·17	105
Dumf .	Dumfries, Crichton, R.I	1·69	76	*Shet* .	Lerwick	2·22	97
,, .	Eskdalemuir Obs.	3·04	89	*Cork* .	Caheragh Rectory	3·37	...
Roxb .	Branxholm	1·21	64	,, .	Dunmanway Rectory	3·24	78
Selk .	Ettrick Manse	2·25	64	,, .	Cork, University Coll.	2·58	98
Peeb .	West Linton	2·55	...	,, .	Ballinacurra	2·12	73
Berw .	Marchmont House	1·62	80	*Kerry* .	Valentia Obsy	2·92	80
E.Lot .	North Berwick Res.	2·10	150	,, .	Gearahameen	3·11	54
Midl .	Edinburgh, Roy. Obs.	1·75	119	,, .	Killarney Asylum	...	...
Lan .	Auchtyfardle	1·43	...	,, .	Darrynane Abbey	2·58	75
Ayr .	Kilmarnock, Kay Pk.	2·82	...	*Wat* .	Waterford, Gortmore	1·85	74
,, .	Girvan, Pinmore	1·49	50	*Tip* .	Nenagh, Cas. Lough	1·31	52
Renf .	Glasgow, Queen's Pk.	1·53	78	,, .	Roscrea, Timoney Park	·72	...
,, .	Greenock, Prospect H.	2·99	82	,, .	Cashel, Ballinamona	1·41	56
Bute .	Rothesay, Ardencraig.	3·80	...	*Lim* .	Foynes, Coolnanes	1·23	50
,, .	Dougarie Lodge	2·02	...	,, .	Castleconnel Rec.	2·06	...
Arg .	Ardgour House	8·79	...	*Clare* .	Inagh, Mount Callan	2·35	...
,, .	Glen Etive	10·75	194	,, .	Broadford, Hurdlest'n.	...	...
,, .	Oban	3·84	123	*Wexf* .	Gorey, Courtown Ho.	1·47	67
,, .	Poltalloch	3·12	106	*Kilk* .	Kilkenny Castle	...	...
,, .	Inveraray Castle	4·72	103	*Wick* .	Rathnew, Clonmannon	1·56	...
,, .	Islay, Eallabus	2·24	78	*Carl* .	Hacketstown Rectory	1·41	53
,, .	Mull, Benmore	8·50	...	*Leix* .	Blandsfort House	1·02	39
,, .	Tiree	3·18	129	,, .	Mountmellick	1·41	...
Kinr .	Loch Leven Sluice	1·30	68	*Offaly*.	Birr Castle	·99	46
Perth .	Loch Dhu	4·40	93	*Kild'r*.	Monasterevin	...	...
,, .	Balquhidder, Stronvar	2·76	...	*Dublin*	Dublin, FitzWm. Sq.	1·02	54
,, .	Crieff, Strathearn Hyd.	1·52	69	,, .	Balbriggan, Ardgillan.	1·14	58
,, .	Blair Castle Gardens	1·55	73	*Meath*.	Beauparc, St. Cloud	1·21	...
Angus.	Kettins School	·84	46	,, .	Kells, Headfort	1·93	77
,, .	Pearsie House	2·06	...	*W.M.* .	Moate, Coolatore	1·64	...
,, .	Montrose, Sunnyside	1·37	75	,, .	Mullingar, Belvedere	1·50	63
Aber .	Braemar. Bank	1·67	70	*Long* .	Castle Forbes Gdns.	1·48	62
,, .	Logie Coldstone Sch.	1·77	88	*Gal* .	Ballynahinch Castle	2·84	80
,, .	Aberdeen, King's Coll.	2·07	111	,, .	Galway, Grammar Sch.	...	...
,,	Fyvie Castle	2·85	133	*Mayo* .	Mallaranny	3·71	...
Moray	Gordon Castle	1·55	89	,, .	Westport House	1·59	59
,, .	Grantown-on-Spey	...	...	,, .	Delphi Lodge	4·63	81
Nairn.	Nairn	2·08	139	*Sligo* .	Markree Obsy	2·29	87
Inv's .	Ben Alder Lodge	2·69	...	*Cavan*.	Belturbet, Cloverhill	1·43	62
,, .	Kingussie, The Birches	2·25	...	*Ferm* .	Enniskillen, Portora	1·24	...
,, .	Loch Quoich, Loan	3·10	...	*Arm* .	Armagh Obsy	·85	40
,, .	Glenquoich	19·69	149	*Down*.	Fofanny Reservoir	5·02	...
,, .	Inverness, Culduthel R.	2·29	...	,, .	Seaforde	2·48	95
,, .	Arisaig, Faire-na-Sguir	3·79	...	,, .	Donaghadee, C. Stn.	1·67	83
,, .	Fort William, Glasdrum	5·25	...	,, .	Banbridge, Milltown	·67	33
,, .	Skye, Dunvegan	4·84	...	*Antr* .	Belfast, Cavehill Rd.	1·76	...
,, .	Barra, Skallary	2·59	...	,, .	Aldergrove Aerodrome	1·30	62
R&C .	Alness, Ardross Castle	2·60	107	,, .	Ballymena, Harryville	1·80	68
,, .	Ullapool	4·35	140	*Lon* .	Londonderry, Creggan	1·37	53
,, .	Achnashellach	0·43	185	*Tyr* .	Omagh, Edenfel	1·97	75
,, .	Stornoway	12·85	94	*Don* .	Malin Head	1·55	...
Suth .	Lairg	2·52	109	,, .	Milford, The Manse	1·53	60
,, .	Tongue	1·97	75	,, .	Killybegs, Rockmount.	2·00	56

Climatological Table for the British Empire, November, 1932

STATIONS	PRESSURE Mean of Day M.S.L.	PRESSURE Diff. from Normal	TEMPERATURE Absolute Max.	TEMPERATURE Absolute Min.	TEMPERATURE Mean Values Max.	TEMPERATURE Mean Values Min.	TEMPERATURE Mean Values ½ max. and min.	TEMPERATURE Mean Values Diff. from Normal	TEMPERATURE Mean Wet Bulb	Relative Humidity	Mean Cloud Am'nt	PRECIPITATION Am'nt	PRECIPITATION Diff. from Normal	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	in.	in.			
London, Kew Obsy.	1018·8	+ 4·2	58	31	49·1	40·5	44·8	+ 0·8	42·1	90	8·2	1·01	— 1·21	15	0·9	10
Gibraltar	1019·2	+ 1·2	72	42	66·6	53·6	60·1	— 0·4	53·9	85	4·7	3·36	— 3·03	10	..	..
Malta	1018·0	+ 2·1	75	55	67·7	58·9	63·3	— 0·6	58·2	74	6·5	4·76	+ 1·19	14	6·2	60
St. Helena	1014·3	— 0·5	64	53	60·7	54·4	57·5	— 2·1	55·6	98	9·7	0·67	..	10	..	..
Freetown, Sierra Leone	1013·1	+ 2·2	89	69	86·5	73·6	80·1	— 1·1	75·9	81	6·3	6·67	+ 1·55	17	..	..
Lagos, Nigeria	1011·4	+ 1·3	89	71	86·5	75·8	81·1	— 0·6	76·3	86	7·7	2·63	— 0·04	9	7·3	62
Kaduna, Nigeria	1012·8	— 0·3	95	51	92·0	59·5	75·7	— 0·5	63·1	63	3·7	0·00	— 0·21	0	9·7	84
Zomba, Nyasaland	1008·5	— 0·4	93	53	86·0	63·1	74·5	— 1·1	64·8	55	4·1	5·26	+ 0·18	8	..	..
Salisbury, Rhodesia	1010·3	0·0	90	46	83·1	59·3	71·2	+ 0·5	59·7	45	3·8	2·39	— 1·21	9	7·6	59
Cape Town	1015·1	— 0·7	95	52	79·2	58·5	68·9	+ 4·5	60·6	63	3·3	0·34	— 0·75	5	..	..
Johannesburg	1011·5	+ 0·6	89	43	77·9	53·7	65·8	+ 2·1	55·5	54	4·7	2·33	— 2·63	13	8·7	65
Mauritius	1016·7	+ 0·6	84	63	82·4	68·2	75·3	— 0·2	69·8	63	6·7	1·36	— 0·22	13	9·3	72
Calcutta, Alipore Obsy.	1012·2	— 1·1	90	58	81·7	67·6	74·7	+ 1·2	68·2	87	4·1	8·89	+ 8·24	6*	..	..
Bombay	1010·3	— 1·7	95	70	90·4	74·1	82·3	+ 1·7	71·7	73	2·6	0·07	— 0·38	..	..	..
Madras	1009·6	— 1·7	89	69	84·3	73·7	79·0	+ 0·1	75·5	91	7·8	11·52	— 2·09	14*	..	..
Colombo, Ceylon	1010·1	+ 0·1	86	70	84·0	73·9	78·9	— 1·1	76·3	81	6·6	14·60	+ 2·84	23	5·6	47
Singapore	1009·5	+ 0·1	90	71	86·1	73·4	79·7	— 0·9	75·8	80	8·2	4·51	— 5·40	15	5·6	47
Hongkong	1016·8	— 0·8	81	54	75·4	66·4	70·9	+ 1·3	63·7	65	5·8	0·10	— 1·64	3	5·9	53
Sandakan	..	..	90	73	87·4	74·8	81·1	+ 0·2	77·0	83	7·4	10·36	— 4·36	19	..	..
Sydney, N.S.W.	1015·7	+ 1·9	87	52	75·4	61·1	68·3	+ 1·3	63·4	63	5·5	3·73	+ 0·88	9	8·5	61
Melbourne	1015·8	+ 1·4	98	43	72·5	52·1	62·3	+ 1·0	56·2	61	6·6	0·64	— 1·59	15	5·2	37
Adelaide	1016·9	+ 1·7	101	43	78·3	55·4	66·9	— 0·1	57·7	44	6·1	0·36	— 0·79	6	8·6	62
Perth, W. Australia	1016·9	+ 1·5	95	49	75·2	56·9	66·1	0·0	58·8	52	5·3	0·13	— 0·67	5	9·8	73
Coolgardie	1014·3	+ 1·2	102	47	85·8	55·5	70·7	0·0	57·1	34	3·2	0·04	— 0·55	2	..	..
Brisbane	1016·9	+ 2·3	87	59	80·3	64·4	72·3	— 1·2	66·1	60	6·3	2·84	— 0·91	9	8·4	63
Hobart, Tasmania	1011·1	+ 1·5	89	40	67·1	48·7	57·9	+ 0·7	51·6	56	6·5	1·26	— 1·21	12	8·1	56
Wellington, N.Z.	1015·0	+ 2·9	69	41	62·6	50·1	56·3	— 0·5	53·1	69	6·7	1·32	— 2·20	7	8·6	60
Suva, Fiji	1011·5	+ 0·4	88	69	83·4	73·3	78·3	+ 1·2	74·3	80	8·1	10·95	+ 1·16	24	4·5	35
Apia, Samoa	1009·1	— 0·4	89	72	85·7	74·5	80·1	+ 1·4	77·3	78	6·5	20·09	+ 10·26	22	6·4	50
Kingston, Jamaica	1010·3	— 2·1	89	69	86·3	72·7	79·5	+ 0·2	71·3	83	6·2	2·67	— 0·36	9	6·6	58
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1022·4	+ 5·1	59	8	42·1	29·3	35·7	— 1·3	31·3	81	6·2	3·26	+ 0·63	11	3·9	40
Winnipeg	1018·5	+ 1·1	46	—20	26·3	10·7	18·5	— 2·8	..	..	6·4	0·36	— 0·71	3	..	..
St. John, N.B.	1022·4	+ 7·8	55	25	43·6	28·5	35·1	— 1·6	33·2	81	6·7	3·56	— 0·85	12	3·5	36
Victoria, B.C.	1015·8	— 0·1	59	38	50·0	43·5	46·7	+ 2·2	45·2	94	8·5	7·45	+ 2·04	21	2·0	22

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