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Spring Frost and Fruit Crops

BY DONALD L. CHAMPION

It is well known that the sharp, though usually brief, frosts of late spring in southern England are frequently a source of anxiety to fruit growers; and the wide-spread damage to fruit and other trees, caused by the severe frosts of May, 1935,* will be long remembered. Sir Napier Shaw, commenting on the effect of frost on a walnut tree, remarks " . . . . One would like to know how far up the frost extends in different situations where there are no walnut trees to act as self-recording instruments . . . "† but it seems that in this country, little has been done to solve the problem.

On behalf of a firm interested in the production of Orchard Heaters, in order to ascertain how far above the surface so-called " ground " frosts may be experienced during late spring, standard M.O. pattern minimum thermometers have been installed on the wind vane mast at Goff's Oak, Herts, and the data so far obtained may not be without interest. The mast, of tubular steel construction, is exposed at an elevation of 330 ft. above ordnance datum, with open country to the west and north, and is about 70 yards and 30 yards respectively from the nearest buildings to the south and east. The thermometers are held in gun-metal clamps at heights of 5 ft., 10 ft. and 20 ft. above the ground. The photographs, Fig. 1, show the mast with the instruments at 10 ft. and 20 ft., and details of the method of fixing which was adopted, to ensure their being firmly held yet well clear of the mast itself.

* See *Meteorological Magazine* 70, 1935, p. 105.

† SIR NAPIER SHAW: Unofficial Meteorology, p. 10.

For the purpose of the investigation, night minima from freely exposed thermometers were required and the instruments are thus unscreened and as open to radiation effects as the grass minimum thermometer, which latter is exposed on the grass plot about 10 ft. east-south-east from the base of the mast. The instruments are all set at 11 p.m. and read at 7 a.m. (Civil Time), and in order that the resultant minima should not be affected by sluggishness on the part of any particular instrument, the thermometers were transposed from time to time during the three months' observations.

A curve, showing the deviation (D) in °F. of the various minima from the minimum in the screen, was prepared from the readings obtained each morning, and these curves can broadly be classified into three groups :—

(*a*) Clear sky, calm.

(*b*) Clear sky followed by cloud and/or increase in wind.

(*c*) Overcast sky and/or windy.

Typical curves selected from the series are reproduced in Fig. 2 and bring to light some interesting features, particularly the curve

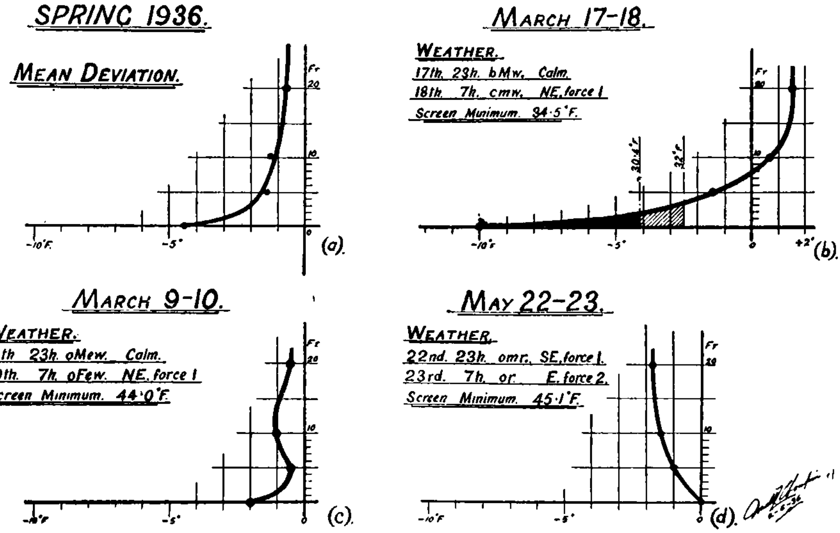


FIG. 2

from minima on the night of March 9th–10th (Fig. 2 (c)) which shows the curious effect obtained on an overcast night with a wet fog. The instruments, both at 23h. on the 9th and at 7h. the following morning, were all dripping with condensed moisture* and doubtless were acting as wet-bulb thermometers ; but even so, the air being almost calm throughout the night, evaporation must have been negligible or entirely absent. This curve is typical of the conditions on overcast nights, but the discontinuity shown was also observed on clear nights with winds of force 4, although in most cases there

* 0.02 in. of this precipitation was measured from the rain-gauge at 7h. on the 10th.

was considerably less difference between the minima at 10 ft. and 20 ft. than on this particular night.

It is reasonable to assume that the minima recorded by these instruments were the result of the balance between the loss of heat due to radiation and the gain of heat by conduction from the air itself. This being so, allowing for air movement, one can appreciate the minima approaching closer to the screen minimum at the higher levels such as in the case of Fig. 2 (*a*) ; but in the case of Fig. 2 (*c*), the minimum at 5 ft. was higher by 0·5° F. than at 10 ft. Assuming radiation constant and minima reached at the same time at all levels, the air at 10 ft. would apparently have been cooler than the strata immediately above and below. If the air at 10 ft. had been cooled by radiation, one would have expected it to sink to some level below 5 ft., or conversely, if cooled by expansion to rise to some level above 20 ft. In either case the conditions would be unstable and it would be difficult to understand its persistence, particularly on occasions when this discontinuity was still apparent with winds of force 6.

In this connexion it should be noted, that about 16 ft. west of the mast is a hawthorn hedge, about 8 to 10 ft. in height, which might tend to screen the thermometer at 5 ft. from westerly winds. Since, however, this instrument on many nights records minima 0·5° F. higher than at 10 ft. with winds above force 4 from all points of the compass, it seems that the hedge is not a contributory factor to the observed difference in minima. If these conditions were only observed to take place on totally overcast nights, it might be inferred that the higher minima at 5 ft. were due to the cumulative effect of terrestrial radiation and reflected radiation from the underside of the cloud sheet, the latter tending to reduce the cooling produced by the former ; but the difference being also apparent on clear nights with considerable wind makes the matter difficult of explanation, the effect of turbulence in removing the observed discontinuity being absent on these nights.

On a number of occasions with overcast skies, the grass minimum has been higher than the minima at 5 ft., 10 ft. or 20 ft., as shown in Fig. 2 (*d*). The greatest differences between the minima at all levels occur on nights which are calm and clear at first, but become considerably clouded before day-break. In the example shown, Fig. 2 (*b*), there was a difference of 11·5° F. between the grass minimum and that at 20 ft. On this occasion, the minimum on the grass was 7·5° F. below the freezing point, and whereas the screen minimum was 34·5° F., the minimum at 20 ft. was as high as 36·0° F. It would seem that the stratum of air below about 8 ft. had suffered considerable loss of heat by radiation, but before this effect could penetrate to a greater height, a slight increase in wind accompanied by considerable cloud, kept the air above this level at a higher temperature than the stratum below.

The average grass minimum in spring is about 4·5° F. lower than that in the screen, but the difference falls off rapidly with height, and the mean curve appears to become asymptotic to the line D = − 0·75° F. at about 25 ft. above the surface. On clear, calm nights the grass minimum averages about 8° F. lower than the screen minimum,* but even so the minimum at 5 ft. above the surface is then rarely more than 2° F. lower than that in the screen and at 20 ft. the difference is usually less than 1° F.

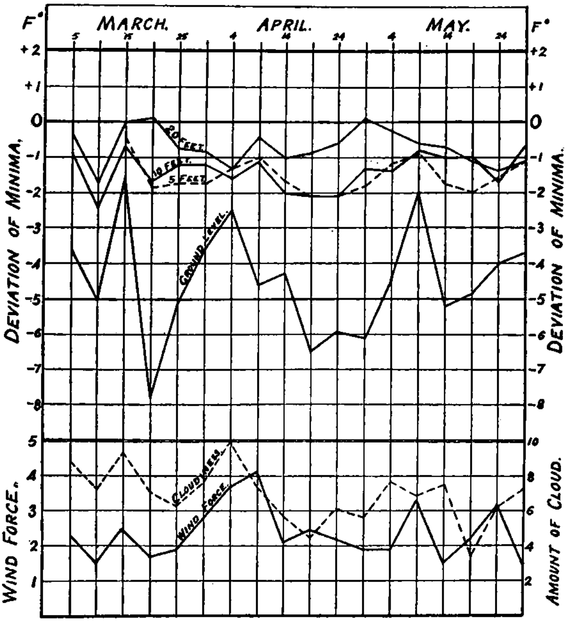


FIG. 3

In Fig. 3 are shown curves of the mean deviations at each level for five-day periods, together with the corresponding means of wind force and amount of cloud. The effect of wind and cloud is at once apparent, the greater difference between the minima when there is little wind and low nebulosity being clearly shown by the opening out of the curves. There is, however, usually less difference between the curves of minima at 5 ft. and 10 ft. than between 5 ft. and ground level or between the curves at 10 ft. and 20 ft.

The critical temperature from the fruit growers' point of view is 30·4° F., at which temperature, it is assumed, the tissues of growing plants may be destroyed and a "ground frost" is said to have occurred. The table below shows the number of occasions when the minima at various levels have reached or fallen below this point, and, for comparative purposes, the number of times a minimum of 32° F. or lower has been recorded.

Height.	Ground Level.		5 ft.		10 ft.		20 ft.	
	30·4°	32°	30·4°	32°	30·4°	32°	30·4°	32°
March	9	10	5	7	3	7	1	3
April	14	17	5	9	6	9	5	8
May	3	5	..	2	..	1	..	..
Total ...	26	32	10	18	9	17	6	11

From these results it would appear that as a rule the term

* See *Meteorological Magazine*, 71, 1936, p. 67.

"ground" frost is justified, but on the other hand, in extreme cases with a screen minimum of 33° F., a "ground" frost may be experienced at heights exceeding 10 ft. above the soil, and perhaps the designation "Crop Frost" would be more correct terminology. It would seem that fruit growers and others should take steps to protect their crops if the screen minimum is likely to fall below about 35° F.

The Design of Cup Anemometers

At the principal Meteorological Office stations the pressure tube anemometer is installed to give a continuous record of wind. There are, however, other stations where some instrumental record of wind speed is required but where the expense of installing and maintaining a pressure tube anemometer is not justified. At these stations anemometers of the small Robinson cup type are used. These are of two patterns—in one, the indicating type, the cups are connected by gearing with a counting mechanism so that the run of the wind can be read from a dial; in the other type, an electric contact is closed after a stated number of revolutions of the cups, causing a buzzer to ring. The interval between successive rings is taken by a stop-watch and the speed of the wind determined with the aid of a table. Cup anemometers have, in the past, suffered from the serious fault that the speed of the cups is not strictly proportional to the speed of the wind, i.e., the value of the factor by which the speed of the cup centre needs to be multiplied to obtain the speed of the wind differs markedly at high wind speeds from its value at low and moderate wind speeds. In the case of the electric type of anemometer this is not a matter of great moment, as the table which is used to relate the interval between successive rings of the buzzer with the speed of the wind can be made to take account of the change in the factor. In the indicating type of anemometer, no such allowance can be made, and if the gearing is such that the anemometer gives a correct record of the run of the wind at low speeds, it will give an incorrect record at high speeds.

A good deal of work has been done on the American continent during the past decade on the design of cup anemometers. Mr. J. Patterson, Director of the Canadian Meteorological Service, devised an instrument in which the customary 4 cups on arms spaced 90° apart were replaced by 3 cups on arms spaced at 120°. This system was found to give improved results and was adopted provisionally in the Meteorological Office for the indicating pattern of anemometer in the year 1930. In the United States *Monthly Weather Review* for April, 1934, Professor C. F. Marvin, Chief of the Weather Bureau, published a paper on recent advances in anemometry in which attention was directed to the marked improvement in the behaviour of cup anemometers which was achieved by turning over the edge of the cup to form a small circular beading. It was decided to make some experiments on the same lines in this country before deciding upon a final design for the cup anemometer. Accordingly, a 4-cup anemometer was made with beading round the edge of the cups and submitted to the National Physical Laboratory for test in a wind tunnel. The improvement at high wind speeds was most marked, the error in the measured run of the wind at 100 m.p.h. which, in a cup anemometer without beading was + 17 per cent, was reduced by the beading to +2 per cent. Unfortunately, at low speeds between 0 and 40 m.p.h. there was no improvement, in fact, the variation of the factor over this range of speed was, if anything, a little greater than before, and as the wind in this country falls within the range 0–40 m.p.h. for the greater part of the time, it was not felt that beading on a 4-cup system formed an entirely satisfactory solution to the problem. A 3-cup anemometer was then made up with $\frac{1}{8}$ in. beading on the outside of the edges of the cups and submitted to the National Physical Laboratory for test. The results showed that the factor remained almost constant over the full range of speed covered by the test, that is from 5 m.p.h. to 95 m.p.h. The test shows that with suitable gearing it is now possible to reduce the error of a cup anemometer, so that in the range 5–95 m.p.h. the error would nowhere exceed 0·6 m.p.h. It is hardly necessary to point out that owing to difficulties in securing a satisfactory exposure, an error of $\frac{1}{2}$ m.p.h. in wind measurement is negligible. It is not justifiable to assume that the behaviour of a cup system in a natural turbulent wind will be identical with its behaviour in a wind tunnel where the wind stream is almost free from turbulence. It is not claimed, therefore, that this cup system in a natural wind would necessarily give errors not exceeding 0·6 m.p.h. throughout the range. There can, however, be no reasonable doubt that the beaded 3-cup system marks a great advance on any other which has been tried in this country, and it has been decided to adopt it both for the indicating and electric types of cup anemometer which are purchased by the Meteorological Office in the future. A photograph of an anemometer of the indicating type with the new cup system is shown in Fig. 1 and the essential particulars of the cup head are as follows :—

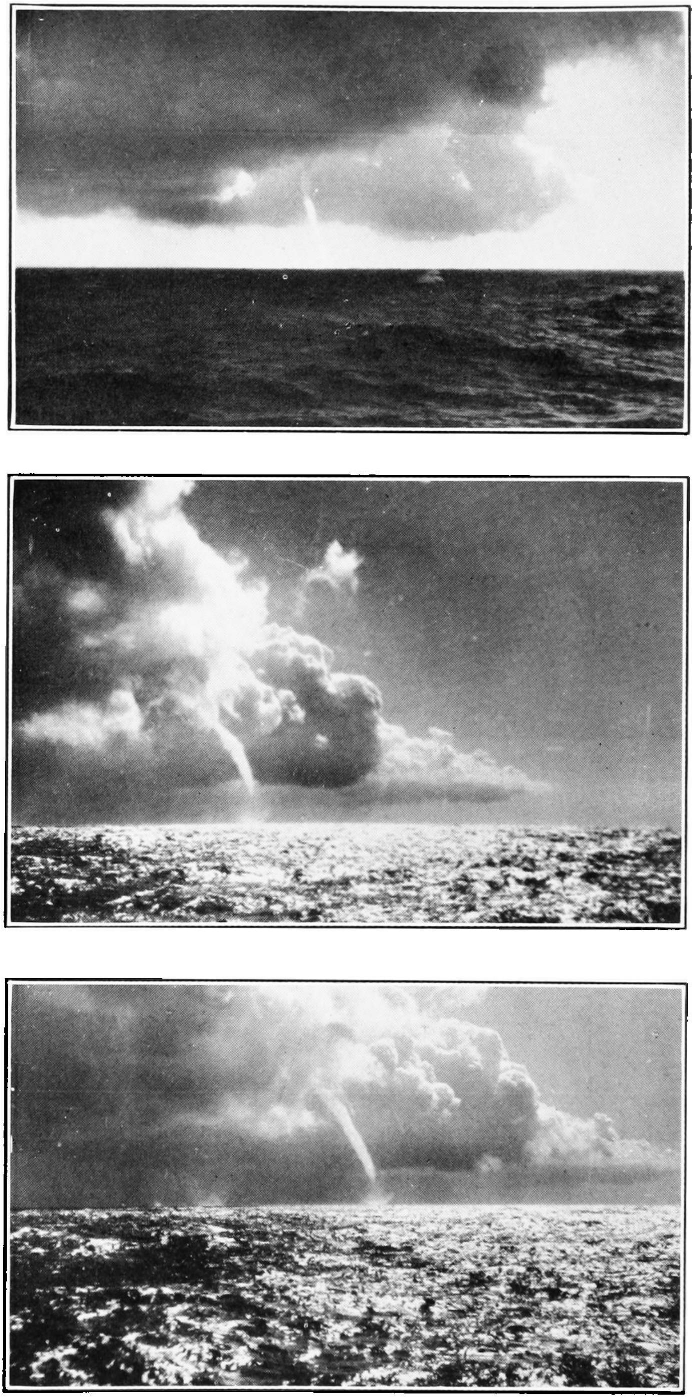
Three cups, 5·0 in. diameter, with $\frac{1}{8}$ in. circular beading, mounted on arms spaced 120° apart. The centres of the cups are 6·3 in. from the axis of rotation and the gearing is such that the dials indicate one mile of wind for every 580 turns of the cups.

J. S. Dines.

Phenomenon Witnessed in New Zealand on February 29th, 1936

Travelling alone by car from Hamilton to Tauranga, I reached

FIG. 1.—3-CUP ANEMOMETER



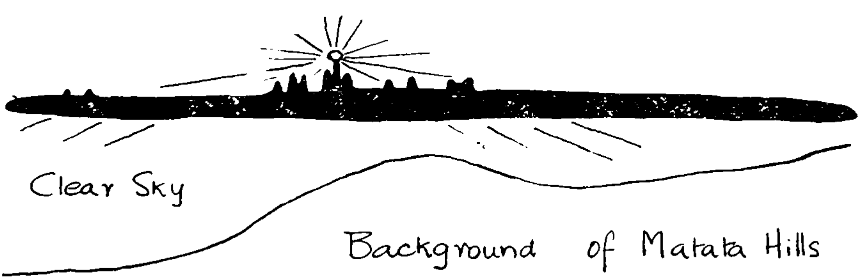
WATERSPOUT IN THE INDIAN OCEAN, OCTOBER, 1935 (*see p.* 138)

the top of the Kaimai Road, and was greatly struck with the vivid lightning display over the Bay of Plenty. As this display gradually increased in intensity, I stopped my car where I had a clear view to the east, at a spot 13 miles from Tauranga on the Kaimai Hills, about 500 ft. above sea level.

Having stopped the engine and extinguished the lights, I noticed that the major flashes came from behind a cloud lying practically due north. After a major flash from the north there would be a pause, and then from a point or two to the east of where the major flash had originated, forked lightning would run across the sky, through east to south. At about 10.10 p.m. I noted, due east, a faintly glowing light. At first I thought this came from a house window, or the headlights of a car. I subconsciously decided the former surmise was correct, as although it was definitely a light itself (and not the reflection of one) it was a bit faint for a car. All the same, I mentally registered the impression that it was a bit high up for a house or a car. (I am well acquainted with the district, so that I am fairly sure as regards localities and directions.)

Some minutes later, a bright flash from the north lit up the sky, and I was more than amazed to realise that the glowing light actually proceeded from the upper surface of a black bank of cloud. The time was then 10.15 p.m. and the glowing light had been practically steady for five minutes. By steady, I mean it had stayed in the same position, no movement right or left, up or down. It had waxed and waned, only very slightly, which had made me think, hitherto, that it was a house light, and that rain had drifted past, causing it to alter in apparent intensity.

At 10.15, as stated, I realised the glowing light was proceeding from a cloud. Before I had time to conjecture what that could mean, I witnessed one of the most weird and uncanny sights I have ever seen. It suddenly seemed to pulsate, it took definite shape as a molten ball of soft light, but although in itself not dazzling to the eyes, threw off an indescribably bright, greenish white light, or rather radiance. This radiance lit up the whole of the upper surface of the cloud bank and showed the ball of light balanced on a finger



of cloud. On either side of this finger were ugly looking black peaks, and all these were silhouetted against the radiance. From being a small ball of light, it instantly became larger, until it was the size of a half-crown, seen from a distance of 18 ft. The radiance became brighter and lit up all the landscape and countryside. The ball itself, although molten in appearance, did not hurt or dazzle the eyes. It held this size for about 15 seconds (I was far too interested in watching it, to take the time). Then it pulsated again (seeming to slightly contract and expand once or twice) and almost immediately became much enlarged. It appeared to be the size of a large orange seen from 18 ft. away. This time the radiance was terrific. Thousands of searchlights would not have equalled the intensity. But still the focal point or ball was not blinding.

My own feelings, although not scientific evidence, were interesting, to say the least. I had no time to be scared for it all was so absorbingly interesting. I felt literally that anything might happen, and nothing could have surprised me. Situated as I was, on an absolutely deserted road, I might have been watching the creation of a new world, or the extermination of an old world.

This phase could have lasted no longer than 15 seconds, but of course, time is only relative. Then the ball of light commenced to contract very quickly, and went back to its original glow. It disappeared momentarily, but for certainly ten more minutes kept on appearing and disappearing. For the 15 minutes that I saw it, it did not move in the sky. It did not again come into prominence, although I waited for at least half an hour. All this time the lightning display continued.

I also noticed a bright and constant radiance, somewhat similar to the one described above. This was approximately in the direction of Rotorua, but it would have needed a city the size of London to give the same effect as a reflection. I could not see the focal point of this radiance, owing to the tops of the hills which were outlined. This glow remained practically steady for 15 minutes.

One other detail I noted with regard to the phenomenon detailed at length above. After the glowing light had finally disappeared, one particular display of lightning emanating from the northern cloud flashed across the sky. One jagged fork was travelling horizontally above the spot where the ball had been. Suddenly this jagged fork resolved itself into an absolutely straight line, and drove itself directly into the spot where the ball had been. Its angle of flight was from 11 o'clock to 5 (i.e., slightly off the perpendicular).

I am writing this on the day following, while it is all fresh in my memory. I have heard no mention of any similar experience over the air, although I have been told that others have witnessed the same thing. Nevertheless, I have purposely refrained from discussing it with any of those people as I do not want to risk having my impressions varied by the experiences of others until I have put my record on paper.

M. D. LAURENSON.

Royal Meteorological Society

His Majesty the King has been graciously pleased to grant his Patronage to the Royal Meteorological Society.

The monthly meeting of this Society was held on Wednesday, June 17th, at 49, Cromwell Road, South Kensington, Dr. F. J. W. Whipple, F.Inst.P., President, in the Chair.

Prof. T. H. Laby, F.R.S., Professor of Physics at the University of Melbourne, and a member of the Australian Radio Research Board, opened a discussion on "Thunderstorm Researches", with an account of the following paper :—" Relation between sources of atmospherics and meteorological conditions in Southern Australia during October and November, 1934." By R. W. Boswell, M.Sc., and W. J. Wark, M.Sc.

The authors describe observations covering 24 hours per day of sources of atmospherics made by means of wireless direction-finding at Melbourne and Canberra during October and November, 1934. The observations are compared with meteorological data for that period for the purpose of ascertaining what relationship, if any, existed between the sources of atmospherics and the cold fronts. The results show that during that particular period there was a general correlation between the days on which sources of atmospherics were active and the days on which fronts were present in Southern Australia, but that any attempt at closer analysis of this problem must allow for the fact that the fronts determined by meteorological observations are merely the intersection of the frontal planes with the earth, and a front at the height of a lightning flash may be some distance from the same front as determined at the ground.

Prof. Laby gave some details of the work of the Radio Research Board of Australia in connexion with thunderstorm tracking, and described observations of atmospherics by means of wireless direction-finders made in Australia over a period of years. Evidence was submitted that lightning alone emits atmospherics and that thunderstorms associated with cold fronts can be followed over considerable distances.

The following papers were read in title :—

M. P. van Rooy, B.Sc.—Influence of berg winds on the temperatures along the west coast of South Africa.

The South African Berg winds, winds of a föhn-like character, blowing off the interior plateaux, are described, and their influence on the temperatures along the west coast of South Africa is discussed. It is found that the minimum temperatures are very seldom affected but that daily maxima are much increased when the Berg winds are blowing. As the number of affected maxima during any one month varies greatly from year to year the mean monthly maxima show wide fluctuations and mean temperature values for this region must therefore be used with discrimination.

S. Chapman, M.A., D.Sc., F.R.S., M. Hardman and J. C. P. Miller.—The lunar atmospheric tide at Melbourne, 1869–1892, 1900–1914.

The lunar atmospheric tide at Melbourne, Australia, has been determined from nearly 36 years' record. The mean result is 28 sin (2t + 84·0°) microbars, with a probable error of 2·3 microbars. This is compared with the determination made by Neumayer from data for the years 1858–63 : his result is found to be affected by so large a probable error as to be practically without value. The Melbourne tide is affected by a seasonal variation, of normal type as regards phase (high tide occurring later in December than in June), but abnormal in that the amplitude is greatest in December. The daily solar variation at Melbourne is also analysed, determined from all or almost all days, and separately from 421 days of barometric disturbance ; the latter show the expected "concave variation," the complement of Bartels' "convex variation" characteristic of barometrically "quiet" days.

Correspondence

To the Editor, *Meteorological Magazine*

Waterspout in the Indian Ocean, October, 1935

The three photographs reproduced, facing p. 135, were obtained from a ship in the Indian Ocean, about 500 miles west of Bombay, by Mrs. T. Harford. The morning (about the middle of October, 1935) was at first sunny and cloudless, but suddenly the sky in the east grew very black and a waterspout appeared directly ahead of the ship.

The three photographs were taken in rapid succession. The interesting point about the phenomenon is that the waterspout seemed to progress in leaps. In the third photograph, traces of an earlier disturbance of the sea are visible to the left of the actual column. After the third photograph was taken the waterspout again made a jump and developed a "whirling corkscrew formation," but unfortunately Mrs. Harford was unable to obtain a photograph of this stage.

As the waterspout passed the ship, rain fell heavily accompanied by terrific wind. Rainstorms can be seen on each side of the spout in the first photograph. Dozens of dead land birds were afterwards picked up from the awnings.

Temperature Observations during the Solar Eclipse of June 19, 1936

The following observations of temperature were made from a point about 400 ft. above mean sea level near Chorleywood Common, Herts., during the partial solar eclipse at and soon after sunrise on June 19th 1936. A non-registering black-bulb thermometer *in vacuo* was used for the solar radiation readings, and the dry-bulb of a Casella sling psychrometer for the "air" readings. The sky was cloudless apart from a few wisps of cirrus, which all steered clear of the sun; the wind was NNE., 3 to 5 miles an hour; and though there was some mist in the neighbouring valleys, visibility from the hill-top was estimated at 8 to 10 miles. It will be seen that, as usual, the greatest depression of temperature resulting from the partial cutting-off of the heat rays was delayed for several minutes after the maximum phase of the eclipse, which occurred at 4h. 15m.

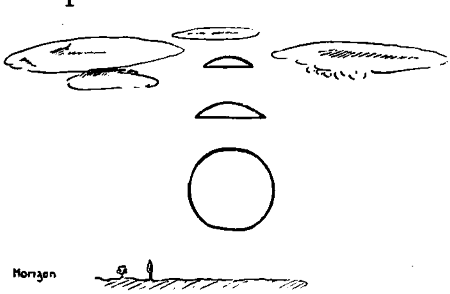
Time. G.M.T.	*Air Temperature.* °F.	*Black Bulb.* °F.	*Black Bulb—Air Temperature.* °F.
3h. 50m.	61·0	66·7	5·7
3h. 55m.	61·0	67·9	6·9
4h. 0m.	61·1	70·9	9·8
4h. 5m.	61·3	70·1	8·8
4h. 10m.	61·8	68·1	6·3
4h. 15m.	61·7	65·3	3·6
4h. 20m.	59·6	62·8	3·2
4h. 25m.	59·9	63·2	3·3
4h. 30m.	60·2	63·5	3·3
4h. 35m.	60·3	64·1	3·8
4h. 40m.	60·5	65·0	4·5
4h. 45m.	61·0	66·2	5·2
4h. 50m.	61·8	67·9	6·1
4h. 55m.	62·7	69·8	7·1
5h. 0m.	64·1	73·5	9·4

E. L. HAWKE.

Caenwood, The Valley Road, Rickmansworth, Herts., June 21st, 1936.

Unusual Solar Phenomenon

At 19h. 45m. G.M.T. on Monday, June 15th, 1936, an unusual solar phenomenon was witnessed at Saughall. At the time the sun was below a band of alto-cumulus lenticularis with the elevation of the centre of the sun about 8°. The sun appeared as a deep red orb while above it were two segments of a circle also deep red in colour. The upper and smaller segment (see diagram) was at a distance of approximately 2° from the upper limit of the sun and the second was about midway between this and the sun.



It is of interest to note that at the same time a particularly well-developed sun pillar was observed from a view point about six miles due east by Mr. W. G. Davies, of Upton Park, Chester.

GEO. R. READ.

Roker, Station Road, Great Saughall, Chester, June 19th, 1936.

Mirage Phenomena

The mirage phenomena reported in the Press as having been seen in the Channel were noted by myself from the train between Bexhill and St. Leonards yesterday evening, June 17th, about 19h. 30m. G.M.T. The line is only about 20–30 ft. above sea level and even without glasses I could see that a steamer with black hull and white upper works which was at an estimated distance of two or three miles had its inverted image on top of it. The sea was smooth and there was practically no wind. On the horizon there was a bank of haze out of which appeared some cumulus tops.

CICELY M. BOTLEY.

17. *Holmesdale Gardens, Hastings, June 18th*, 1936.

Visibility in Specified Directions

On reading Mr. Flower's note on this subject in the *Meteorological Magazine* for May, 1936, one wonders what the result of his investigation would be if (1) Heliopolis lay to the south-west of Cairo instead of to the north-east, (2) there were definite visibility objects over the desert to the north-east, and (3) the investigation had been confined to visibilities between one and four miles. His result, that within three hours of sunrise (elevation of sun small) and with a high relative humidity, visibility is greatest looking towards the sun, may be universally true for moderately good visibility, but it has always been my impression in this country, although I have made no actual measurements, that in generally hazy weather (visibility one to four miles) the visibility is least looking towards the sun whatever the sun's elevation, but more particularly when the elevation is comparatively small. I exclude from the last statement, however, the hour immediately following sunrise or preceding sunset, for as the sun sinks down just before sunset into the haze layer and assumes the familiar red colouration the visibility looking towards the sun appears to increase. In support of the above statements I have had frequent reports from aircraft pilots to the effect that in hazy weather the visibility when flying towards the sun has been much worse than when flying in other directions and on occasions has almost amounted to blind flying.

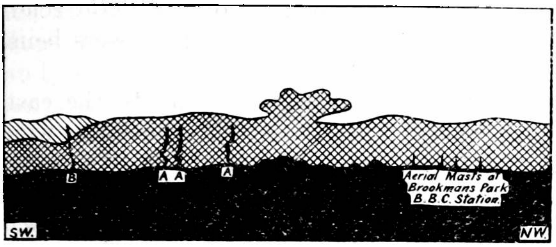
W. H. BIGG.

Meteorological Station, R.A.F., Bircham Newton, Norfolk, June 8th, 1936.

Recurrent Group Lightning Flashes

The exposure to the west of the Meteorological Station at Goff's Oak, Herts, is such that the natural horizon is visible from about south-west by south through west to north and thus is ideal for the observation of distant thunderstorms in this azimuth.

The storm of the night of June 18th–19th, as viewed from the anemometer mast, gave a brilliant and prolonged display of lightning. The storm was too far to the west for thunder to be audible, but the eastern boundary of the cloud, which appeared to move from the south, was clearly defined, and lightning was observed from 21h. 20m. to 23h. 0m. G.M.T. The attached sketch shows diagrammatically the form of the cloud as observed at 22h. 15m., when the storm centre appeared to be about due west from this station.



The point of interest is that the three lightning flashes (A) and the single flash (B) were alternately repeated at intervals of about one or two minutes during the period under observation. The three flashes would appear simultaneously and about 15 seconds after, the single flash, partly hidden by cloud, would follow to the south. The flashes kept to their relative positions as the cloud slowly moved northwards, but the curious fact was that the group of three always flashed together without any appreciable time interval and, as regularly, the single flash to the south of them would follow. Other flashes were observed at times but were far less distinct. It would be interesting to know if similar recurrent groups of flashes have been noted by other observers.

The wind was almost dead calm at 21h. but gradually increased to force 3 from NE, as the cloud moved northwards, the mean velocity from 22h. to 6h. the next day being 3·5 m.p.h. Barometer fairly steady at 1022 mb. and temperature at 22h. was 63° F., falling slowly to night minimum of 58° F.

DONALD L. CHAMPION.

7, Robinson Avenue, Goff's Oak, Herts, June 21*st,* 1936.

Severe Thunderstorms in the Chester District and over the Dee Estuary

Thunderstorms occurred in the Chester district and the regions surrounding the estuary of the River Dee on each day of the period June 19th to 22nd inclusive. The two which occurred on the 21st were particularly severe and the characteristics of these storms are a matter of some interest.

The pressure distribution at 2 p.m. on the 21st was characterised by an elongated centre of low pressure to the south-west of Ireland with two associated occlusions, one orientated roughly from Valentia to Plymouth and Abbeville and the other roughly from near Belfast to Conway and thence south-eastwards. These occlusions were moving slowly northward with a sharp contrast in temperature across the northern one, at least in so far as the North Wales coast region was concerned. The passage of both these occlusions across Chester and the Dee estuary was marked by an intense squall, severe thunderstorms and torrential rain with severe hail locally, particularly in Chester and Saughall where hailstones exceeding one inch diameter were experienced. Considerable damage was done to gardens and fruit trees, while portions of the main roads were temporarily flooded owing to the capacity of the sewers being insufficient to deal with the heavy rainfall.

Thunder and lightning were first reported at 5 p.m. to the east, and at 5.25 p.m. the storm was overhead. At this time the wind suddenly increased from 4 to 60 m.p.h. and after about 10 minutes decreased as suddenly to about 10 m.p.h. A sudden backing in direction of 90° occurred at the time of sudden increase and this was followed by a gradual veer to the original direction. There was slight rain, 0·1 in. between 5.10 and 5.25 p.m., but in the 10 minutes ended 5.35 p.m. there was a fall of 0·52 in. At the time of commencement of heavy rain temperature fell 19·5° F., relative humidity increased, atmospheric pressure rose by 3 mb. and visibility decreased temporarily to 50 yards.

The passage of the second occlusion at about 1 a.m. on the 22nd was accompanied by a less severe storm, although the individual characteristics were similar. In this storm the lightning was almost continuous for about 15 minutes giving the effect of a marvellous and awe-inspiring pyrotechnic display. Both storms moved towards the north-west.

The decrease in temperature and change in wind direction was well marked at Abergele, about 40 miles west of Chester, where thunder with slight rain occurred between 3.45 and 4.40 p.m.

The velocity recorded in the squalls was in no way connected with the pressure field, as that was very flat, so that the squalls were obviously associated with the inrush of air, beneath the cumulonimbus, which is necessary for intense thunderstorm development.

WILLIAM D. FLOWER.

Meteorological Station, R.A.F., Sealand, Chester, June 26th, 1936.

Thunderstorms and unusually heavy Rain at Shanklin

I thought it might be of interest to you to know that for the first 21 days of June no less than 3·8 in. of rain had fallen at Shanklin (Isle of Wight), which is a record since 1906. It is interesting to note that this has followed the driest May on record, when last month only 0·16 in. fell. The bulk of this June rain has come down in a series of extraordinarily violent thunderstorms, and it is almost unheard of for Shanklin to experience four storms on four successive days. The storm early on Friday, June 19th, was extremely severe, two houses being struck by lightning in Green Lane, and the total fall of rain and hail measured 1·27 in. in the gauge, which is the heaviest 24-hour fall at Shanklin in June on record. On Friday evening, June 19th, between 7.30 and 9 p.m., another severe thunderstorm came in from the sea, giving a total of 0·97 in. of rain; so for the four days, June 17th–20th, no less than 2·85 in. fell at Shanklin during thunderstorms. At Ventnor Park, both on June 18th and 19th, there were falls of more than 1 in. of rain, and the total is just over 4 in., which is remarkable, for June is normally the driest month of the year. The normal rainfall in June at Shanklin is 1·64 in.

J. E. COWPER.

18, Duchess Road, Edgbaston, Birmingham, June 26th, 1936.

Unusually severe Thunderstorms in Breconshire

On the night of June 20th and early hours of June 21st, we experienced a thunderstorm of terrific violence.

Storms of moderate intensity had moved from about east to north during the afternoon, and the cumulonimbus accompanying them was of immense height and showed signs of exceptionally violent convection. The day had been very hot with a light easterly surface breeze.

At 9.15 p.m. (summer time) conditions became extremely threatening—enormous cumulonimbus from east and two additional storm centres to the north. The lightning and thunder were almost continuous until about midnight, when a storm centre of terrific intensity rapidly came up from about east-south-east. This centre could be heard approaching above the roar of the other storm, and burst overhead at 12.25. The lightning was continuous—flash upon flash of blinding intensity which left the eyes aching, and the thunder shook the windows. Heavy hail fell very locally for a few minutes, then torrential rain. One observer saw a " ball of blue fire travelling from east to west high up in the sky."

The storm died out in the north about 2 a.m. on the early morning of the 21st. I measured 0·91 in. of rain, all of which must have fallen in about half an hour. This storm was comparable to the worst tropical storms.

R. G. SANDEMAN.

Dan Y Parc, Crickhowell, Breconshire, June 23rd, 1936.

NOTES AND QUERIES

British Health Resorts

In happy Victorian days only the rich could afford to be ill, and the rich found it more impressive to go for their cures to high-sounding continental spas than to trust to home resources. Hence, with a few fashionable exceptions, British medicinal waters were neglected or enjoyed only a local reputation, though several of them were known as long ago as Roman times. During the past few years, however, the British Health Resorts Association has been doing invaluable work in putting British Spas " on the map ", both by interesting doctors in their properties and powers and by encouraging the local authorities of the spas themselves to improve their facilities and amenities for patients. Even places which are not so fortunate as to possess healing springs may have climates which make them specially suitable for one purpose or another; all health resorts are not equally appropriate even for restoring jaded nerves, and the ordinary holiday maker who has no intention of consulting a doctor may find guidance useful in selecting the venue for his annual holiday. An important element of this programme of education and guidance is the preparation and publication at a nominal price of an official handbook to the British Health Resorts*.

The fourth edition of this Handbook, published in 1936, has been considerably enlarged. Dr. R. Fortescue Fox, the editor, has had the support of a powerful sub-committee including two meteorologists, Mr. E. G. Bilham and Mr. L. C. W. Bonacina. Considering the intimate relations between climate and health, it is not inappropriate that the accident of alphabetical arrangement should bring these two gentlemen first on the list! The plan of the book is simple and convenient; after a medical introduction explaining the types of health resort and the medical purposes which each can serve, the main part of the book comprises three sections giving in alphabetical order descriptions of spas, seaside resorts and inland resorts. The spas naturally receive the most detailed treatment, and here again the alphabetical arrangement is fortunate in giving first place to Bath, the doyen of British spas. Each description includes a short section on climate, not only during the recognised holiday season of summer, but in many cases also during the " invalids' winter " (November to March, a new addition to the category of seasons), with special reference to sunshine and fog. The climatic notes are not merely dry statistics, but pay special attention to the requirements of leisure, in many cases discriminating between the frequency of rainy days and rainy nights.

An interesting section of the Handbook, included in this edition for the first time, gives descriptions of the main characteristics and chief health resorts of the Dominions and Colonies, though one gathers that with a few notable exceptions the resources of the Empire in this direction have not yet been extensively developed.

This very well produced and attractively illustrated Handbook

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* British Health Resorts, Spa, Seaside, Inland, including Australia, Canada' New Zealand, South Africa and British West Indies. Official Handbook of the British Health Resorts Association. Size 9¾ in. × 6¼ in., pp. 288. *Illus.*, London, 1936. 1*s*. net.

is published by J. & A. Churchill, Ltd., and is obtainable at all the establishments of W. H. Smith & Sons, Ltd., price 1s., at which price it is remarkably good value.

C. E. P. BROOKS.

Sir Thomas Middleton

We learn with pleasure of the election to Fellowship of the Royal Society of Sir Thomas Middleton, K.C.I.E., K.B.E., C.B., LL.D. As an agriculturist, Sir Thomas has had a long and distinguished career both in this country and in India. From 1889 to 1907 he held University appointments at Baroda, Aberystwyth, Durham and Cambridge. From 1906 to 1919 he was Assistant Secretary to the Board of Agriculture and was Director General of the Food Production Department from 1917 to 1919. Since 1919 Sir Thomas has been a member of the Development Commission.

Sir Thomas Middleton has always taken a keen interest in meteorology and in 1910 he was appointed by the Board of Agriculture and Fisheries as their representative on the newly-constituted Meteorological Committee, which is the advisory committee of the Meteorological Office, and in 1925 he became one of the original members of the Agricultural Meteorological Committee, of which Sir Napier Shaw is the Chairman. To both these committees Sir Thomas's wide knowledge, clear grasp of essentials, shrewd commonsense and genial personality have been of the utmost value. We are glad to take this opportunity of congratulating him on the honour now conferred upon him by the Royal Society.

BOOKS RECEIVED

Royal Alfred Obvservatory. Mauritius. Annual Report, 1933; Annual Report, 1934. Results of magnetical and meteorological observations for October to December, 1933; and January to October, 1934. Port Louis 1934 and 1935.

The distribution of temperature in the upper levels of a depression originating in the Bay of Bengal during the Indian south-west monsoon. By N. K. Sur, India Meteor. Dept., Sci. Notes, **6,** No. 62.

NEWS IN BRIEF

The Regents of the University of California have appointed Dr. H. U. Sverdrup, Professor of Geophysics at the Chr. Michelsens Institute of Bergen, to be Director of the Scripps Institution of Oceanography of the University of California.

The Senate of the University of Edinburgh has conferred the degree of D.Sc. on Mr. J. M. Stagg, M.A., B.Sc., of the Meteorological Office, Edinburgh.

The Council of the Royal Meteorological Society has awarded the Howard Prize for 1936 to Cadet John Burton Davies, of H.M.S. *Worcester*. The subject of the competition was an essay on "The causes of fog over the open sea and in coastal waters".

The Weather of June, 1936

Pressure was above normal over north-west Siberia, northern Europe, across Poland and Austria to Italy and Spain, over the northern North Atlantic including the Azores, central Canada, southern Alaska, the greatest excesses being 3·9 mb. at Ekaterinburg, 5·7 mb. at 50° N. 30° W., and 4·0 mb. near Lake Athabaska (Canada). Pressure was below normal over most of Alaska, western and eastern Canada, Greenland and Spitsbergen, the United States except Lower California, Bermuda, Madeira, France and the Netherlands, south-east Europe and south-west Siberia and the eastern Mediterranean. Temperature was above normal over northern, western and central Europe, but below normal generally in south-east Europe. Rainfall was mainly below normal.

The main features of the weather of June over the British Isles were the frequency and severity of the thunderstorms and in the north of Scotland the abundant sunshine. Rainfall was above normal except in Scotland and south-west Ireland, and sunshine, except in North Scotland, generally below normal. On the 1st a secondary depression developed over the Hebrides, and moved south to the Bristol Channel on the 2nd ; it moved slowly east on the 3rd and 4th. Cool unsettled weather prevailed during this time with thunderstorms in many parts and hail locally. Maximum temperatures did not exceed 50° F. at several inland places on the 3rd, while 1·84 in. of rain was measured at Newbiggin (Durham) and 1·81 in. at Llangynhafal (Denbigh) on the 3rd. The 3rd and 4th were sunny days in Scotland and west Ireland and the 5th further south ; 16·1 hrs. at Oban on the 4th, 15·5 hrs. at Inchkeith on the 3rd and 13·5 hrs. at Blackpool and Llandudno on the 5th. By the 5th the Azores anticyclone had extended north-east across the British Isles and from the 6th to 14th pressure was high to the south, while depressions moving in an easterly direction from Iceland passed at times across the country, though chiefly only across the north and west. Weather was generally unsettled with bright periods, but considerable falls of rain were recorded locally—local mist or fog also occurred at times in the south-west. Temperature was mainly about or below normal except on the 8th to 10th ; on the 9th 70° F. was exceeded at many places—75° F. was recorded at South Farnborough and Greenwich and 74 F. at Aberdeen. The 9th was a very sunny day in England and the 10th in Scotland and Ireland. From the 15th to 17th pressure was low generally and the weather unsettled, with some rain but bright intervals, except in the south-east where it was dry and sunny. From the

18th to 23rd pressure was high to the north and east and low to the south-west, giving sunny warm weather. Temperature rose considerably above the normal after the 17th, exceeding 80° F. in many parts of England and locally in Scotland, 87° F. was recorded at Tottenham on the 20th, and 85° F. at Nairn on the 21st and 22nd. On the 18th thundery conditions again set in and widespread and frequent thunderstorms, severe locally, were experienced until the 23rd. Two distinct thunderstorms on the same day were reported from several places on both the 19th and 20th. At South Farnborough " two distinct thunderstorms occurred on each of the three days, 18th to 20th . . . . On the 20th the first thunderstorm, occurring from 14h. 5m. to 14h. 25m., was accompanied by squalls up to 30 m.p.h., while temperature fell from 85·5° F. to 70·0° F. in 28 minutes. During the second thunderstorm on the same day, lasting from 21h. 10m. to 22h. 20m., the wind rose from about 5 m.p.h. to 48 m.p.h. and 0·94 in. of rain and hail fell in 48 minutes, of which 0·79 in. fell in 26 minutes. The hailstones were generally described as the " size of cherries " and did considerable damage to plants . . . . Low-lying portions of roads were still flooded to a depth of 10 in. at 7h. next morning." During a thunderstorm on the 21st at Rothamsted Experimental Station (Herts) 3·15 in. of precipitation was recorded, mainly in two periods of half-an-hour. Severe squalls and heavy falls of hail accompanied the storms in many places and much flooding and damage to crops were experienced. At Hailsham, Sussex, 2·20 in. were measured on the 19th and at Wigan 2·11 in. on the 22nd. During this period, sunshine records were good especially in Scotland, 17·3 hrs. were recorded at Lerwick on the 21st and 16·3 hrs. at Inverness on the 18th. From the 24th to 28th a ridge of high pressure covered most of the country but shallow disturbances passed occasionally in a southerly direction affecting chiefly the eastern districts. Weather was generally sunny and dry, but there were occasional dull periods with rain, heavy locally. The Rev. C. L. O. Ferrall, of Hogmaston, Ashbourne (Derbyshire) writes that 2·33 in. of rain fell there on the 25th between 4.15 p.m. and 5.45 p.m., but there was no thunder or lightning, " the back of our house was a raging torrent." Temperature, though lower than the previous few days, still continued above the normal and mist or fog was experienced in the mornings and evenings locally. Thunderstorms were reported from Clacton on the 25th and from Ireland on the 27th. On the 28th a complex depression approached from the Atlantic and covered the country on the 30th. Unsettled weather, with heavy rain and hail at times and thunderstorms locally, prevailed generally ; 3·20 in. fell in 3 hrs. at Florencecourt (Co. Fermanagh) on the 30th and 1·18 in. in 4 hrs. at Campsea Ashe (Suffolk) on the 28th, while Mr. Everett of Rutlish School, Wimbledon, writes that " 0·94 in. fell there between 8.40 and 10.30 a.m. on the 29th, the bulk of which fell in the first hour."

At Bodmin (Cornwall) 3.12 in. fell on the 29th. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	241	+73	Chester ...	151	−43
Aberdeen ...	274	+93	Ross-on-Wye ...	153	−37
Dublin	187	+ 1	Falmouth ...	180	−42
Birr Castle ...	145	−16	Gorleston ...	239	+21
Valentia... ...	163	−13	Kew	190	− 9

Miscellaneous notes on weather abroad culled from various sources

Wintry weather prevailed in Switzerland at the beginning of the month causing much damage to the fruit trees. Snow fell on the mountains down to the 4,800 ft. level and some of the passes were closed to vehicular traffic. On the 8th two pilots were killed when their aeroplanes crashed into the side of Mount Grappa. Fog also occurred in Czechoslovakia and south Germany on the 12th, and 7 people were killed when a seaplane travelling from Bergen to the north crashed in a fog on the side of a mountain. Fog occurred also at Palamos (Spain) on the 21st. A whirlwind in the Mouscron district of Belgium did much material damage on the 29th and many people were injured. (*The Times*, June 5th–July 1st.)

The monsoon set in in Bombay on the 4th though the rain consisted only of sharp showers at intervals. The floods of the Brahmaputra had subsided in the Dibrugarh area by the 13th and the monsoon was approaching Calcutta. By the 20th Bombay city had had little rain and the dry spells had produced great heat. Rainfall was mainly fair to excess in the eastern part of India during the week ending the 17th, when the monsoon was extending to the United Provinces and north-west India ; during the following week the monsoon was active generally. Bombay had had copious rainfall by the 25th and by the 27th rain had also ended the drought in Kolhapur, and the fears of a drought in Poona. Six inches of rain fell in 24 hrs. in Bombay on the 28th and flooding was reported. A small boat containing 120 Koreans was overwhelmed in a heavy sea off Seoul on the 19th and only 12 people were saved. (*The Times*, June 4th–30th.)

A dense fog occurred in Wellington, N.Z., on the 5th. Gales were reported off Cape Jaffa, South Australia, on the 21st. The total rainfall for the month in Australia was generally below normal except in northern Queensland and southern New South Wales. (*The Times*, June 6th–24th and cable.)

Beneficial rain was experienced in most of the prairie country about the 6th and 7th though severe drought conditions were still prevailing in parts of Saskatchewan and Alberta on the 12th. Owing to floods railway communications were cut off for 100 miles between Kitwanga and Kwinitsa (British Columbia) on the 10th. A heat wave was experienced in Alaska about the 10th–17th. Fog frequently occurred off the eastern coast of the United States during the first half of the month. Prolonged drought and high temperatures were experienced in many parts of the wheat-growing areas of the United States. In the United States, temperature was above normal in the eastern districts and below normal in the west early in the month, becoming considerably above normal in the south and west but mainly below normal in the north-east during the middle and end of the month; rainfall was below normal generally. (*The Times*, June 8th–27th, and *Washington, D.C., U.S. Dept., Agric. Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, June, 1936

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp.		Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see vol. 69, 1934, p. 1).
			Min.	Max.				
	mb.		°F	°F	%	in.	hrs.	
1	1014·1	SSW.3	44	61	42	0·06	6·7	pr$_0$ 15h. r 19h.–20h.
2	1011·7	SSE.3	46	59	82	0·40	4·3	r 2h.–10h. R 14h.
3	1006·9	SW.3	44	58	63	0·19	5·5	PRH 6h.
4	1011·7	NNW.2	44	61	55	0·09	2·3	t pr 17h.
5	1015·5	N.5	48	62	66	0·07	7·9	r$_0$–r 4h.–6h.
6	1015·8	W.3	44	62	48	0·02	4·2	r–r$_0$ 17h.–18h.
7	1014·7	NNW.2	54	61	74	0·15	1·0	r$_0$–r 3h.–10h.
8	1020·7	W.2	54	69	43	—	10·9	
9	1018·9	W.2	52	72	54	—	11·8	
10	1017·4	WNW.2	55	66	70	—	0·0	r$_0$ 13h.
11	1016·3	SSW.3	54	65	69	—	0·7	
12	1013·8	SW.2	53	65	83	0·09	0·4	r–r$_0$ 12h.–15h. [24h.
13	1014·9	WSW.3	55	62	87	0·57	0·2	r$_0$–r 0h.–11h. & 21h.–
14	1016·9	WSW.3	52	66	49	0·01	3·8	r$_0$0h.–3h., & 20h.–24h.
15	1013·0	SW.4	53	64	58	0·04	9·2	r$_0$ 0h.–4h., pr$_0$ 11h.–
16	1018·2	S.4	50	68	56	—	13·0	[13h.
17	1018·3	S.3	49	77	46	—	14·4	w early.
18	1023·3	W.1	57	76	80	0·52	1·9	TLR 9h. & 22h.–23h.
19	1016·0	ENE.3	61	79	55	0·32	7·8	tl 2h. TLR h 14h. tl 22h.
20	1010·1	E.2	64	86	55	—	12·8	tl 0h.–1h. & 21h.–23h.
21	1009·7	S.3	65	83	59	0·28	6·0	TLR 18h.–21h.
22	1015·3	SW.3	60	78	54	—	12·9	
23	1021·2	WSW.2	60	76	56	0·02	11·0	r$_0$ 0h.–1h.
24	1020·7	WNW.2	60	77	47	—	14·3	w early.
25	1021·2	NNW.2	58	77	45	0·08	11·4	r 23h.
26	1021·0	E.2	60	63	89	0·19	0·0	r–r$_0$ 0h.–13h. F 20h.
27	1020·4	SW.2	57	74	57	—	7·2	F early.
28	1017·0	SSW.2	51	75	65	—	5·3	
29	1007·3	NNW.2	59	67	81	0·36	0·0	r$_0$ 8h.–10h. TR 18h
30	1007·7	S.4	59	69	79	0·08	2·8	r–r$_0$ 21h.–24h.
*	1015·7	—	54	69	62	3·53	189·7	* Means or totals.

General Rainfall for June, 1936

England and Wales ...	151	per cent of the average 1881–1915
Scotland	74	
Ireland	115	
British Isles	124	

Rainfall : June, 1936 : England and Wales

Co.	STATION.	In.	Per cent of Av.	Co.	STATION.	In.	Per cent of Av.
Lond .	Camden Square	3·82	188	*Leics* .	Belvoir Castle	2·53	132
Sur .	Reigate, Wray Pk. Rd.	3·61	173	*Rut* .	Ridlington	3·73	195
Kent .	Tenterden, Ashenden	3·91	205	*Lincs* .	Boston, Skirbeck	3·36	185
,, .	Folkestone, Boro. San.	2·54	...	,, .	Cranwell Aerodrome	3·20	190
,, .	Margate, Cliftonville	3·54	202	,, .	Skegness, Marine Gdns.	3·19	177
,, .	Eden'bdg., Falconhurst	2·75	125	,, .	Louth, Westgate	4·16	193
Sus .	Compton, Compton Ho.	3·17	127	,, .	Brigg, Wrawby St.	2·98	...
,, .	Patching Farm	2·72	135	*Notts* .	Worksop, Hodsock	4·37	220
,, .	Eastbourne, Wil. Sq.	2·57	140	*Derby*.	Derby, L. M. & S. Rly.	3·48	155
Hants.	Ventnor, Roy.Nat.Hos.	4·09	224	,, .	Buxton, Terr. Slopes	4·22	131
,, .	Fordingbridge, Oaklnds	2·35	127	*Ches* .	Runcorn, Weston Pt.	2·81	109
,, .	Ovington Rectory	3·41	147	*Lancs*.	Manchester, Whit. Pk.	3·43	130
,, .	Sherborne St. John	2·98	140	,, .	Stonyhurst College	3·55	115
Herts .	Royston, Therfield Rec.	4·92	220	,, .	Southport, Bedford Pk.	5·30	244
Bucks.	Slough, Upton	2·89	140	,, .	Lancaster, Greg Obsy.	4·64	181
,, .	H. Wycombe, Flackwell	4·19	208	*Yorks*.	Wath-upon-Dearne	4·04	182
Oxf .	Oxford, Mag. College	3·35	157	,, .	Wakefield, Clarence Pk.	4·03	187
N'hant	Wellingboro, Swanspool	4·39	209	,, .	Oughtershaw Hall	5·08	...
,, .	Oundle	3·46	...	,, .	Wetherby, Ribston H.	4·27	203
Beds .	Woburn, Exptl. Farm	3·58	183	,, .	Hull, Pearson Park	2·98	144
Cam .	Cambridge, Bot. Gdns.	3·53	167	,, .	Holme-on-Spalding	2·75	125
Essex .	Chelmsford, County Gdns	3·79	199	,, .	West Witton, Ivy Ho.	6·66	327
,, .	Lexden Hill House	3·11	...	,, .	Felixkirk, Mt. St. John.	3·58	164
Suff .	Haughley House	3·24	...	,, .	York, Museum Gdns.	3·51	169
,, .	Campsea Ashe	3·61	191	,, .	Pickering, Hungate	2·86	135
,, .	Lowestoft Sec. School	2·39	132	,, .	Scarborough	2·12	115
,, .	Bury St. Ed., WestleyH.	2·81	134	,, .	Middlesbrough	3·57	189
Norf. .	Wells, Holkham Hall	4·20	217	,, .	Baldersdale, Hury Res.	3·60	153
Wilts .	Calne, Castle Walk	2·23	...	*Durh* .	Ushaw College	3·81	176
,, .	Porton, W.D. Exp'l. Stn	1·89	98	*Nor* .	Newcastle, D. & D. Inst.	2·95	150
Dor .	Evershot, Melbury Ho.	2·32	102	,, .	Bellingham, Highgreen	1·72	75
,, .	Weymouth, Westham.	1·39	78	,, .	Lilburn Tower Gdns.	2·42	117
,, .	Shaftesbury, Abbey Ho.	2·39	103	*Cumb*.	Carlisle, Scaleby Hall	2·67	106
Devon.	Plymouth, The Hoe	·99	46	,, .	Borrowdale, Seathwaite	...	...
,, .	Holne, Church Pk. Cott.	2·30	80	,, .	Borrowdale, Moraine	6·62	135
,, .	Teignmouth, Den Gdns.	1·28	67	,, .	Keswick, High Hill	3·75	129
,, .	Cullompton	1·77	83	*West* .	Appleby, Castle Bank	2·82	123
,, .	Sidmouth, U.D.C.	1·50	...	*Mon* .	Abergavenny, Larchf'd	4·88	200
,, .	Barnstaple, N. Dev.Ath	2·04	91	*Glam* .	Ystalyfera, Wern Ho.	4·95	132
,, .	Dartm'r, Cranmere Pool	2·30	...	,, .	Cardiff, Ely P. Stn.	3·38	136
,, .	Okehampton, Uplands.			,, .	Treherbert, Tynywaun.	4·83	...
Corn .	Redruth, Trewirgie	2·30	92	*Carm* .	Carmarthen, Coll. Rd.	4·58	160
,, .	Penzance, Morrab Gdns.	1·54	69	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	3·78	191
,, .	St. Austell, Trevarna	2·57	99	*Card* .	Aberystwyth	3·81	...
Soms .	Chewton Mendip	2·84	96	*Rad* .	BirmW.W.Tyrmynydd	6·61	202
,, .	Long Ashton	2·93	116	*Mont* .	Lake Vyrnwy	6·48	205
,, .	Street, Millfield	2·07	...	*Flint* .	Sealand Aerodrome	4·34	...
Glos .	Blockley	2·98	...	*Mer* .	Blaenau Festiniog	10·22	171
,, .	Cirencester, Gwynfa	2·50	104	,, .	Dolgelley, Bontddu	5·99	172
Here .	Ross, Birchlea	3·85	177	*Carn* .	Llandudno	3·21	169
Salop.	Church Stretton	3·74	154	,, .	Snowdon, L. Llydaw 9	12·25	...
,, .	Shifnal, Hatton Grange	3·37	151	*Ang* .	Holyhead, Salt Island	4·99	232
Staffs.	Market Drayt'n, Old Sp.	3·23	133	,, .	Lligwy	3·62	...
Worc .	Ombersley, Holt Lock.	3·06	136	*Isle of Man*			
War .	Alcester, Ragley Hall	2·97	130		Douglas, Boro' Cem.	3·37	139
,,	Birminghm, Edgbaston	3·34	144	*Guernsey*			
Leics .	Thornton Reservoir	4·90	226		St. PeterP't.Grange Rd.	1·77	96

Rainfall: June, 1936: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig	Pt. William, Monreith.	2·96	126	*Suth*	Tongue	1·03	50
„	New Luce School	3·94	136	„	Melvich	·96	49
Kirk	Dalry, Glendarroch	2·40	86	„	Loch More, Achfary	1·64	44
Dumf.	Dumfries, Crichton R.I.	2·68	112	*Caith*	Wick	1·11	62
„	Eskdalemuir Obs.	2·89	92	*Ork*	Deerness	1·50	81
Roxb	Hawick, Wolfelee	2·49	106	*Shet*	Lerwick	·87	49
Selk	Ettrick Manse	2·28	63	*Cork*	Dunmanway Rectory	2·16	62
Peeb	West Linton	1·67	...	„	Cork, University Coll.	1·55	61
Berw	Marchmont House	1·32	57	„	Ballinacurra	1·72	66
E.Lot.	North Berwick Res.	2·18	132	„	Mallow, Longueville	1·77	80
Midl	Edinburgh, Blackfd. H.	1·28	64	*Kerry*	Valentia Obsy	2·39	75
Lan	Auchtyfardle	1·84	...	„	Gearhameen	2·60	52
Ayr	Kilmarnock, Kay Pk	1·80	...	„	Bally McElligott Rec.	2·69	...
„	Girvan, Pinmore	2·70	93	„	Darrynane Abbey	3·08	98
Renf	Glasgow, Queen's Pk	1·61	70	*Wat*	Waterford, Gortmore	2·76	105
„	Greenock, Prospect H.	1·73	52	*Tip*	Nenagh, Cas. Lough	2·93	120
Bute	Rothesay, Ardencraig	2·34	...	„	Roscrea, Timoney Park	3·35	...
„	Dougarie Lodge	1·69	...	„	Cashel, Ballinamona	4·41	195
Arg	Ardgour House	4·22	...	*Lim*	Foynes, Coolnanes	3·46	134
„	Glen Etive	3.15	67	„	Castleconnel Rec.	3·18	...
„	Oban	2·51	...	*Clare*	Inagh, Mount Callan	5·40	...
„	Poltalloch	3·53	116	„	Broadford, Hurdlest'n.	3·71	...
„	Inveraray Castle	3·99	101	*Wexf*	Gorey, Courtown Ho.	2·16	89
„	Islay, Eallabus	2·75	105	*Wick*	Rathnew, Clonmannon.	2·95	...
„	Mull, Benmore	8·70	111	*Carl*	Hacketstown Rectory	2·71	97
„	Tiree	...	...	*Leix*	Blandsfort House	4·51	174
Kinr	Loch Leven Sluice	1·05	48	*Offaly*	Birr Castle	2·96	128
Fife	Leuchars Aerodrome	1·56	93	*Dublin*	Dublin, FitzWm. Sq.	3·25	167
Perth	Loch Dhu	2·75	66	„	Balbriggan, Ardgillan	...	...
„	Balquhidder, Stronvar.	...	...	*Meath.*	Beauparc, St. Cloud	4·68	...
„	Crieff, Strathearn Hyd.	1·87	71	„	Kells, Headfort	4·62	174
„	Blair Castle Gardens	1·60	81	*W.M*	Moate, Coolatore	3·63	...
Angus.	Kettins School	1·89	91	„	Mullingar, Belvedere	5·14	197
„	Pearsie House	1·89	...	*Long*	Castle Forbes Gdns	3·19	124
„	Montrose, Sunnyside	1·31	79	*Gal*	Galway, Grammar Sch.	3·58	...
Aber	Braemar, Bank	·97	50	„	Ballynahinch Castle	3·71	105
„	Logie Coldstone Sch.	1·49	76	„	Ahascragh, Clonbrock.	2·89	103
„	Aberdeen, Observatory.	·84	49	*Mayo.*	Blacksod Point	2·11	76
„	Fyvie Castle	1·30	62	„	Mallaranny	4·08	...
Moray	Gordon Castle	1·52	74	„	Westport House	2·13	79
„	Grantown-on-Spey	1·02	45	„	Delphi Lodge	4·23	74
Nairn.	Nairn	1·01	57	*Sligo*	Markree Castle	5·23	178
Inv's	Ben Alder Lodge	...	...	*Cavan.*	Crossdoney, Kevit Cas.	3·46	...
„	Kingussie, The Birches.	1·36	...	*Ferm*	Newtwnbtlr, Crom Cas.	3·03	112
„	Loch Ness, Foyers	1·24	56	„	Enniskillen, Portora	4·45	...
„	Inverness, Culduthel R.	·95	...	*Arm*	Armagh Obsy	4·41	175
„	Loch Quoich, Loan	2·60	...	*Down.*	Fofanny Reservoir	4·05	...
„	Glenquoich	2·89	57	„	Seaforde	2·12	77
„	Glenleven, Corrour	2·13	63	„	Donaghadee, C. G. Stn.	2·82	121
„	Fort William, Glasdrum	2·54	...	*Antr*	Belfast, Cavehill Rd.	4·94	...
„	Skye, Dunvegan	1·92	...	„	Aldergrove Aerodrome.	3·51	146
„	Barra, Skallary	2·05	...	„	Ballymena, Harryville.	2·43	84
R&C	Alness, Ardross Castle.	1·14	51	*Lon*	Garvagh, Moneydig	1·81	...
„	Ullapool	1·25	53	„	Londonderry, Creggan.	2·94	104
„	Achnashellach	1·63	41	*Tyr*	Omagh, Edenfel	3·49	124
„	Stornoway, Matheson	·93	40	*Don*	Malin Head	1·72	...
Suth	Lairg	1·60	77	„	Killybegs, Rockmount.	2·99	...

Erratum: Birr Castle, May, for 2·50/112 read ·98/44.

Climatological Table for the British Empire, January, 1936

STATIONS.	PRESSURE. Mean of Day M.S.L. (mb.)	PRESSURE. Diff. from Normal. (mb.)	TEMPERATURE. Absolute. Max. (°F.)	TEMPERATURE. Absolute. Min. (°F.)	TEMPERATURE. Mean Values. Max. (°F.)	TEMPERATURE. Mean Values. Min. (°F.)	TEMPERATURE. Mean Values. ½ Max. and Min. (°F.)	TEMPERATURE. Mean Values. Diff. from Normal (°F.)	TEMPERATURE. Mean. Wet Bulb. (°F.)	Relative Humidity. (%)	Mean Cloud Am'nt (0–10)	PRECIPITATION. Am'nt. (in.)	PRECIPITATION. Diff. from Normal. (in.)	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
London, Kew Obsy.	1000·7	−16·9	56	22	45·0	36·7	40·9	+ 2·0	39·0	90	7·8	3·91	+ 2·15	22	1·0	12
Gibraltar	1018·1	− 3·4	67	48	59·3	52·3	55·8	...	53·2	87	7·7	8·19	...	20	...	...
Malta	1016·0	− 1·0	69	49	61·7	53·4	57·5	+ 2·2	52·8	80	6·5	0·89	− 2·32	7	5·8	58
St. Helena	1012·0	− 0·3	71	58	67·6	59·7	63·7	− 0·3	60·2	92	9·8	2·93	+ 0·89	17	...	...
Freetown, Sierra Leone	1011·9	+ 2·8	89	68	86·3	73·5	79·9	− 1·4	74·7	82	5·0	0·00	− 0·41	0	...	...
Lagos, Nigeria	1010·1	+ 0·5	90	71	87·4	75·2	81·3	+ 0·4	75·2	90	3·5	0·93	− 0·11	2	6·0	51
Kaduna, Nigeria	1010·1	− 1·8	93	49	89·0	55·8	72·4	− 1·0	52·1	35	1·0	0·00	0·00	0	8·9	77
Zomba, Nyasaland	1007·4	0·0	90	50	80·8	62·8	71·8	− 1·0	70·0	81	7·6	5·31	− 5·79	15	...	...
Salisbury, Rhodesia	1009·1	− 1·3	86	47	79·7	59·1	69·4	− 0·3	62·3	65	7·0	5·22	− 2·10	16	6·4	49
Cape Town	1014·5	+ 1·1	87	51	75·6	58·2	66·9	− 3·0	59·1	69	3·3	2·13	+ 1·45	9	...	...
Johannesburg	1009·3	− 0·2	87	42	77·4	56·2	66·8	+ 0·1	57·5	63	5·0	3·94	− 2·23	11	8·3	61
Mauritius	1011·2	− 0·7	89	69	86·0	73·6	79·8	+ 0·5	75·9	76	5·6	9·81	+ 2·05	24	8·4	64
Calcutta, Alipore Obsy.	1014·8	− 0·4	83	50	79·0	56·0	67·5	+ 0·9	55·3	75	2·2	0·43	+ 0·01	1*	...	...
Bombay	1013·0	− 0·6	87	60	81·2	66·2	73·7	− 1·8	64·5	72	1·3	0·00	− 0·10	0*	...	...
Madras	1013·0	− 1·1	90	65	85·0	68·9	76·9	+ 0·7	71·7	86	3·6	0·10	− 1·04	0*	...	...
Colombo, Ceylon	1011·5	+ 0·7	88	67	85·4	71·1	78·3	− 1·2	72·4	72	5·5	2·52	− 0·73	3	7·7	65
Singapore	1009·6	− 0·8	89	72	85·2	74·5	79·9	+ 0·2	75·5	83	7·9	6·22	− 3·67	19	4·3	36
Hongkong	1020·1	+ 0·4	69	45	63·2	53·7	58·5	− 1·7	53·0	72	6·8	0·58	− 0·74	6	5·7	53
Sandakan	1009·9	...	88	72	85·4	73·8	79·6	− 0·2	76·1	85	9·0	15·37	− 4·03	21	...	...
Sydney, N.S.W.	1012.2	− 0·2	99	57	75·8	65·3	70·5	− 1·1	65·8	72	7·4	4·48	+ 0·81	16	5·9	42
Melbourne	1012·1	− 0·8	106	50	79·6	58·6	69·1	+ 1·7	61·1	59	6·7	1·30	− 0·59	11	6·9	48
Adelaide	1011·8	− 1·2	104	51	84·3	62·5	73·4	− 0·5	62·7	49	5·7	1·45	+ 0·73	8	8·6	61
Perth, W. Australia	1011·0	− 1·5	105	56	83·2	63·7	73·5	− 0·3	63·1	55	5·0	0·26	− 0·08	6	10·1	83
Coolgardie	1009·1	− 2·4	107	60	92·5	69·2	80·9	+ 3·5	67·0	62	2·2	1·63	+ 1·17	5	...	...
Brisbane	1011·7	+ 0·4	97	62	83·6	67·8	75·7	− 1·5	69·4	71	6·4	5·73	− 0·72	15	7·5	55
Hobart, Tasmania	1012·9	+ 2·6	88	45	70·0	54·3	62·1	+ 0·1	54·9	61	7·4	0·65	− 1·18	10	6·4	43
Wellington, N.Z.	1012·7	− 0·6	76	47	68·2	55·5	61·9	− 0·6	58·5	73	6·3	3·34	+ 0·01	8	7·5	51
Suva, Fiji	1007·9	+ 0·4	92	70	86·6	75·6	81·1	+ 1·2	76·3	83	7·2	9·38	− 2·05	21	6·2	47
Apia, Samoa	1006·4	− 1·5	89	73	85·8	75·7	80·7	+ 1·7	77·2	82	7·3	14·78	− 2·27	25	5·3	41
Kingston, Jamaica	1013·7	− 1·4	88	66	85·8	68·5	77·1	+ 0·3	66·2	83	2·7	0·66	− 0·30	4	5·5	49
Grenada, W.I.	1011·0	− 1·8	89	76	85	72	78·5	+ 1·4	74	79	4	5·35	+ 0·97	21	...	...
Toronto	1014·8	− 3·1	41	− 2	27·8	17·0	22·4	+ 0·2	...	...	8·0	0·93	− 1·86	4	1·8	19
Winnipeg	1022·7	+ 1·8	21	−43	−3·1	−23·2	−13·1	− 9·2	...	...	4·0	1·07	+ 0·16	11	2·4	28
St. John, N.B.	1009·6	− 5·9	49	− 7	28·0	12·5	20·3	+ 1·1	15·3	78	5·9	4·29	− 0·51	7	3·0	33

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