

FIG. 2. CONSTRUCTION OF THE DISC  
AND TUBES.



FIG. 3. A DEEP DEPRESSION CENTRED  
NEAR THE MOUTH OF THE BRISTOL  
CHANNEL.

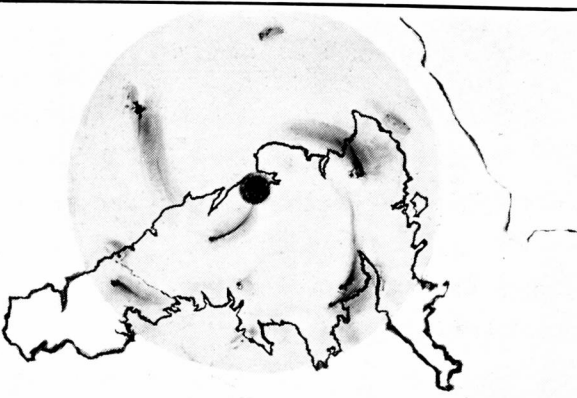


FIG. 4. THE EFFECT OF A CYCLONE  
ON SMOKE MOVEMENT.

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## An Atmospheric Disturbance illustrated by a Working Model

By T. C. ANGUS,

*Department of Industrial Physiology,  
London School of Hygiene and Tropical Medicine.*

It has recently been the writer's task to give instruction in the elements of climate and meteorology to students whose studies are mainly directed in quite different directions. It has been found that to such students the consideration, in a very limited time, of pressure systems in the atmosphere, with their rotational and translational movements, often presents some difficulty. Here is described a model in which the movements of the winds over the earth are to some extent imitated by currents of coloured water passing behind a transparent map. It has been found that such a model presents in a few minutes and in an entertaining manner ideas which would otherwise require a somewhat difficult and lengthy explanation.

A glass tank (shown in plan, Fig. 1) bears on its outer surface (A—A), facing the audience, a sketch map of some part of the world drawn plainly in Indian ink. A "cyclonic depression," passing over land and sea, is represented by a white enamelled metal disc, (D), 9 inches in diameter, placed in clear water against the side of the tank and held with its face within  $\frac{1}{4}$  inch of the inside surface. The centre of the disc is pierced by a hole  $\frac{3}{4}$  inch in diameter over the further side of which is attached the

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slightly coned end of a metal tube, (B). This tube, being bent at right angles just behind the entrance, passes up out of the water in the tank and forms a handle by which the whole system can be moved across behind the map traced on the glass. Near the periphery of the disc are six equally spaced bent tubes, all the ends of which are pressed so as to form flattened jets. These jets (when we are considering the Northern Hemisphere) all point in an anti-clockwise direction, while they incline towards the centre of the disc at an angle of 35 degrees from the tangent to the circle from which they start. The jets are formed from composition tubing of the smallest available size and the highest parts of the bends in the jets act as distance pieces to hold the

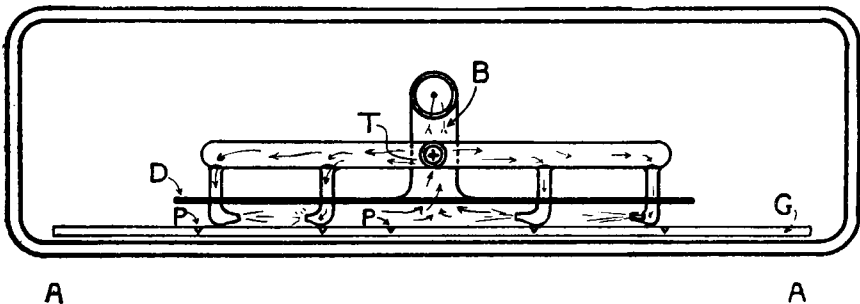


FIG. 1. PLAN DIAGRAM OF THE JETS AND DISC IN POSITION.

metal disc at the correct distance from the glass of the tank. All the jets are fed from a common supply tube, (T), behind the disc and connected to a suitable supply. Fig. 2 shows the construction of this part of the apparatus from behind.

To show a cyclonic depression water is turned on so as to flow gently from the six jets (the whole being, of course, submerged in the water in the glass tank), while a syphon is started from the tube (B), opening into the "centre of the depression," causing a flow of water towards and into this. While this invisible flow is in progress the lecturer, pointing to the "depression centred near the mouth of the Bristol Channel," begins to describe the action of the winds and, at the right moment, releases a small quantity of coloured ink into the supply to the jets by means of a small side tube and a pinch cock. The "winds," with their characteristic spiral movements, at once become visible when the ink emerges from the jets and, slowly rotating anti-clockwise, move to the calm centre of the depression, where they disappear. (Fig. 3.)

It is quite an easy matter slowly to traverse the "cyclone" across the map in an easterly or north-easterly direction, explaining the onset and progress of stormy weather and its ultimate replacement by the less windy conditions associated with a high barometer.

So far the "winds" have been made visible; to give a picture of the movement and passage of a cyclone: the next step is to

show how in actual fact the passage of the invisible winds of a cyclone affect the visible weather vanes and smoke at fixed points on the earth. To produce "smoke" on the map—from cities and the funnels of steamers—a sheet of glass (G in Fig. 1) is prepared to fit snugly in the tank against the side bearing the map, the disc representing the cyclone being moved back sufficiently far to allow this new sheet of glass to be interposed. This glass sheet is made so as always to fit into the same position and on its inner surface a number of conical pits (P, P), are drilled which come behind points on the map appropriately marked to indicate cities or ships at sea. Into these pits, which are washed by the moving water, crystals of potassium permanganate or acid fuchin are stuck to rubber cement with which the pits have been treated. As soon as the glass plate is lowered into position in the tank these crystals begin to emit fine red lines into the water, which, during the passage of the "depression", clearly show how changes of wind are produced at different places. (Fig. 4.) Thus a depression passing with its centre in the Channel is heralded by south-easterly winds on the coast, whilst one approaching Scotland is announced by south-westerly winds in London, veering to north-west as the weather clears.

There are several imperfections in the model illustrated. The outline map of England is too large for the "depression" and in the small tank available adequate movements of the weather system cannot be reproduced: obvious defects in a rapidly-constructed apparatus put together to see whether a new idea will "work". The success which has attended the use of this preliminary model encourages us to the belief that its principles may be further extended to include an anticyclone, and also possibly to show the formation of "rain fronts"; by supplying inks of different colours at the top and at the bottom of the map showing by their union when drawn into a depression, how the warm, moist winds of the Atlantic meet the cold, dry winds from the north.

Perhaps this short account will encourage others interested in the teaching of meteorology to try elaborations of the methods described.

The writer wishes to express his thanks to Mr. W. R. Luxton, not only for the photography, but for several useful suggestions which have helped to make the apparatus a success.

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## Remarkable Cloud Movement at Leuchars

On November 21st, 1932, a report of nephoscope observations was received from Leuchars, which recorded that cirrus cloud had been seen moving from west and from north-east, both observations showing considerable velocities.

This report gave rise to considerable scepticism, but that the

observations were correctly made and checked is put beyond doubt by the following account given by Mr. R. H. Mathews, who was at that time in charge of the station.

"At 15h., November 21st, 1932, Mr. L. S. Matthews reported to Mr. Plummer that he had just observed cirrus cloud travelling from  $240^\circ$ , and another patch from  $40^\circ$ . Mr. Plummer at once checked the observations and then reported to me. At 16h. on the same day we all three observed that the *same* cloud patches were moving from the same direction as at 15h., and we also saw a sheet of alto-cumulus 2/10, stretching from west to north-west, was moving from  $40^\circ$ . The actual observations are given:—

13h.	alto-cumulus	$250^\circ$	50	secs.*	vv =	7*	
	cirrus	$240^\circ$	44	"	"	= 8	} A rapid speed-up.
15h.	cirrus	$240^\circ$	24	"	"	= 15	
	cirrus	$40^\circ$	20	"	"	= 18	
16h.	cirrus	$240^\circ$	20	"	"	= 18	
	cirrus	$40^\circ$	28	"	"	= 13	
	alto-cumulus	$40^\circ$	30	"	"	= 12	

The apparently strange motion of the  $40^\circ$  cirrus was first noticed because it travelled against the pointer on the nephoscope and therefore the rake had to be rotated."

The clouds were described as being situated in two patches, one to the south (at elevations of  $30^\circ$  and  $35^\circ$  at 15h. and 16h. respectively), the other to the north-west (at  $25^\circ$  and  $20^\circ$  elevation respectively). Both patches were small (about 1/20 of the sky each) and were of similar appearance, resembling that shown in Plate 33 of the "Abridged International Cloud Atlas" (cirrus composed of irregularly arranged filaments, orientated in various directions, they are not arranged in sheets or bands and have no tendency to fuse together into cirro-stratus). That moving from north-east was the one situated to north-west of the station.

The synoptic situation at 7h. on the 21st showed a back-bent occlusion over the north of Scotland, which on the Bergen charts is marked as an upper front, while out on the Atlantic 750 miles from Renfrew there were indications of a warm front with a second warm front following it. At 13h. there was cirrus moving from  $240^\circ$  at Leuchars and from  $340^\circ$  at Renfrew, the latter having a velocity of 120 miles per hour, if at a height of five miles. At that hour there were indications that the warm front had advanced to about  $50^\circ\text{N.}$ ,  $24^\circ\text{W.}$ , but there were no surface indications of how the upper front had moved. At 1h. on the 22nd the warm front was over the west coast of Ireland. There certainly were strong currents in the cirrus level over

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\* In this table the times given are those taken by the cloud to pass from spike to spike on a Besson's Comb Nephoscope: vv is the velocity-height ratio of the cloud.

western Scotland and England, as in addition to the Renfrew observation Sealand gave a north-westerly cirrus movement of 100 miles per hour at 16h. It is noteworthy, too, that at 13h. the alto-cumulus at Leuchars was moving from a westerly direction and at 16h. from a north-easterly, so that at that level, as well as in the cirrus level, there appeared to be a change in direction, though in the alto level it was spread over three hours.

There was a notable rise in temperatures at Duxford above 8,000 feet between 13h. 30m. on the 21st and 8h. 15m. on the 22nd amounting to about  $10^{\circ}\text{F.}$  at 10,000 ft. and  $17^{\circ}$  at 11,500 ft.

Two possible explanations might be given of these remarkable observations (*a*) that the clouds seen at Leuchars were at the same level and that somewhere in the high atmosphere there was a sharp discontinuity of the line squall type, (*b*) that the clouds were at different levels and that there was a great change of velocity with height. To take these in turn, in the former case it is possible that the upper front marked on the Bergen chart was sharply defined in the upper part of the troposphere; but if that were so and it were generating strong winds at that level, there would have been considerable pressure changes and these would tend to be represented at the base of the atmosphere also. But, as is stated above, there was little or no indication of the passage of this upper front. If, however, we suppose that there were two currents in different levels, it is to be presumed that the lower one was from north-east since that was also the direction from which the alto-cumulus cloud was moving. In those circumstances the probability would be that the westerly current above was warm air spreading upwards over the warm front which lay over Ireland the following night. It has been calculated that the slope of this front was of the order of 1 in 130 or 140, and since the front was about 450 miles away at the time of observation, the height of the discontinuity above Leuchars would be about 17,000 feet. It must be recognised that these measurements are very rough, but they at least show that there is a possibility that the warm front was in the neighbourhood of the clouds, though, if this explanation is the true one, it is surprising that the clouds at two different heights formed in different currents should assume so similar a form. It is not out of the question, though it seems improbable, that the lower of the two clouds was due to orography, and if that is so, it is possible that it was cloud of cirroform type, though at a much lower level than is usually associated with cirrus.

Another alternative is that the upper cloud was in fact a stratospheric (Störmer) cloud. In that case, however, it is remarkable that a similar cloud should be in the same position an hour later. Indeed this is a serious difficulty unless we introduce topography into the explanation, for any clouds with

angular velocities such as these had would have travelled out of the observer's range of vision within an hour, yet similar clouds in similar positions were in fact observed after the lapse of an hour.

At this stage it does not seem possible even to hazard a guess at what is the true explanation of these remarkable observations, but it is felt that they are worthy of record in the hope that perhaps some other observer may have some note that may be of assistance in the unravelling of a riddle, which at any rate emphasises with what discrimination and care high cloud observations must be used. As Mr. Mathews has pointed out: "It is our knowledge of cirrus cloud, its formation, height and movement which is much more doubtful" (than the accuracy of the observations) "and in the Leuchars observations in question you have an example of the general doubt concerning these matters."

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[There is another possible explanation which helps to remove some of the difficulties but introduces new ones. Reference should be made to two papers by A. H. R. Goldie\* in which he discusses the effect of wave-motion on the formation of clouds at a surface of discontinuity in the atmosphere. He remarks in Section 3 (c) of the second paper that "increased attention in recent years to nephoscope observations has revealed cases of apparently high velocities in the cirrus level, and if many of these cases are merely the effects of travelling waves and not of actual drift of air, the significance of the observations is entirely altered." The cloud patches described by Mr. Matthews are not of a typical wave pattern—according to the subscript to Plate 33 of the "Abridged International Cloud Atlas" "the irregularly arranged filaments, orientated in various directions are not arranged in sheets or bands"—but it is not altogether impossible that the parts of the cloud utilised in the observations were the result of wave-motion. If then one of the nephoscope observations gave the wave-motion, and the other the air-motion, or if both gave a wave-motion, then there would be no difficulty in the two cloud patches being at the same level. Also if both the high velocities from  $240^{\circ}$  and  $40^{\circ}$  are apparent only, then this would help to explain why the "same" patches of cloud were seen in the same positions after an hour's interval, the sameness arising from the continued wave-motions in those parts of the sky. It seems probable that the moderate velocities observed for alto-cumulus and cirrus at 13h. and perhaps also for alto-cumulus at 16h. may be genuine. If the other high velocities are fallacious, they would correspond to two wave-motions (in different parts of the sky) differing by  $160^{\circ}$  in

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\* *London Q.J.R. Meteor. Soc.* 51, 1925, p. 239. and *Edinburgh Proc. R. Soc.* XLV, 1924-5. Part II, No. 17, p. 213.

direction. Whether this is possible under the circumstances requires a separate investigation. Whatever the complete explanation, there seems to be some case for regarding one or both of the high cirrus velocities as spurious. In conclusion it may be remarked that cinematograph observations of clouds in wave-form would probably yield some useful information on this subject, which is clearly of considerable importance to forecasting.—A. F. CROSSLEY.]

## Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, April 18th, at 49, Cromwell Road, South Kensington, Lt.-Col. E. Gold, D.S.O., F.R.S., President, in the chair.

Mr. E. G. Bilham, B.Sc., gave a short informal talk on the rainfall of the winter half-year, October, 1933 to March, 1934. The talk was illustrated by a map of the rainfall in percentages of normal, which showed that the whole country received less than the normal amount with the exception of part of the north-east coast of England. In the Thames Valley the deficiency exceeded 50 per cent.

*D. Brunt, M.A., B.Sc.—The Possibility of Condensation by Descent of Air.*

From a consideration of the variation with height of the humidity-mixing-ratio it is shown that in the stratosphere condensation can occur in descending air-masses which take up the temperature of their environment. The fact that saturated water vapour produces condensation when expanded adiabatically while other saturated vapours produce condensation when compressed adiabatically, is discussed briefly.

*D. Dewar, B.Sc.—An Investigation of the Statistical Probability of Rain in London.*

The paper gives an account of an investigation of the frequency of rain at Kew, based on hourly tabulations of rainfall from 1872-1921.

Amounts of rain were classified as "heavy", "moderate", "slight", or "no rain", according as the quantity which fell in a 6-hr. interval of the day was 1 mm. or more, between 0.5 and 1 mm., between 0.2 and 0.5 mm., or less than 0.2 mm. The intervals were defined as early morning, forenoon, afternoon and night, each division of the day being taken to cover an interval of 6 hrs. Each month was divided into three periods of approximately 10 days. The probability of rain of a given amount in a given interval of the day during these periods was obtained by dividing the number of occasions on which rain of that amount had fallen by the number of possible occasions.

The results are given in several tables accompanied by discussions of the outstanding features.



A comparison between actual values and figures computed from the average probability shows that the frequency of "heavy" rain in 6-hr. intervals for individual days is distributed approximately according to a chance distribution.

The average probability of rain in a 6-hr. interval is:—

Approximately 1 in 9 for heavy rain.
„ 1 in 20 for moderate rain.
„ 1 in 33 for slight rain.

*Caleb Mills Saville, B.A.—Some rainfall Variations, England and New England (U.S.A.).*

The paper brings out some interesting points of similarity and dissimilarity between the fluctuations of rainfall experienced in England and in New England, in the east of the United States. It is shown that the maximum and minimum rainfall experienced during periods of from one to twelve consecutive months is similar in both localities. Details are given as to the extremes of rainfall recorded at West Hartford (U.S.A.) for periods of from 1 to 120 consecutive months. In this country a run of wet years persisted before the present drought but in New England dry years predominated. This marked inverse relationship is shown to hold from 1868 to 1932 in the case of residual mass curves and from 1838 to 1932 with a somewhat different set of data expressing the rainfall as 5-year means. Probability curves of the frequency of occurrence of means of specified amounts during three consecutive years are also given for both England and New England.

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## Correspondence

To the Editor, *The Meteorological Magazine*.

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### Prediction of Minimum Temperatures at Larkhill

I was much interested by Mr. Andrews' note on the prediction of minimum temperature in your April issue. His results show that the fall of temperature diminishes in amount as the humidity increases. The explanation which naturally suggests itself is that condensation of water vapour supplies part of the heat lost by radiation—and thus reduces the rate of cooling in much the same way as it reduces the vertical lapse-rate in the atmosphere.

Examination of Mr. Andrews' results shows that this cannot be the whole explanation. If it were, we should expect the cooling for 100 per cent. R.H. to diminish as the temperature increases: for a fall of temperature of 1°F. from 70°F. to 69°F. is accompanied by condensation of 3 times as much water vapour as a fall from 40°F. to 39°F. Mr. Andrews' diagram shows, however, that the cooling increases with the temperature: thus at 70°F. R.H. 100 per cent. the cooling is about 16°F., while at 40°F. R.H. 100 per cent. the cooling is only about 11°F. The explanation of this apparent anomaly is not obvious:

it seems probable that it is due, in part at least, to a greater vertical lapse-rate when the temperature is high. This would accelerate the initial cooling.

If the amount of cooling ( $T - M$ ), derived from Mr. Andrews' diagram for relatively calm nights are plotted against the difference between the temperature and the dew point temperature ( $T - D$ ), the resulting points lie on a series of approximately parallel straight lines: and an examination of them leads to a formula connecting  $T - M$  and  $T$  and  $T - D$ . It differs from the formula previously suggested by Pick, in that it allows automatically both for the humidity and the initial temperature. The formula is:—

$$(T - M) = 5.5 + \frac{3}{20} T + \frac{2}{5} (T - D)$$

where  $T$  = 15h. temperature in degrees F.

$M$  = minimum temperature in degrees F.

$D$  = 15h. dew point temperature in degrees F.

It would be interesting to know if the formula applies as it stands to other places than Larkhill (under the conditions of relative calm and clear nights hypothesized), or if the values of the constants depend upon the locality; *e.g.*, does it apply in Egypt and 'Iraq?

It is suggestive that the actual amount of cooling (at 100 per cent. humidity) for a temperature of 40°F. is about 20 per cent. less than that for a temperature of 70°F., while for a black body the loss of heat by radiation at 40°F. is about 25 per cent. less than at 70°F. I was inclined at first to dismiss the idea that the difference in cooling at 70°F. and at 40°F. could be due directly to the difference in the intensity of radiation at these temperatures. But on examining the figures I thought there might be some ground for the idea.

At 70°F. the loss by radiation from the earth's surface is about 9 gram calories per cm.<sup>2</sup> per hour if one assumes that 25 per cent. of the radiation is transmitted freely through the atmosphere. This would amount in 10 hours to 90 gram calories per cm.<sup>2</sup>, which is the heat lost by a layer of air 1,000 feet thick in cooling about 25°F.; it is also equivalent to the cooling required to condense a layer of water about 1.5 mm. thick. If a layer of air 1,000 feet thick, initially saturated, were cooled 25°F. from 70°F. to 45°F., about 3 mm. of water would be condensed. In other words, at 70°F. about one-third of the loss of heat is required to cool the air and two-thirds to condense the water. The loss of 90 gram calories per cm.<sup>2</sup> would suffice to cool by 16°F. a layer of about 500 feet of saturated air at 70°F., with simultaneous condensation of water vapour. This is a point of some interest, as indicating roughly the height to which a fog might be expected to extend at Larkhill, in the course of 10 hours after it began to form at the surface.

If  $T=D$ , the formula given above reduces to  $T-M=5.5 + \frac{3}{20} T$ . If we assumed  $T-M$  directly proportional to the radiation at temperature  $Y$ , we should get:—

$$T-M=8.5 + \frac{T}{14}$$

the constants being determined by the condition  $T-M=11.5$  for  $T=42^{\circ}\text{F}$ . The variation of  $T-M$  with  $T$  in this formula is only about half as rapid as that derived from Andrews' results. Hence, I think there is no escape from the conclusion that some other contributory cause than radiation is operative, such as a higher lapse rate.

E. GOLD.

*April 27th, 1934.*

### **Bush Fires—Smoke Haze Phenomena**

Severe bush fires in Tasmania in January and February resulted in an extraordinary interference with daylight illumination by smoke haze on January 18th and February 9th, giving rise to bizarre effects such as appear to have been outside the range of previous experience.

February 9th was another "Black Friday" in Tasmania. After a period of fine weather since the middle of October broken by an occasional moderate rain, the country had become very dry. Under such conditions the wind and heat associated with certain types of depression quickly sweep bush and grass fires out of control. Outbreaks were severe on the southern slopes of the Derwent Valley, on the west coast and in the north-west and north-east of the State.

The morning was calm and sultry. A strong north-westerly wind rose suddenly at about 11.30 a.m. and reached gale force between 1.30 p.m. and 3.30 p.m. with many gusts of velocities of between 50 and 60 miles per hour. Owing to smoke haze visibility during the day did not exceed 5 miles. Between 3 and 4 p.m. it decreased to 1,000 yards and the light changed to an intense orange tint. Greens showed up in a brilliant hue. Electric lights (ordinarily pale orange) appeared white. The sun, when visible, appeared as a red ball. Between 5.30 p.m. and 6 p.m. a dense pall of smoke enshrouded Hobart, causing great discomfort, particularly to the eyes. Visibility decreased to approximately 50 yards and illumination varied in a marked degree, decreasing at intervals to that of twilight, due, apparently, to the passage of cloud across the sun. In some centres total darkness was reported. A temporary westerly change occurred at about 6 p.m. and conditions improved slightly. Electric lights were visible at 1,000 yards at 9 p.m.

The illumination effects were similar on January 18th, but the day was calm. Burnt leaves from fires some 30 or 40 miles

distant were deposited over the city. The orange character of the light was more intense. On each occasion the maximum phase synchronised with a barometric trough.

The Head Teacher, State School, Campania, about 20 miles north-north-east from Hobart reported:—At 5.45 p.m. it was noted overhead that a vast volume of smoke flowing north-west to south-east was gradually swinging more towards the direction west to east, which confirmed the prediction of a westerly change. When the west to east direction of the flow of the smoke was complete almost total darkness (at 6 p.m.) ensued. A newspaper could not be read out of doors, no letter at all being distinguishable. At 7.30 it became lighter. A man was visible at a distance of 50 feet on the road. At 7.45 a paper could be read outside.

The Observer, Bushy Park, 30 miles north-west of Hobart (in the Derwent Valley) reported:—“By 5.10 p.m. it was quite dark and needed a torch to read instruments. Slowly got light till about 6 p.m., when it was twilight till 8. Thick smoke everywhere. At 4 p.m. colours of flowers in garden appeared different—blue violas were dull red, red cluster roses appeared salmon pink. Yellow appeared dirty white.”

J. C. FOLEY.

*Commonwealth Meteorological Bureau, Hobart, Tasmania. March, 1934.*

### **A Phenomenon accompanying Lightning**

This afternoon this locality was on the edge of a thunderstorm which at one time appeared to spread from north to west and later to withdraw from the west and spread from north-eastwards. In spite of this there was some electrical display close at hand. My wife and I were sitting by the open window looking west and the circumstances of one flash of lightning are, I think, of some interest. We did not see the actual discharge as it was on the other side of the house. The illumination from it was, however, brilliantly white (no rain was falling) and was accompanied by a peculiar sound as if of the noise of something swiftly rushing through the air across the garden from north to south or the swishing of a long whip. This sound was also heard by my wife, who describes it like that of a sudden rush of wind, although there was almost a calm. This was followed almost immediately by a terrific crash of thunder. I learned later that the Methodist Church in Walm Lane, about 100 yards away from here was struck, although happily without serious consequences.

J. E. BELASCO.

6, Blenheim Gardens, N.W.2. April 28th, 1934.

### **Sun Pillar**

A phenomenon of some brilliance was observed at Westcliff on

Good Friday, March 30th. At 18h. 5m. G.M.T. the sun appeared as an orange coloured ball, from which ascended for about  $15^{\circ}$  a well-defined and even column of light of a similar hue.

At the time of the first observation the sun's altitude was approximately  $5^{\circ}$ , and the width of the ascending column of light appeared to be the same as the sun's diameter. By 18h. 18m. the sun had disappeared from view behind distant clouds, leaving a column of orange light which gradually changed to a reddish hue. Fading commenced at 18h. 21m. and the pillar was finally lost to view at 18h. 26m.

During the period of observation the visibility was good, wind direction was east and force 2, and the sky was about five-tenths covered, the greater part by strato-cumulus and the remainder by cirrus.

E. J. HORREX.

*Colombo, 32, Ceylon Road, Westcliff-on-Sea, Essex. April 6th, 1934.*

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## NOTES AND QUERIES

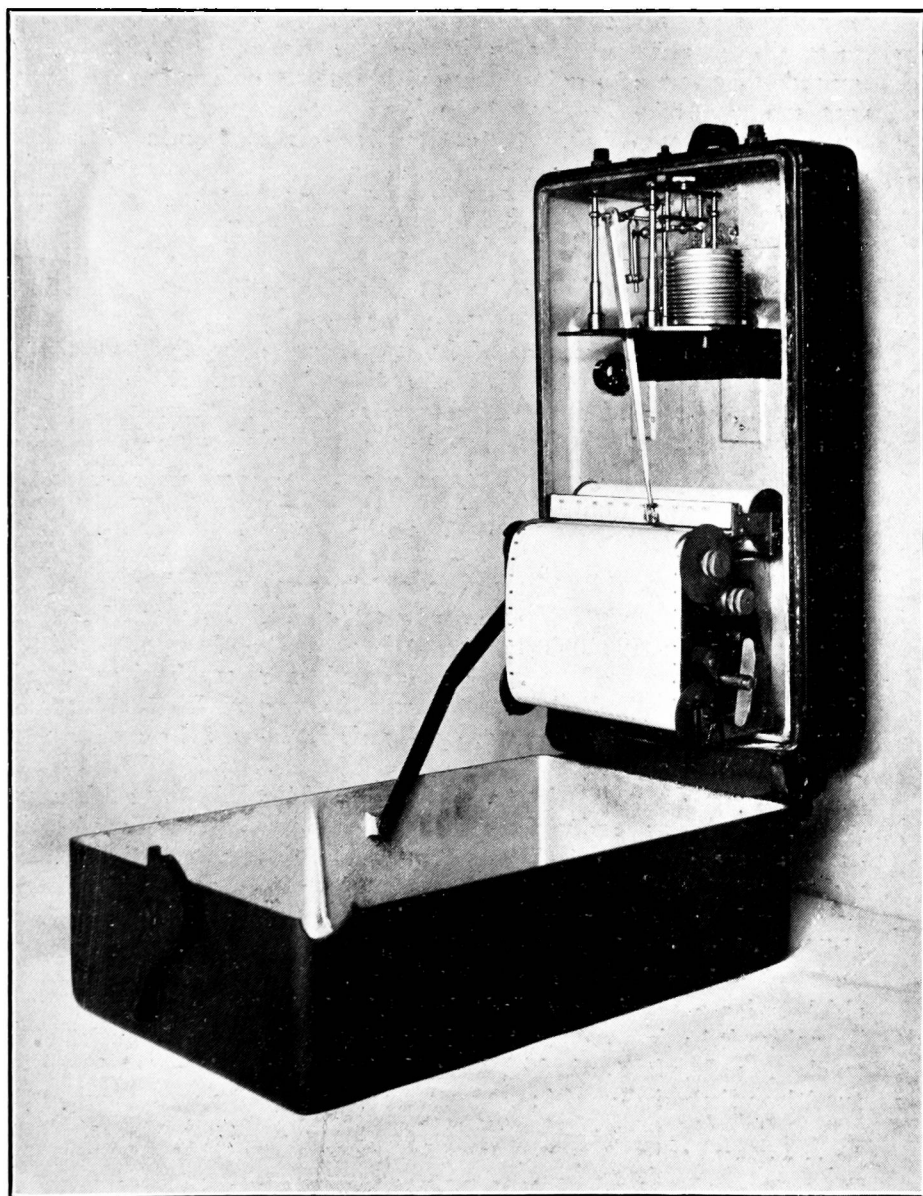
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### A Barograph with Yearly Chart

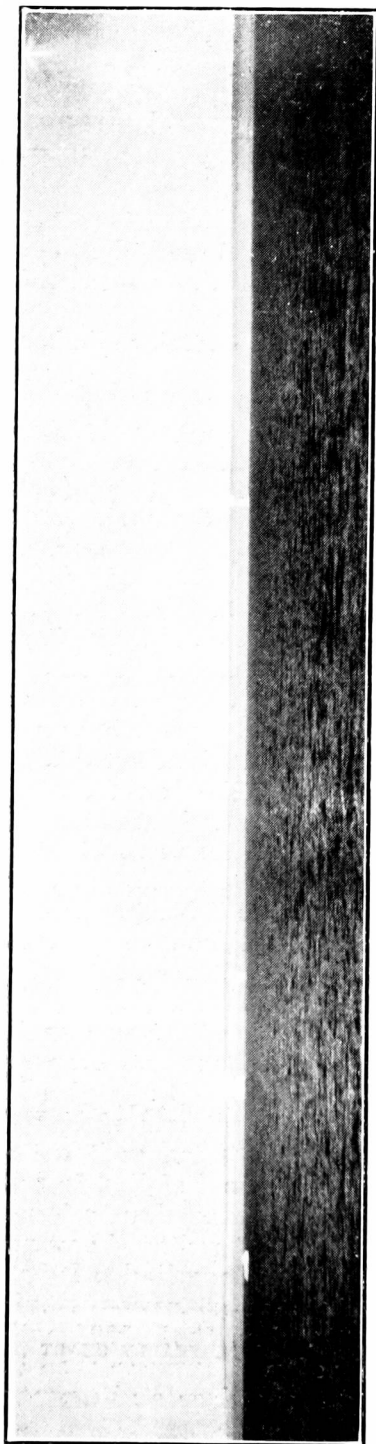
The view has often been expressed that the barograph would be improved if it were constructed so that the line made by the pen, if it moved up and down with the clock stopped, was a straight line and not a curved line. It has also been suggested that a further improvement would be effected if the drum on which the record is made were horizontal instead of vertical. An instrument has been designed to achieve both these purposes, and at the same time to take a chart which is changed only about once a year.

The instrument, which is shown in the accompanying illustration, has been constructed by taking the mechanism from one of Messrs. Short & Mason's well-known open scale barographs and fixing this in a Murday recorder. The Murday recorder, a recorder which is marketed by Messrs. Evershed & Vignoles and used by them with a wide variety of electrical instruments, consists of a strong cast-iron case containing a clock driving a roll type chart, the charts being obtainable either in 70 or 100 feet lengths. The records are usually made with an open time scale of  $\frac{1}{2}$  or 1 inch per hour, but by changing the gear wheels there is no difficulty in reducing the time scale to that normally used on large barographs and other instruments in the Meteorological Office, namely, 30 mm. per 12 hours. With this scale a chart 70 feet long would run for 357 days while a 100 feet chart would need changing only after 510 days.

It will be seen that the aneroid mechanism has been modified by the substitution of a vertical pen arm for the horizontal pen arm usually fitted. On the bottom of the vertical pen arm the



BAROGRAPH WITH YEARLY CHART



REFRACTION AT SEA ON THE WAY TO NAIN, CANADA.

special type of pen used with the Murday recorder is fitted, the movement of the pen over the paper being linear so that a straight line time scale is given.

The instrument has been in operation in the Meteorological Office for some time and has needed no attention apart from winding the clock once a month and inking the pen at even longer intervals.

It may be stated that at the present time the instrument is purely experimental. This description is published because it is felt that a barograph with a chart which only needs changing once in 12 months is a sufficient novelty to be of some interest outside the Meteorological Office.

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### Refraction at Sea

The photograph which is reproduced on the opposite page is a good example of the effect of refraction on icebergs. It was taken from H.M.S. *Challenger* with a long-focus camera in the vicinity of South Wolf Island off the coast of Labrador, and was sent to the Meteorological Office by the Admiralty. Two icebergs are clearly seen both directly and inverted by refraction. The one in the middle of the picture can apparently be seen directly, and twice by refraction, the uppermost image being erect. Another small one further to the left can be seen twice by refraction, although it is not visible directly.

Following are further particulars of the observation :—Date, July 22nd, 1933, 12h. local time. Wind ESE., force 2. Temperature, dry bulb 47°F., wet bulb 46°F., sea 46°F. Relative humidity 92 per cent. Pressure 1018·2mb. Weather fine. Visibility 12 to 18 miles. The camera was directed towards north-north-west. The ship from which the photograph was taken had been in fog for some hours beforehand. This confirms the existence of a surface inversion of temperature, which is a necessary condition for the observation of refraction effects of this type.

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### Hail and Thunder in May

Some time ago discussion arose on the subject of whether the plentiful occurrence of thunder in May is followed by a wet summer and a letter by E. L. Hawke appeared in the *Daily Mail* of May 12th, 1932, stating that thunder in May is not usually followed by a wet summer. I have been prompted to investigate the matter in the records at Grayshott during the 34 years 1900-33.

The three months June, July and August have been taken as constituting summer, and the elements considered in this summer period are temperature, sunshine, rainfall and days of rain.



Mean values of the number of days in May on which thunder or hail occurred were worked out.

TABLE I.

	Temperature.		Sunshine.		Rainfall.		Raindays.	
	Above aver.	Below aver.	Above aver.	Below aver.	Above aver.	Below aver.	Above aver.	Below aver.
Years with hail								
above average (10)	6	4	5	5	6	4	6	4
Years with hail								
below average (24)	11	13	11	13	16	8	10	14

Table I gives the variation of the four elements above or below the mean, according as the hail in the previous May was above or below the mean.

Table II gives similar data, depending this time on thunder in May.

TABLE II.

	Temperature.		Sunshine.		Rainfall.		Raindays.	
	Above aver.	Below aver.	Above aver.	Below aver.	Above aver.	Below aver.	Above aver.	Below aver.
Years with thunder								
above average (16)	8	8	9	7	7	9	7	9
Years with thunder								
below average (18)	10	8	8	10	6	12	6	12

These tables throw little light on the question raised by Mr. Hawke, but it is significant that years deficient in hail in May seem frequently to be followed by wet summers; however, this is not true of days of rain, and it is likely that the rain in these wet summers is provided by isolated heavy falls of thundery type. Deficiency of thunder in May seems from Table II to be followed by a dry summer.

So far the elements have been treated separately. An attempt has now been made to correlate hail and thunder in May with what constitutes to the public mind a "good" summer and a "poor" summer. A "good" summer has been defined as one in which temperature and sunshine have both been above normal and rainfall and raindays below normal. In the period considered 13 summers satisfied these conditions and have been termed "good" summers. Conversely, the nine poor summers in the period all gave temperature and sunshine below normal and rainfall and raindays above normal.

From Table III it is seen that excess of thunder in May is followed more often than not by a good summer; the same is true for deficiency of hail in May. The converse does not hold; deficiency of thunder and excess of hail in May tend to be followed by "average" rather than "poor" summers.

It is to be noted that hail and thunder in May have been considered separately. However, on five of the occasions of "good" summers, including 1911, 1921 and 1933, excess of thunder and deficiency of hail have occurred together in the same May. This is not a common event in a spring month. Actually the correla-

tion coefficient between hail and thunder in May was found to be + 0.35.

TABLE III.

May weather	Good summers following	Poor summers following
Excess thunder	8	6
Deficient thunder	5	3
Excess hail ..	3	3
Deficient hail ..	10	6

In summarising, we can say that excess of thunder in May, especially if in conjunction with deficiency of hail, is likely to be followed by a "good" summer. This supports to some extent the statement of Mr. Hawke that thunder in May does not necessarily predict a wet summer. Deficiency of hail alone appears to predict a wet summer and deficiency of thunder a dry summer. However, none of these results can be used for attempts at prediction. Correlation coefficients between hail in May and thunder in May and rain in the following summer are quite insignificant.

S. E. ASHMORE.

### Microbarograph Oscillations

In a review in the *Meteorological Magazine*, Vol. 68, 1933, p. 293, on the influence of topography on the microbarometric observations (*Geophys. Mag.* Tokyo 7, 1933), Durst remarks that "in Japan the microbarograph may, under suitable conditions, be of considerable use in detecting the arrival of a front, especially above a mountain station, and it is not unnatural to ask whether the instrument could not be used in this way in the British Isles." In the *Meteorological Magazine*, Vol. 61, 1926, p. 112, Read attributes the formation of stationary pressure waves at Holyhead as probably due to two surfaces of discontinuity (revealed by inversions and change of wind direction), one between 2,500 and 3,000 ft. and the other about 7,000 ft. He remarks that "the formation of inversions is by no means an infrequent occurrence and one might be led to expect evidence of them on autographic records much more often than appears to be the case."

My recollection of microbarograph traces at home stations is that while waves of very small amplitude are recorded from time to time, the traces are seldom if ever "disturbed," *i.e.*, there are no regular or irregular oscillations in which the variation of pressure reaches values of  $1\frac{1}{2}$  to 2 mb.

In Middle East area oscillations of this magnitude are recorded

with considerable frequency during the winter months. A very good case is illustrated in the *Meteorological Magazine*, 1928, p. 59, and it seems natural to conclude that if microbarograph traces are of any assistance in locating fronts and so aiding forecasting, they would be of great use in Middle East area. Actually, however, this does not appear to be the case. Examination of the records shows that "disturbed" traces on a microbarograph occur several hours after the passage of a cold front or occlusion. No good case has yet been found several hours ahead of the passage of a warm front, which is rather surprising, and presumably implies that the depressions which cross Egypt have no real warm sectors, the E.-SE. wind in front being as warm as the S.-SW. in what would normally be regarded as the warm sector.

It is obvious then that as oscillations most frequently occur after the arrival of a cold front their value from a forecasting

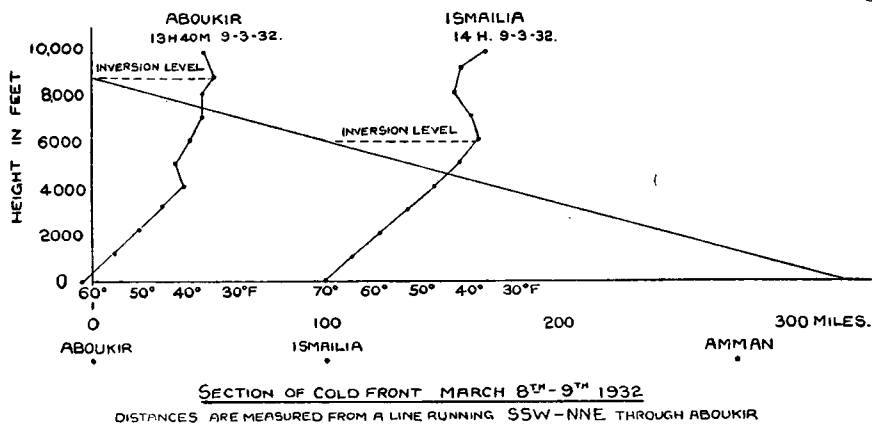


FIGURE 1

point of view is very little. All that they give is an indication of the depth of the cold air over the station because the oscillations seem to commence when the depth of cold air lies between certain limits. In the example described below the oscillations commenced when the depth was about 2,000 feet and ceased when the depth was 5,000 feet.

An example of "disturbed" microbarograph traces at stations in Egypt and Palestine occurred on March 8th and 9th, 1932, and as a good deal of data is available for this particular case it may be of interest to describe it in some detail. A cold front passed over Egypt and Palestine as follows:—

Station.	Time of Passage (G.M.T.).
Aboukir ... ..	8h. 50m., March 8th, 1932
Heliopolis ... ..	14h. 45m., " " "
Ismailia ... ..	16h. 5m., " " "
Ramleh ... ..	22h. " " "
Amman ... ..	1h. " 9th, "

The front was orientated south-south-west to north-north-east and its speed to east-south-east was about 15 m.p.h.

Upper air temperatures are available at Aboukir and Ismailia between 13h. and 14h. G.M.T. on March 9th (see Fig. 1). At Aboukir an inversion is shown about 9,000 feet and at Ismailia about 6,000 feet. These inversions presumably occurred at the cold front. If the angle of slope is determined for these two observations, the surface of discontinuity is found to be at ground level about 70 miles east of Amman in reasonable agreement with the passage of the front at Amman at about 1h. G.M.T. March 9th.

About seven hours after the cold front passed Aboukir, Heliopolis, Ismailia and Ramleh the trace on the microbarograph

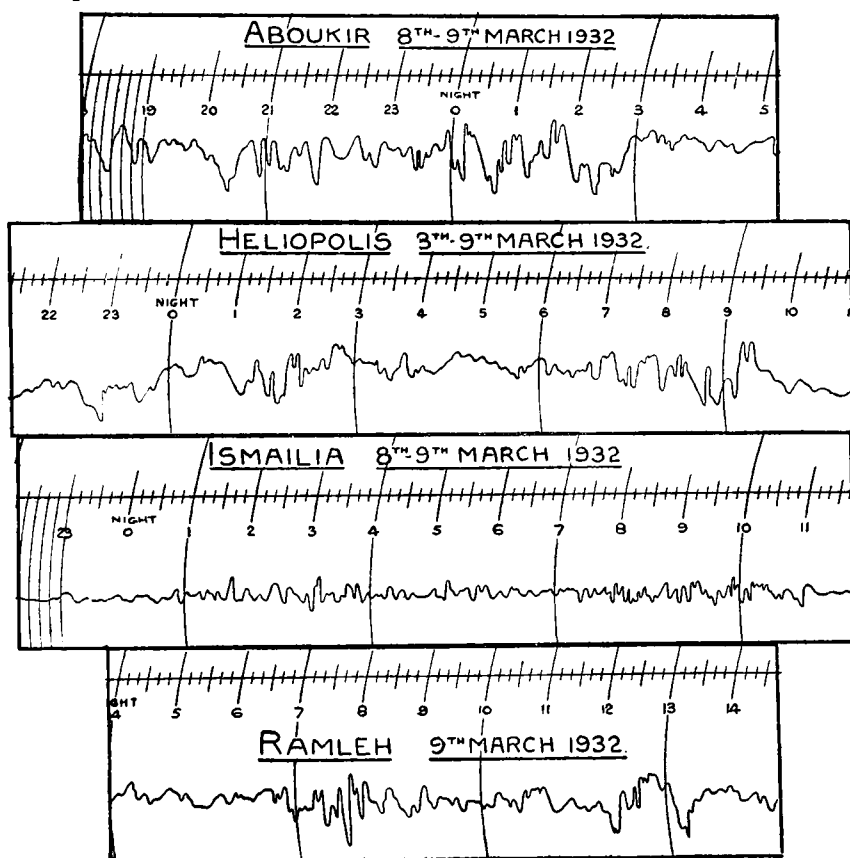


FIG. 2.

became very disturbed and continued so for about ten hours. The traces from these stations are reproduced in Fig. 2; the instrument at Amman was unfortunately out of action at this time. The height of the discontinuity at this time over the station may be determined as follows. At Aboukir the height was about 9,000 feet 29 hours after the passage of the front and at

Ismailia 6,000 feet 22 hours after. The height 7 to 17 hours after the passage of the cold front is therefore approximately 2,200-5,300 feet at Aboukir and 1,900-4,700 feet at Ismailia. Roughly then in this case a wave motion set up at a surface 2,000-5,000 feet above the ground was recorded on a micro-barograph.

Additional data for determining the heights of the discontinuity can also be obtained from pilot balloon observations.

At Heliopolis at 5h. G.M.T. on March 9th, 1932, the following upper winds were measured :—

1,000 ft.	297°	25 m.p.h.
2,000 „	301°	25 „
3,000 „	295°	23 „
4,000 „	273°	21 „
5,000 „	255°	22 „
6,000 „	262°	31 „

the height of the discontinuity at this time calculated from temperature considerations was 4,275 feet and the winds show a change from about 295° 23 m.p.h. through a transitional layer to 255° 22 m.p.h. at 5,000 feet. Wind changes at Ismailia at 8h. 45m. G.M.T. were almost exactly similar.

A point which invites comment is the rather sudden appearance and disappearance of the oscillations. The theory of Goldie indicates that the oscillation should be in evidence at the surface when the wave length ( $\lambda$ ) is large compared with the height ( $h$ ) of the discontinuity on which the wave motion originates, but there is nothing to indicate that the relation between “ $\lambda$ ” and “ $h$ ” is such that the wave motion commences and ceases suddenly.

J. DURWARD.

### The Effect of Tapping a Kew Barometer before Reading

On all certificates of examination of Kew pattern barometers issued by the National Physical Laboratory, the following note occurs :—

In order to obtain the highest accuracy from this instrument, it is advisable to tap both the cistern and the brass tube before taking a reading.

The question of lag in a Kew barometer has been extensively investigated at the National Physical Laboratory, as explained in the article on “Barometers and Manometers,” Dictionary of Physics, Volume III, pp. 158-63. The lag depends on the variations in the accommodation of the menisci in the cistern and in the tube. On page 160 the following passage occurs: “In a given barometer tube the average variation of the angle of contact from its mean value was found to be  $\pm 8^\circ$ . This does

not include variation with age, but represents variations dependent on the position and cleanness of the mercury in the tube, and also to some extent on the rising or falling condition of the meniscus." On page 162, we have also the following: "It should be remarked that during an increase of pressure the tendency of a Kew barometer to read low is twofold, i.e., the flattening of the cistern meniscus consequent upon mercury flowing into the barometer tube operates in the same direction as the bulging of the meniscus in the tube, due to increase of pressure. Unless the barometer is tapped there will undoubtedly be an appreciable difference between its rising and falling indications. Tapping very nearly eliminates this difference in the case of Kew barometers with unconstricted tubes."

No quantitative results for a Kew barometer are given in the article quoted above and it was felt that figures obtained from a station Kew pattern barometer would be of general interest. When the standard Fortin barometer was returned to Eskdalemuir from Casella after repair in July, 1932, an overlapping comparison was made with the Kew pattern barometer then in use as standard, prior to the Fortin barometer being reintroduced as standard. Advantage was also taken of the opportunity to test the effect of tapping the Kew barometer before reading.

The experiments were carried out in October and November, 1932, and rather more than 300 readings were taken under the following conditions:—

(1) The two barometers were read six times a day at 7, 9, 13, 15, 18 and 21h.

(2) One observer took all the readings for a week, each man taking a week in rotation.

(3) On alternate days the Kew barometer was tapped before reading. On the other days it was not tapped.

(4) A note of the barometric tendency was made at the time of observation.

The mean differences from all the readings are:—

	<i>Kew-Fortin.</i>
Kew barometer tapped ... ..	+ 0.096 mb.
Kew barometer not tapped ... ..	+ 0.04 mb.

Thus the Kew barometer reads slightly higher than the Fortin and the mean effect of tapping the Kew barometer is to increase the difference between the two by 0.056 mb.

The differences were then analysed according as the barometer was rising, steady or falling, and the following summary shows the effect of the barometric tendency on the magnitude of the changes due to tapping. The figures in brackets denote the number of readings:—

<i>Difference (Kew-Fortin).</i>			
	<i>Bar. rising.</i>	<i>Bar. steady.</i>	<i>Bar. falling.</i>
Kew barometer tapped ...	+0·08 (41)	+0·09 (94)	+0·13 (30)
Kew barometer not tapped	-0·02 (34)	+0·06 (90)	+0·09 (15)
Difference (tapped—not tapped) ... ..	+0·10 mb.	+0·03 mb.	+0·04 mb.

Thus, as may be expected, the Kew barometer lags behind the Fortin, the difference being greater when the barometer is rising than when it is falling. This may be accounted for by the meniscus of the mercury in the Kew barometer tending to flatten-out when the barometer is falling fairly rapidly. For marine barometers under laboratory tests the difference between rising and falling indications varies from 0·34 mb. to 0·17 mb. for ordinary changes of barometric pressure (*loc. cit.*). The effect of tapping the Fortin barometer before reading was not investigated. The bore of the tube of the Fortin barometer is 1 in. and it was assumed that the variations in the shape of the meniscus of the mercury in such a tube would be negligibly small. (*Cf.*, p. 162; *loc. cit.*). In any case, the effect of adjusting the level of the mercury in the cistern to the fiducial point will answer the same purpose as tapping, by disturbing the menisci in the cistern and tube, thus ensuring that the normal stable shape is produced before a reading is taken.

R. E. WATSON.

### Cold Spell in Egypt, February, 1934

The Report on the weather of Egypt for February, 1934, states that :—

“ From the 8th until the end of the month Egypt was almost continuously under the effect of low pressure over the eastern Mediterranean, and a prolonged spell of abnormally cold weather was experienced.

“ On the 10th the depression over Cyprus deepened, and the weather became very unsettled and rainy for three days. At Alexandria the wind velocity at one time reached 90 kilometres an hour, and maintained gale force for 15 hours; conditions over the eastern Mediterranean were very rough. A current of cold air from the Black Sea reaching Egypt on the 10th eventually traversed the Sudan to the extreme south.

“ The weather improved on the 12th, but two days later a depression moved from Asia Minor to Cyprus and deepened. Very severe cold was prevailing at this time in the Balkans, and on the 15th northerly winds arriving from this region struck western Egypt, resulting in remarkably cold weather conditions along the coast. At Salum the temperature fell to freezing point (an extremely rare phenomenon for coastal localities in Egypt),

and sleet and snow fell more or less continuously during the morning. The ground was covered, in some places about an inch deep, and the western and north-western walls of buildings were covered with snow, which remained for some hours. During this blizzard the wind velocity rose to 90 kilometres (56 miles) an hour. Freezing point was reached also on the following night. At Mersa Matruh the temperature did not exceed  $4^{\circ}\text{C}$ . throughout the day, and fell to  $2^{\circ}\text{C}$ . during the night. At Alexandria the minimum temperature was  $2.8^{\circ}\text{C}$ . ( $37.0^{\circ}\text{F}$ .)—the lowest on record there since 1888 at least. Heavy rain and hail fell along the coast, the largest amount recorded being 28 mm. (1.10 in.) at Matruh and in many localities severe sandstorms occurred, seriously affecting transport. The cold wave crossed Egypt rapidly, and in the early morning of the 17th the temperature fell to freezing point at many places in the Delta and the Fayum, and even at Qena in Upper Egypt, while in the oases of Baharia, Dakhla and Kharga, temperatures of  $3^{\circ}$ ,  $2^{\circ}$  and  $4^{\circ}\text{C}$ . below freezing point were registered. In the Sudan the temperature fell to  $9^{\circ}$  or  $10^{\circ}\text{C}$ . below the normal.

“Subsequently the cold became less pronounced, but on the 23rd, following the passage of a depression along the Mediterranean to ‘Iraq, winds from Asia Minor again brought a sharp fall in temperature in Egypt, and the cold weather continued with gradually diminishing intensity until the end of the month.”

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### Royal Society of Arts

On April 13th, Mr. J. H. Field, C.S.I., late Director-General of Observatories, India, read a paper on “The Meteorology of India” before the Indian Section of the Royal Society of Arts. The Chair was taken by Dr. G. C. Simpson, C.B., F.R.S. Mr. Field described recent meteorological work in India—the application of seismographs to the forecasting of cyclones, the investigation of the free air at moderate heights, the dangers, especially from turbulent currents, when flying among the mountains, and the possibilities of motorless soaring and gliding in India. Finally he referred to the part played by meteorologists in India in the investigation of the stratosphere and the general circulation of the atmosphere in the tropics.

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### Review

*India Meteorological Department, Scientific Notes, Vol. V, No. 54—A Note on fog and haze at Poona during the cold season.* By L. A. Ramdas, M.A., Ph.D., and S. Atmanathan, M.A., 1933.

From the top of the meteorological tower (120 feet) at Poona,



the authors made observations on the development of fog and haze over the city. During the cool months it was found that the dust raised into the atmosphere during the day began to settle in the evening into a definite haze layer which persisted until sunrise. The variations in height and thickness of this layer at night were observed and in the Note are discussed briefly with reference to temperature and humidity; also the nocturnal variation of turbulence is deduced. Finally, a description is included of the effect of a katabatic wind on the haze layer; on one occasion the upper surface of the layer was seen to develop into a wave form. The paper opens an important subject which is clearly capable of further detailed investigation, both practically and theoretically, and the results of further study by the authors will be awaited with interest.

A. F. CROSSLEY.

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## Obituary

*Prof. Demetrius Eginitis.*—We regret to learn of the death at Athens on March 14th of Professor Demetrius Eginitis. Prof. Eginitis was born in Athens on July 22nd, 1862. In 1890 he became Director of the National Observatory of Athens, a post which he retained until his death. He was also Professor of Astronomy at the University of Athens, General Secretary and at one time President of the Academy of Athens, and formerly President of the National Geodetic and Geophysical Committee. In 1917 he was appointed Minister of Public Worship and Education. He was the author of numerous publications in the field of meteorology, seismology and astronomy, of which the best known to meteorologists is his great work on the climate of Athens. He originated the network of climatological stations in Greece and published and discussed the observations in the *Annales of the Observatory*, which he founded in 1916 and edited himself. In all these ways he did much to promote the study of meteorology among his countrymen, and his loss will be deeply felt.

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## News in Brief

We learn from Athens that M. P. Roussen has been promoted to the rank of Rear-Admiral, and has retired from the post of Director of the National Meteorological Service of Greece to take up a naval command. He is provisionally succeeded by M. A. Kyriakidis.

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We learn that Dr. P. L. Mercanton has been appointed Director of the Schweizerischen Meteorologischen Zentralanstalt in Zürich on the retirement of Dr. J. Maurer.

## The Weather of April, 1934

Pressure was above normal over northern Canada, the Atlantic coast of North America as far south as Atlantic City and over an area on the Rocky Mountains stretching as far south as Salt Lake City; it was also above normal over the western North Atlantic including Greenland, Europe east of 20°E. and south of 60°N. and southern Italy; the greatest excess was 11.4 mb. off the east coast of Newfoundland. Pressure was below normal over most of the United States, southern and central Canada, Alaska, the eastern North Atlantic and western Europe; the greatest deficits were over the southern British Isles and northern France and north Alaska. Temperature was above normal in Spitsbergen, southern Scandinavia and central Europe, but below normal in northern Scandinavia and Portugal. Rainfall was abundant in Norrland and western Svealand but below normal elsewhere in Sweden and in central Europe.

Over the British Isles the weather of April was generally unsettled; there was excess of precipitation in England and Scotland, and more than twice the average was recorded over a broad belt along the north and east coasts of Scotland and north-east England. Aberdeen had a total of 6.15 in. for the month, being 328 per cent. of the normal and the greatest amount recorded there for April since 1871. Sunshine was deficient except in south-west Ireland. A remarkably warm spell occurred in the middle of the month.

Until the 11th, high pressure over Iceland maintained a drift of air from the north-east across the British Isles with cool weather. Secondaries moved across westwards, causing rain in many districts and snow and sleet in Scotland (heavy locally) and at some stations in the north of England on various days from the 5th to the 10th. Low minimum temperatures were recorded, particularly on the 7th; on the 11th the minimum of 29°F. at Valentia was the lowest recorded there in April since the records began in 1870. Winds were strong locally, reaching gale force on several days at stations in Scotland and in the Orkneys. Sunshine was variable, the 5th was generally the sunniest day, though many places also had good sunshine on the 8th and 9th. On the 12th heavy rain fell in the north of England and in Scotland, Aberdeen had 2.05 in. There was heavy rain in Ireland on the 12th and 13th. From the 13th to the 18th low-pressure systems on the Atlantic caused southerly to south-westerly winds over the country; temperatures rose generally and the 15th and 16th were unusually warm for the time of year in many districts. On the 15th, which was generally the warmest day of the month, high maximum temperatures were recorded, notably 70° at

Manchester, 71° at Hull, 73° at Oxford, 75° at Kew, 78° at Tottenham and 79° at Cambridge. Rain fell on most days during this period in Scotland and Ireland but there was not much in England. On the 18th a depression was centred over Ireland and as it moved eastwards winds became northerly over the British Isles and the weather became cooler. Thunderstorms occurred locally on the 17th-19th and again on the 22nd-26th, being widespread on the 24th. On the 20th, which was sunny in many districts, several stations in the west recorded 12 hours and more of bright sunshine, and Ross-on-Wye recorded 13·3 hours. Nairn had 13 hours on the 21st. Unsettled and rather cool weather continued until nearly the end of the month, but on the 29th and 30th a ridge of high pressure covered the country, giving mainly fine or fair conditions with good sunshine records except in east England and west Scotland. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	117	—40	Liverpool	140	—19
Aberdeen	128	—23	Ross-on-Wye	119	—28
Dublin	136	—26	Falmouth	131	—57
Birr Castle	136	—18	Gorleston	125	—45
Valentia	192	+33	Kew	132	—17

*Miscellaneous notes on weather abroad culled from various sources.*

A warm spell occurred in many parts of Europe about the middle of the month. On the 16th in Germany temperatures above 77°F. were recorded generally except on the coast, 80°F. was recorded at Berlin and 85°F in Upper Rhineland. Strasbourg Observatory recorded 83°F. (28·4°C.), which is the highest temperature recorded in April since the opening of the Observatory in 1891. On the 18th the maximum at Frankfurt was 83°F., which is the highest April temperature recorded there since April 26th, 1862. Abnormally warm weather in Switzerland caused the snow to melt rapidly on the mountains and the rivers were as much swollen as they usually are at the beginning of June. During a thunderstorm in Belgium on the 17th a passenger train near Namur was struck by lightning. (*The Times*, April 17-19th.)

South Africa has had an unusual amount of rain during the last four months; between November 8th, 1933, and March 8th, 1934, 17½ inches was recorded in the Graaff Reinet district. The Molopo River in the Kalahari, which last had water in it 40 years ago, is now in full flood. (*The Times*, April 7th.)

Nearly 14 inches of rain fell on the 19th in Rangoon in one of the heaviest falls in the history of Burma. (*The Times*, April 23rd.)

In Canada the belated spring thaw caused floods as the rivers were still blocked with ice. Navigation opened in the St. Lawrence on the 26th, when a steamer helped by ice breakers reached Montreal. Temperature was above normal over the western half of the United States and over portions of the Atlantic coast, but was below normal in the centre. Precipitation was moderately heavy in the Atlantic States and in portions of the Gulf States, and was scanty generally in the west. *The Times* April 4th, 28th, and *Washington, D.C., U.S. Dept. Agric. Weekly Weather and Crop Bulletin*.

### Daily Readings at Kew Observatory, April, 1934

Date	Pressure, M.S.L. 13h	Wind, Dir., Force 13h	Temp.		Rel. Hum. 13h.	Rain	Sun	REMARKS (see p. 1)
			Min.	Max.				
	mb.		°F	°F	%	in.	hrs.	
1	1016.3	NNE.4	35	50	56	—	3.9	
2	1015.5	NNE.4	41	52	70	—	5.6	
3	1015.9	NNE.4	39	48	63	0.07	0.0	r <sub>o</sub> -r 13h.-15h.
4	1010.0	NNE.3	40	45	87	0.14	0.0	r <sub>o</sub> -r4h.-9h.; 15h.-17h.
5	1002.7	E.4	36	57	30	—	9.2	mist till 10h.
6	1005.0	N.3	40	43	72	—	0.0	
7	1002.1	NE.1	37	49	60	trace	0.3	f 16h.-19h.
8	999.9	Calm	28	52	41	—	3.5	x F to 9h.
9	1004.2	N.3	39	46	60	—	2.4	
10	1006.6	SE.2	32	54	53	0.05	5.5	xF till 10h. r <sub>o</sub> from 19h.
11	998.6	S.4	45	63	67	0.13	0.8	r-r <sub>o</sub> till 8h. & 23h-24h.
12	1007.0	WSW.5	51	55	53	—	4.5	r <sub>o</sub> 7h. & 10h.
13	1018.1	SSW.4	39	60	43	—	10.5	Solar halo 9h. & 15h.
14	1012.7	SW.4	52	60	79	0.01	0.0	r <sub>o</sub> early & 15h.
15	1014.6	S.5	50	75	50	—	6.1	
16	1018.6	SW.2	53	67	67	—	5.7	
17	1009.2	SSW.3	49	65	58	—	10.9	
18	996.3	SW.5	46	52	73	0.11	1.5	pr 8h. pr <sub>o</sub> 12h.30m.
19	1003.8	WNW.3	45	58	55	0.01	7.5	prh <sub>o</sub> 10h.
20	1016.3	W.2	43	57	46	—	11.5	
21	1009.8	SSW.3	43	57	87	0.13	0.8	r <sub>o</sub> morning & evening
22	1004.6	NW.2	44	57	45	—	7.7	
23	1003.9	NW.4	39	55	47	0.07	3.1	r 22h.35m. to 24h.
24	987.9	WNW.2	41	53	60	0.27	5.3	tlhr 11h.; t 15h.20m.
25	996.1	SW.4	39	55	55	0.10	4.7	rr <sub>o</sub> evening [17h.-18h.
26	993.0	SSW.2	43	55	82	0.13	3.9	pr <sub>o</sub> during day; tl
27	1005.1	N.2	43	53	69	0.20	0.6	rf evening
28	1015.0	W.2	44	54	74	0.04	0.4	t 14h. fr <sub>o</sub> evening
29	1019.7	ESE.3	37	61	54	0.01	6.7	F morning
30	1019.3	ENE.4	43	62	65	—	9.1	

### General Rainfall for April, 1934

England and Wales	...	137	} per cent of the average 1881-1915.
Scotland	...	182	
Ireland	...	107	
British Isles	...	<u>142</u>	

**Rainfall: April, 1934: England and Wales.**

Co.	STATION	In.	Per- cent. of Av.	Co.	STATION	In.	Per- cent. of Av.
<i>Lond.</i>	Camden Square .....	2'24	145	<i>Leics.</i>	Thornton Reservoir ...	4'31	253
<i>Sur.</i>	Reigate, Wray Pk. Rd.	2'65	159	„	Belvoir Castle.....	2'41	157
<i>Kent.</i>	Tenterden, Ashenden...	2'57	159	<i>Kut.</i>	Ridlington .....	2'15	137
„	Folkestone, Boro. San.	2'05	...	<i>Lincs.</i>	Boston, Skirbeck .....	1'80	133
„	Eden'bdg., Falconhurst	2'82	151	„	Cranwell Aerodrome ...	2'02	153
„	Sevenoaks, Speldhurst	2'33	...	„	Skegness, Marine Gdns	2'24	167
<i>Sus.</i>	Compton, Compton Ho.	2'35	117	„	Louth, Westgate .....	2'25	135
„	Patching Farm .....	3'41	195	„	Brigg, Wrawby St. ...	2'05	...
„	Eastbourne, Wil. Sq.	2'40	132	<i>Notts.</i>	Workshop, Hodsock ...	2'38	162
„	Heathfield, Barklye ...	2'65	143	<i>Derby.</i>	Derby, L. M. & S. Rly.	2'14	131
<i>Hants.</i>	Ventnor, Roy. Nat. Hos.	2'46	146	„	Buxton, Terr. Slopes	2'57	87
„	Fordingbridge, Oaklands	2'26	123	<i>Ches.</i>	Runcorn, Weston Pt. ...	2'10	121
„	Ovington Rectory .....	2'89	153	<i>Lancs.</i>	Manchester, Whit. Pk.	1'72	90
„	Sherborne St. John ...	1'74	98	„	Stonyhurst College ...	2'19	81
<i>Herts.</i>	Welwyn Garden City...	1'43	98	„	Southport, Hesketh Pk	2'31	125
<i>Bucks.</i>	Slough, Upton .....	1'53	107	„	Lancaster, Greg Obsy.	3'10	138
„	H. Wycombe, Flackwell	1'29	79	<i>Yorks.</i>	Wath-upon-Dearne ...	1'96	124
<i>Oxf.</i>	Oxford, Mag. College...	1'94	126	„	Wakefield, Clarence Pk.	2'37	141
<i>Nor.</i>	Pitsford, Sedgebrook...	...	...	„	Oughtershaw Hall.....	4'51	...
„	Oundle.....	1'66	...	„	Wetherby, Ribston H.	3'15	179
<i>Beds.</i>	Woburn, Exptl. Farm.	1'37	91	„	Hull, Pearson Park ...	1'93	124
<i>Cam.</i>	Cambridge, Bot. Gdns.	...	...	„	Holme-on-Spalding ...	2'14	129
<i>Essex.</i>	Chelmsford, County Lab.	2'06	161	„	West Witton, Ivy Ho.	3'88	180
„	Lexden Hill House ...	2'05	...	„	Felixkirk, Mt. St. John	2'61	156
<i>Suff.</i>	Haughley House.....	2'67	...	„	York, Museum Gdns.	2'39	149
„	Campsea Ashe .....	2'16	153	„	Pickering, Hungate ...	2'47	148
„	Lowestoft Sec. School	1'97	133	„	Scarborough .....	2'39	153
„	Bury St. Ed. Westley H.	2'63	172	„	Middlesbrough .....	2'40	102
<i>Norf.</i>	Wells, Holkham Hall	2'45	191	„	Baldersdale, Hury Res.	3'54	146
<i>Wilts.</i>	Calne, Castleway .....	2'19	118	<i>Durh.</i>	Ushaw College .....	4'54	240
„	Porton, W.D. Exp'l. Stn	1'76	105	<i>Nor.</i>	Newcastle, Town Moor	4'67	285
<i>Dor.</i>	Evershot, Melbury Ho.	3'44	146	„	Bellingham, Highgreen	3'90	180
„	Weymouth, Westham.	1'63	98	„	Lilburn Tower Gdns...	5'20	263
„	Shaftesbury, Abbey Ho.	2'05	96	<i>Cumb.</i>	Carlisle, Scaleby Hall	2'64	135
<i>Devon.</i>	Plymouth, The Hoe ...	2'79	123	„	Borrowdale, Seathwaite	6'50	94
„	Holne, Church Pk. Cott.	5'06	140	„	Borrowdale, Moraine...	6'96	125
„	Teignmouth, Den Gdns.	3'22	161	„	Keswick, High Hill...	4'01	131
„	Cullompton.....	3'44	151	<i>West.</i>	Appleby, Castle Bank	2'71	139
„	Sidmouth, Sidmount...	2'86	134	<i>Mon.</i>	Abergavenny, Larchfd	3'08	121
„	Barnstaple, N. Dev. Ath	2'44	115	<i>Glam.</i>	Ystalyfera, Wern Ho.	4'52	119
„	Dartm'r, Cranmere Pool	6'10	...	„	Cardiff, Ely P. Stn. ...	2'74	108
„	Okehampton, Uplands	4'20	132	„	Treherbert, Tynywaun	6'05	...
<i>Corn.</i>	Redruth, Trewirgie ...	3'80	132	<i>Carm.</i>	Carmarthen, Priory St.	3'55	129
„	Penzance, Morrab Gdn.	3'97	163	<i>Pemb.</i>	Haverfordwest, School	3'17	121
„	St. Austell, Trevarna...	3'63	129	<i>Card.</i>	Aberystwyth .....	2'60	...
<i>Soms.</i>	Chewton Mendip .....	3'37	113	<i>Rad.</i>	Birm W.W. Tyrmynydd	4'74	128
„	Long Ashton .....	2'79	128	<i>Mont.</i>	Lake Vyrnwy.....	3'80	126
„	Street, Millfield.....	2'09	105	<i>Flint.</i>	Sealand Aerodrome ...	1'85	125
<i>Glos.</i>	Blockley .....	2'81	...	<i>Mer.</i>	Dolgelley, Bontddu ...	4'42	121
„	Cirencester, Gwynfa ...	1'91	102	<i>Carn.</i>	Llandudno .....	1'52	90
<i>Hers.</i>	Ross, Birchlea.....	2'11	111	„	Snowdon, L. Llydaw 9	7'95	...
<i>Salop.</i>	Church Stretton.....	3'10	143	<i>Ang.</i>	Holyhead, Salt Island	1'20	58
„	Shifnal, Hatton Grange	2'67	159	„	Lligwy.....	1'69	...
<i>Staffs.</i>	Market Drayt'n, Old Sp.	2'19	127	<i>Isle of Man</i>			
<i>Worc.</i>	Ombersley, Holt Lock	1'63	107		Douglas, Boro' Cem. ...	2'82	114
<i>War.</i>	Alcester, Ragley Hall..	2'92	173	<i>Guernsey</i>			
„	Birmingham, Edgbaston	2'20	126				

**Rainfall: April, 1934: Scotland and Ireland.**

Co.	STATION	In.	Per- cent. of Av.	Co.	STATION	In.	Per- cent. of Av.
<i>Wig</i>	Pt. William, Monreith	2'95	134	<i>Suth</i>	Melvich	6'29	270
	New Luce School	2'41	90		Loch More, Achfary	11'17	230
<i>Kirk</i>	Dalry. Glendarroch	3'46	113	<i>Caith</i>	Wick	5'29	266
	Carsphairn, Shiel	4'90	118	<i>Ork</i>	Deerness	4'27	206
<i>Dumf</i>	Dumfries, Crichton, R.I.	3'30	149	<i>Shet</i>	Lerwick	2'33	102
	Eskdalemuir Obs.	5'09	150	<i>Cork</i>	Caheragh Rectory	3'40	...
<i>Rozb</i>	Bransholm	4'76	252		Dunmanway Rectory	4'27	103
<i>Selk</i>	Ettrick Manse	5'10	146		Cork, University Coll.	3'52	134
<i>Peeb</i>	West Linton	4'53	...		Ballinacurra	3'29	127
<i>Berw</i>	Marchmont House	4'76	236		Mallow, Longueville	4'70	193
<i>E. Lot</i>	North Berwick Res.	2'84	203	<i>Kerry</i>	Valentia Obsy	3'65	99
<i>Midl</i>	Edinburgh, Roy. Obs.	4'06	276		Gearhameen	6'40	111
<i>Lan</i>	Auchtyfardle	1'49	...		Darrynane Abbey	3'40	99
<i>Ayr</i>	Kilmarnock, Kay Pk.	3'07	...	<i>Wat</i>	Waterford, Gortmore	3'36	135
	Girvan, Pinmore	3'00	101	<i>Tip</i>	Nenagh, Cas. Lough	2'36	94
<i>Renf</i>	Glasgow, Queen's Pk.	2'62	133		Roscrea, Timoney Park	1'39	...
	Greenock, Prospect H.	3'58	98		Cashel, Ballinamona	3'47	139
<i>Bute</i>	Rothsay, Ardenraig	3'59	...	<i>Lim</i>	Foynes, Coolnanes	1'85	76
	Dougarie Lodge	4'72	...		Castleconnel Rec.	2'21	...
<i>Arg</i>	Ardgour House	6'92	...	<i>Clare</i>	Inagh, Mount Callan	2'33	...
	Glen Etive	4'84	87		Broadford, Hurdlest'n.	2'13	...
	Oban	2'66	...	<i>Wexf</i>	Gorey, Courtown Ho.	3'02	138
	Poltalloch	3'46	118	<i>Wick</i>	Rathnuew, Clonmannon	2'73	...
	Inveraray Castle	5'70	124	<i>Carl</i>	Hacketstown Rectory	3'57	135
	Islay, Eallabus	3'17	110	<i>Leix</i>	Blandsfort House	2'00	77
	Mull, Benmore	8'30	107		Mountmellick	2'21	...
	Tiree	3'35	136	<i>Offaly</i>	Birr Castle	1'89	88
<i>Kinr</i>	Loch Leven Sluice	5'52	287	<i>Dublin</i>	Dublin, FitzWm. Sq.	2'42	127
<i>Perth</i>	Loch Dhu	6'65	140		Balbriggan, Ardgillan	1'73	87
	Balquhiddel, Stronvar	4'32	...	<i>Meath</i>	Beauparc, St. Cloud	2'66	...
	Crieff, Strathearn Hyd.	4'36	199		Kells, Headfort	2'30	92
	Blair Castle Gardens	2'02	96	<i>W.M.</i>	Moate, Coolatore	1'41	...
<i>Angus</i>	Kettins School	4'81	264		Mullingar, Belvedere	1'95	82
	Pearsie House	4'51	...	<i>Long</i>	Castle Forbes Gdns.	2'37	99
	Montrose, Sunnyside	6'32	347	<i>Gal</i>	Galway, Grammar Sch.	1'86	...
<i>Aber</i>	Braemar, Bank	3'96	167		Ballynahinch Castle	2'71	77
	Logie Coldstone Sch.	6'43	319		Ahascragh, Clonbrock	1'78	70
	Aberdeen, King's Coll.	6'15	328	<i>Mayo</i>	Blacksod Point	2'82	97
	Fyvie Castle	5'75	269		Mallaranny	3'69	...
<i>Moray</i>	Gordon Castle	4'06	232		Westport House	2'33	86
	Grantown-on-Spey	3'49	177		Delphi Lodge	6'20	108
<i>Nairn</i>	Nairn	4'08	272	<i>Sligo</i>	Markree Obsy	2'78	105
<i>Inv's</i>	Ben Alder Lodge	5'37	...	<i>Cavan</i>	Crossdoney, Kevit Cas.	2'70	...
	Kingussie, The Birches	4'42	...	<i>Ferm</i>	Enniskillen, Portora	2'33	...
	Inverness, Culduthel R.	5'06	...	<i>Arm</i>	Armagh Obsy	2'54	121
	Loch Quoich, Loan	7'97	...	<i>Down</i>	Fofanny Reservoir	5'46	...
	Glenquoich	6'78	104		Seaforde	2'29	87
	Arisaig, Faire-na-Sguir	2'30	...		Donaghadee, C. Stn.	2'95	146
	Fort William, Glasdrum	...	...		Banbridge, Milltown	1'89	92
	Skye, Dunvegan	7'48	...	<i>Antr</i>	Belfast, Cavehill Rd.	3'10	...
	Barra, Skallary	3'01	...		Aldergrove Aerodrome	2'49	118
<i>R &amp; C</i>	Alness, Ardrross Castle	6'49	267		Ballymena, Harryville	3'37	128
	Ullapool	5'21	168	<i>Lon</i>	Garvagh, Moneydig	3'11	...
	Achnashellach	6'82	121		Londonderry, Creggan	3'70	144
	Stornoway	3'73	123	<i>Tyr</i>	Omagh, Edenfel	2'43	92
<i>Suth</i>	Lairg	4'96	215	<i>Don</i>	Malin Head	2'58	...
	Tongue	6'61	252		Killybegs, Rockmount	1'69	...

Climatological Table for the British Empire, November, 1933

STATIONS	PRESSURE		TEMPERATURE						PRECIPITATION			BRIGHT SUNSHINE						
	Mean of Day M.S.L.	Diff. from Normal	Absolute		Mean Values			Mean	Relative Humidity %	Mean Cloud Am't 0-10	Am't in.	Diff. from Normal in.	Days	Hours per day	Per- cent- age of possible			
			Max.	Min.	Max.	Min.	1/2 and min.									Diff. from Normal	° F.	° F.
London, Kew Obsy. . .	1013.6	-1.0	56	31	47.5	38.7	43.1	-0.9	40.1	89	7.5	0.94	1.28	10	1.6	18		
Gibraltar. . . . .	1012.8	-5.2	70	44	62.6	49.3	55.9	-4.1	49.5	82	4.6	8.55	2.12	18	..	..		
Malta . . . . .	1013.8	-2.1	77	52	69.2	60.6	64.9	+1.0	59.3	73	6.4	2.95	0.62	11	4.6	45		
St. Helena . . . . .	1012.9	-0.8	65	53	60.5	54.2	57.3	-2.3	55.2	95	9.4	2.08	..	24	..	..		
Freetown, Sierra Leone . .	1012.2	+1.3	89	62	84.4	67.1	75.7	-5.5	75.4	87	7.1	13.12	8.00	19	..	..		
Lagos, Nigeria . . . . .	1009.9	-0.2	89	70	86.7	75.2	80.9	-0.8	76.3	86	7.4	5.31	2.64	16	6.9	59		
Kaduna, Nigeria . . . . .	1010.0	-3.1	96	59	93.8	65.1	79.5	+3.3	70.9	79	3.9	0.22	0.01	2	8.5	73		
Zomba, Nyasaland . . . . .	1004.3	-4.6	93	60	86.5	67.0	76.7	+1.1	66.1	58	5.6	3.81	1.27	8	..	..		
Salisbury, Rhodesia . . . .	1010.6	-1.0	91	54	79.1	60.0	69.5	-1.2	61.8	62	6.5	9.29	5.69	17	5.0	39		
Cape Town. . . . .	1015.0	-0.8	91	52	75.9	58.6	67.3	+2.9	59.3	65	3.0	0.43	0.66	1	..	..		
Johannesburg . . . . .	1012.4	-0.2	80	44	71.8	52.0	61.9	-1.8	55.6	74	6.6	10.90	5.94	20	7.0	52		
Mauritius . . . . .	1017.0	+0.9	86	64	82.4	67.6	75.0	-0.5	68.7	60	6.2	0.46	1.12	18	9.8	75		
Calcutta, Alipore Obsy. . .	1012.8	-0.5	87	60	83.5	65.7	74.6	+1.1	65.7	80	2.0	0.00	0.65	0*	..	..		
Bombay . . . . .	1011.0	-1.0	94	71	90.3	73.9	82.1	+1.5	71.5	71	2.3	0.01	0.44	0*	..	..		
Madras . . . . .	1011.0	-0.3	87	65	84.7	72.4	78.5	-0.4	74.8	87	6.6	5.76	7.85	8*	..	..		
Colombo, Ceylon . . . . .	1010.1	+0.1	89	68	84.2	72.3	78.3	-1.7	75.1	79	5.6	8.72	3.04	16	6.4	54		
Singapore . . . . .	1008.8	-0.6	89	70	85.2	72.4	78.8	-1.8	75.6	83	7.9	9.12	0.79	23	3.3	27		
Hongkong . . . . .	1017.3	-0.3	82	59	75.3	65.3	70.3	+0.7	63.1	64	4.3	4.13	2.39	6	6.8	61		
Sandakan . . . . .	1008.5	..	90	72	88.4	74.6	81.5	+0.6	77.7	83	7.3	11.37	3.35	19	..	..		
Sydney, N.S.W. . . . .	1016.3	+2.5	76	50	69.2	58.6	63.9	-3.1	60.5	72	7.4	4.51	1.69	15	5.9	42		
Melbourne . . . . .	1016.6	+2.2	88	43	72.7	51.2	61.9	+0.6	55.2	63	5.9	2.46	0.23	9	6.8	48		
Adelaide . . . . .	1015.9	+0.7	101	42	78.0	55.5	66.7	-0.3	56.3	39	6.1	0.18	0.97	5	8.6	62		
Perth, W. Australia . . . .	1016.2	+0.8	99	48	80.3	59.1	69.7	+3.6	59.1	45	4.5	0.24	0.56	3	10.4	76		
Coolgardie . . . . .	1015.2	+2.1	100	43	81.4	51.0	67.7	-3.0	56.8	39	3.0	0.96	0.37	3	..	..		
Brisbane . . . . .	1012.7	-1.9	84	58	76.6	63.3	69.9	-3.6	65.1	68	8.5	8.41	4.68	19	5.5	39		
Hobart, Tasmania. . . . .	1018.0	+8.4	80	39	64.5	47.7	56.1	-1.1	51.8	57	6.2	2.04	0.43	10	7.7	53		
Wellington, N.Z. . . . .	1016.9	+4.8	72	35	62.4	47.6	55.0	-1.8	52.5	71	7.1	1.58	1.94	9	7.0	49		
Suva, Fiji . . . . .	1011.1	0.0	90	69	85.4	72.6	79.0	+1.9	74.6	77	6.4	14.76	4.97	23	7.0	54		
Apia, Samoa . . . . .	1009.8	+0.3	88	71	83.1	73.9	79.5	+0.8	76.5	77	5.7	12.63	2.80	20	7.3	57		
Kingston, Jamaica . . . . .	1011.4	-1.0	87	68	84.5	70.4	77.5	-1.8	70.8	92	4.7	6.09	3.06	15	6.7	59		
Grenada, W.I. . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
Toronto . . . . .	1014.2	-3.1	61	7	39.0	24.4	31.7	-5.3	28.6	78	7.4	1.43	1.20	7	3.0	31		
Winnipeg . . . . .	1017.2	-0.2	40	16	25.5	9.5	17.5	-3.8	16.5	83	8.0	0.00	1.07	0	1.7	19		
St. John, N.B. . . . .	1011.2	-3.4	54	9	37.3	22.6	29.9	-6.8	26.3	74	7.5	2.51	1.90	10	3.5	36		
Victoria, B.C. . . . .	1024.2	+8.3	55	36	48.7	43.1	45.9	+1.4	44.6	96	8.6	3.88	1.53	19	1.5	16		

\* For Indian stations a rain day is a day on which 0.1 in. or more rain has fallen.