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Notes on Meteorology and the Navigation of Airships

BY M. A. GIBLETT, M.SC.

1. *The loss of the "Dixmude."*

THE loss of the French airship "Dixmude" last December is to be deplored not only on account of the loss of gallant lives, but because it will inevitably add to the difficulties of the promoters of the Imperial airship service in securing the public confidence and a sympathetic attitude towards airship development, however little the individual case may really bear on the general question. No official report has yet been published, but, from accounts in the press, it seems that the weather is under suspicion, and, accordingly, a description of the meteorological conditions may prove of interest.

It appears that the airship left Toulon at 5 a.m., December 18th, setting out for a long cruise to North Africa. At this time the weather situation was determined by a large anti-cyclone stretching from Iceland to the Azores with an extension over France; pressure was low over central and northern Europe and rather uniform over the western Mediterranean. The next day or two saw the nose of high pressure over France give way and the Mediterranean invaded by a strong, cold wind current pouring through the gap between the Alps and the Pyrenees and sweeping round a depression which developed rapidly over the Adriatic.

Such was the situation when, on the evening of December 20th, the airship last signalled her position not far from Biskra (Algeria).

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A simple acknowledgment of a wireless signal is said to have been obtained at 2 a.m. the next morning but nothing more was heard. The body of the Commander was recovered from the sea off Sciacca, south-west Sicily, some days later, and fragments of charred wreckage were also found in the same region.

The depression had reached its full intensity by the morning of the 21st, when it was centred over southern Italy, and in steering, or perhaps drifting, from the land to the sea off Tunisia, the airship actually passed towards the centre of the disturbance. High winds do not, however, constitute a danger to an airship in the air, but conditions were squally and thundery. The air which entered the Mediterranean was of Arctic origin, and, in a region with a normal sea surface temperature above 60° F., there was a good chance of thunderstorms of the "polar air" type* which are not unusual on the north-west coasts of the British Isles.

It may be assumed that the airship was lost on the 21st, some 150 miles WNW (*i.e.* up-wind) from Malta, and the following observations at Malta probably represent the conditions encountered by the ship.

	18h. to 7h. G.M.T.		At 7h G.M.T.			7h. to 18h. G.M.T.		At 18h. G.M.T.			
Date	Weather	Rain	Temp.	Wind	Weather	Weather	Rain	Temp.	Wind	Weather	Highest Gust
Dec.		mm	°F				mm	°F			m.p.h
20	c	—	57	W3	c	bc	—	57	WSW2	bc	28
21	bcr	2·5	49	WNW4	bc	rtlr th	4·5	45	W3	op	39
22	rtlr th	13·9	46	WNW5	roh	ortlr ts	10·2	45	NNW6	c	46
23	cr	1·0	53	NW'W3	o	bc	—	57	WNW3	c	28

The snow reported was light.

UPPER WINDS

	20th. 17h G.M.T.		21st. 7h G.M.T.		21st. 17h G.M.T.	
		m.p.h.		m.p.h.		m.p.h.
1000 feet	240°	18	270°	45	310°	33
2000 feet	240°	20	270°	53	—	—
3000 feet	250°	17	270°	60	310°	34

Direction is in degrees from North through East.

The "*Daily Telegraph*" of February 1st, stated that the Ministry of Marine had received a report from the Commission of Enquiry. The main contents were given on the authority of the "*Matin*," but as the report has not officially been made public perhaps these should be accepted with reserve. The commission is alleged to have agreed unanimously that the immediate cause of the disaster was that the airship was struck by lightning, and to have found that the meteorological service at the airship base was perfect.

The importance of meteorological factors was discussed from the airship pilot's standpoint by Major G. H. Scott† in 1921. Electrical storms are cited by him as a source of danger to rigid airships, not so much because of lightning as on account of the risk of the violent associated air movement severely stressing the structure. The loss of three balloons in the Gordon Bennett Race last year amply demonstrated the possibility of their being destroyed by lightning, but the event seems to have been rare in the history of ballooning, and, further, airships have been known to have been struck without serious effects. It is to be hoped that some protective device will be invented before long.

2. *Wind and Airship Navigation.*

In Major Scott's paper on *Airship Piloting* he emphasized the point that the pilot should vary his route in accordance with the information which he would receive by wireless telegraphy as to the wind distribution. The present writer was led to consider such problems by a suggestion from Lieut. Col. Gold that Francis Galton's "Isodic Curves,"‡ devised years ago in connection with the choice of the best routes for sailing vessels, might find an application to the new form of travel. A geometrical method was readily found for investigating the quickest route from point to point for an airship cruising with constant air-speed. The method is illustrated by the diagrams. In the inset diagram, A represents the starting point of the airship, AO, the distance the ship would drift with the wind in a small interval, say 2 hours, without the engines running, and OB, the distance the airship would cover in still air if headed in this direction with the chosen cruising speed. Under the combined influence of wind and propellers, the path of the ship

* When cold air is being heated from below, vigorous convection is to be expected, *vide* "On the formation of thunderstorms over the British Isles in Winter," by E. V. Newnham, London Met. Office Professional Notes, No. 29.

† "Airship Piloting" by Major G. H. Scott. *Aeronautical Journal*, February, 1921.

‡ *Report of the British Association for the Advancement of Science*, 1866, Miscellaneous communications to the sections, p. 17; and *Minutes of the Proceedings of the Meteorological Committee*, November 25th, 1872, and December 2nd, 1872.

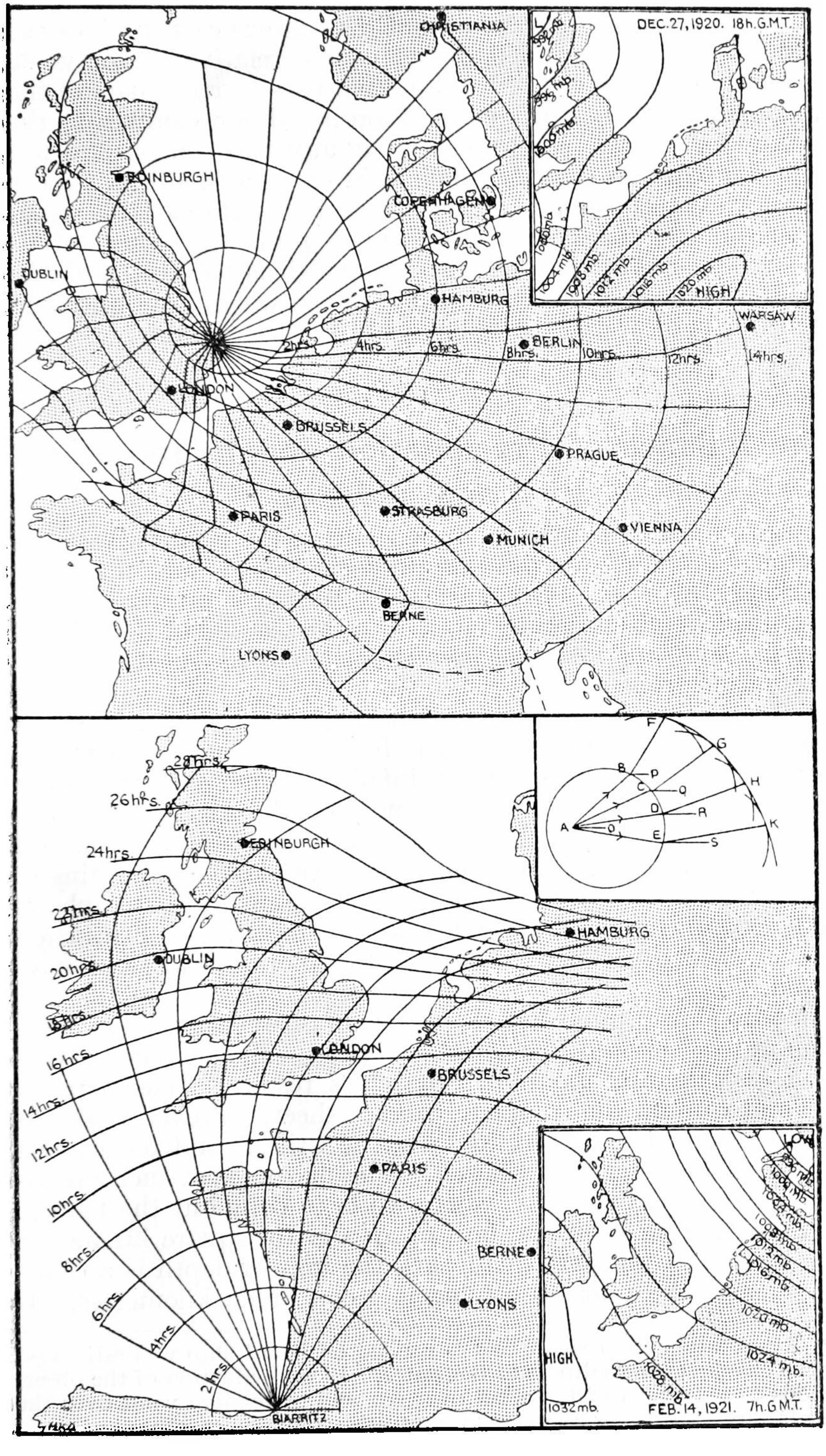
would be AB. Heading in other directions, points C, D, E, etc., could be reached, but not passed, in the given time ; B, C, D, E, etc., lie on a circle with centre O. The construction may be repeated taking each point B, C, D, E, etc., in succession as point of departure of the airship, using the wind velocities appropriate to the new places and time. P, Q, R, S, etc., are the centres of the new circles, which, for a constant air-speed are of equal radius to the first. The outer envelope of these circles is then drawn touching them at F, G, H, K, etc., the resulting curve being one which could be reached from A, but not passed, in the double interval, 4 hours, by the routes ABF, ACG, etc. Any other route would result in a failure to reach the curve in 4 hours. The construction may be repeated again, starting with F, G, H, K, etc., and so on, certain steps being taken to avoid accumulating errors.

The two larger diagrams show the application to particular cases, the airship being supposed to fly with air-speed 50 m.p.h., and at an altitude of 2000 feet so that the wind may be taken as the "geostrophic wind." The first shows a set of "quickest routes" emanating from Pulham (Norfolk), leaving at 7h. G.M.T., December 27th, 1920. The isobaric chart for 18h. G.M.T., December 27th, alone is reproduced, but changes with time were allowed for. With the particular air-speed, Paris could not have been reached under 10 hours, whereas a route could have been found reaching Warsaw in just over 14 hours. The second example shows a set of "quickest routes" leaving Biarritz at 17h. G.M.T., on February 13th, 1921. The bending of the routes on approaching the Scandinavian depression may be noted, the quickest route to Hamburg, 26 hours, passing near London. When the wind is uniform the quickest route from one point to another is the straight one, curvature only arising when there is a change of wind in a horizontal direction (or in time).

The construction is the same as is used when Huyghens's Principle is applied to the advance of a wave-front in a moving medium, so that the mathematical treatment of the propagation of sound in the atmosphere* might find an application in the present connection. The air-speed of the ship is analogous to the speed of sound, the "quickest routes" to sound rays, and the curves reached in given intervals of time to the wave-fronts. But an extension is required for the case of time-variations in the wind distribution which are unimportant in the acoustical problem on account of the relatively great speed of sound.

An "isodic curve" in Galton's work corresponded to the first circle in the above construction, and showed an eight hours run of a sailing vessel in each direction from a given point under average

* *Vide e.g.* E. A. Milne's article on Sound Waves in the Atmosphere in *Phil. Mag.* Vol. xlii., July, 1921, p. 96.



Highways of the Air.

conditions of current and wind, but it was not circular, since the speed of the ship depended on its course relative to the wind. One such curve was constructed in each two-degree square of the chart, and a geometrical method proposed for comparing the time, under average conditions, along any two routes. Such a method might certainly be applied in choosing the best airship route for average conditions, but for regions with variable winds the method we have been discussing is probably better. It is not suggested that the construction, which is tedious, could be done in this form on every occasion, but, if worked out once and for all for typical cases it might yield results of value.

The Balance of Precipitation and Evaporation by Land and Sea

THE first draft of a balance sheet showing the relation between precipitation and evaporation over the globe was made by Brückner[1] in 1905. Brückner used Murray's estimate of the amount of water carried by rivers into the sea and of the rainfall over the land, and made his own estimates of the most probable evaporation from the sea.

In 1906 Fritzsche[2], a pupil of Brückner's, worked over Murray's ground, taking later estimates of the flow of individual rivers, and using Supan's map of the rainfall over the land surfaces in place of Loomis's. From his study of the rivers, Fritzsche adopted 30 per cent. as the fraction of its rainfall that runs off the peripheral land, *i.e.* off the part of the land that drains to the open sea. For the remainder, which we may call aperipheral land, evaporation and rainfall must be equal. In Fritzsche's balance sheet Brückner's estimate of evaporation at sea is preserved.

In 1920 Wüst[3] published the results of observations of evaporation at sea,* revised Brückner's estimate of the average evaporation and thereby modified Fritzsche's results. Wüst's paper does not contain the complete balance sheet, however, and it is left to the reader to refer to Fritzsche's thesis and reconstruct such a balance sheet for himself. The matter is of such importance, however, that it is worth while to copy out the figures. In the following table the unit of area is 10^8 square kilometres (the square on an earth-quadrant), the unit of depth is a centimetre, and the unit of volume is 1,000 cubic kilometres. It

* Evaporation from small vessels carried on board ship was estimated by the change in the saltness of the water. In the reduction of the observations the strength of the wind over sea and of relative wind over the vessels was allowed for as well as temperature differences, etc.

will be noticed that if the average rainfall over 10^8 square kilometres is one centimetre, the volume of water is 1,000 cubic kilometres. The fundamental data are shown in heavy type, all with the exception of the 82 cm. for evaporation over the sea, coming from Fritzsche's paper. The other figures are obtained by mere arithmetic. It is remarkable that the average rainfall for the whole globe is estimated as practically the same as the average for the sea alone. It is a little below the average for England which is 80 cm.

		Area	Annual Depth	Annual Volume
Unit		10^8 km^2	cm	10^3 km^3
APERIPHERAL LAND	Rainfall (Fritzsche)	**0·32**	**33**	10·5
	Evaporation.	0·32	33	10·5
PERIPHERAL LAND	Rainfall (Fritzsche)	**1·17**	**87**	101·5
	Run-off=**30**% (do.)	1·17	26	30·5
	Evaporation=70%	1·17	61	71·0
THE SEA	Evaporation (Wüst)	**3·61**	**82**	296·0
	Run-in (from land)	3·61	8·5	30·5
	Rainfall	3·61	73·5	265·5
THE GLOBE	Rainfall	5·10	74	377·5
	Evaporation	5·10	74	377·5

The researches of Fritzsche and Wüst do not furnish direct information as to the distribution of rainfall over the sea. The only meteorologist who has charted the rainfall of the oceans is Supan.[4] Supan's chart was utilised by Herbertson in the preparation of Plate 18 of Bartholomew's Atlas of Meteorology.[5] The data at Supan's disposal were very scanty. He relied largely on the observations collected by an English author, W. G. Black,[6] rain-gauge observations made on various ships in the years 1864 to 1881. In view of the acknowledged difficulty of measuring rainfall at sea no very high order of accuracy can be expected in the charts even for the limited areas which they cover. Nevertheless an attempt has been made to utilize them for assessing the average rainfall over the sea. Kerner[7], who carried out this investigation, found that the average rainfall over the sea was about 100 cm., Wüst compares this amount with that given in the foregoing balance sheet and comes to the conclusion that Kerner's estimates for the rainfall in different latitudes should be reduced by one quarter. This conclusion is supported by a discussion of the salinity of the ocean.

The moral seems to be that the rainfall shown on Supan's charts and therefore on Herbertson's must be discounted somewhat. All the authors agree in urging the desirability of organized observations of rainfall at sea. In this branch of practical meteorology there has been little progress since 1864.

Another paper on the subject was published by Wüst in 1922. In this paper balance sheets are given. These are not quite in accordance with the earlier paper: Fritzsche's estimate of the continental evaporation is considerably reduced and, on the other hand, Wüst's own estimate of evaporation over the sea is increased.

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3. Wüst, Dr. Georg. .. Die Verdunstung auf dem Meere (Institut für Meereskunde, Berlin, 1920).*

4. Supan, A. .. .. Die jährlichen Niederschlagsmengen auf den Meeren (Gotha, Petermanns Mitt., 1898).

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6. Black, W. G. .. .. Ocean Rainfall by Rain-gauge observations at sea, 1864-75-81 (E. & S. Livingstone, Edinburgh, 1894).

7. Kerner, Dr. Fritz, v. .. Eine neue Schatzung des Gesamtniederschlages auf den Meeren (Mitteilungen der Geographischen Gesellschaft in Wien, 1918).

8. Wüst, Dr. Georg. .. Verdunstung und Niederschlag auf der Erde (Zeitschrift der Gesellschaft für Erdkunde zu Berlin, 1922, Nr. 1-2).

NOTE.—Wüst's papers contain full references to other work on the subject.

Discussions at the Meteorological Office

January 21st, 1924. *The auroral spectrum and the upper strata of the atmosphere,* and *The constitution of the upper strata of the atmosphere.* By L. Vegard (Phil. Mag. XLVI., 1923). *Opener*—C. E. Britton, B.Sc.

Some account of these papers has been given in the *Meteorological Magazine, vide* Recent Researches on the Constituents of the Upper Atmosphere, by M. T. Spence. Vol. 58, p. 223.

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* See also *Meteorological Magazine,* vol. 57, Feb., 1922, p. 8, for discussion on this paper.

February 4th, 1924. *A statistical study of surface and upper air conditions in cyclones and anti-cyclones passing over Davenport, Iowa.* By A. D. Udden (Monthly Weather Review, February, 1923). *Opener*—Capt. J. Durward, M.A.

Critics often allege that meteorologists accumulate observations but spend too little time in analysing the observations in such a way that they will prove useful in correlating local weather with the variations in atmospheric circulation. The author of the paper under discussion takes up this challenge and finds what wind, cloud and temperature occur on the average when Davenport is, for example, to the south of the centre of a depression and between 100 and 400 miles from the centre. The results are set out in a series of telling diagrams. One of the more striking conclusions is that the meteorological situation most productive of rain is a depression centred due south of Davenport, but that even then the odds against rain at any instant are 2 to 1. When a depression is to the north-east of Davenport, and within 400 miles, the odds against rain at any instant are 8 to 1. The discussion of the movement of the upper clouds shows that the general drift is hardly correlated at all with the winds near the ground. The drift is steady from the west across a cyclone, from west north west across an anti-cyclone. The paper provided material for a good discussion. Criticism was directed to the pooling of data for all seasons of the year and to the division of a cyclone into sectors which had no reference to the direction of motion. The temptation to regard the results as applicable to the distribution of weather round the pressure centres instead of as data for Davenport was found to be very strong. The temptation will not be overcome until many studies of the kind are available. Perhaps the energetic co-operation of the Weather Bureau officials will make this possible in the near future.

THE subjects for discussion for the next two meetings will be:

February 18th, 1924. *On the nature of atmospherics* by R. A. Watson Watt and E. V. Appleton (Proc. Roy. Soc., Vol. 103, 1923, p. 84). *Opener*—G. I. Taylor, F.R.S.

March 3rd, 1924. *Der tägliche Gang der Temperatur in der freien Atmosphäre über Lindenberg,* by H. Hergesell (Braunschweig, Die Arb. der Preuss. Aero. Obs. bei Lindenberg, XIV Band). *Opener*—Capt. D. Brunt, M.A., B.Sc.

The Cart before the Horse.—A member on the debate on the Address in the House of Commons: " There was no thunder or lightning and consequently no storm." *New Leader,* January 18th, 1924.

Royal Meteorological Society

THE annual general meeting of this society was held on Wednesday, January 16th, at 49, Cromwell Road, South Kensington, Dr. C. Chree, F.R.S., President, in the Chair. The report of the council for 1923 was read and adopted and the council for 1924 duly elected, the new President being Mr. C. J. P. Cave, M.A., J.P.

The Symons Gold Medal awarded to Prof. Takematsu Okada, Director of the Central Meteorological Observatory, Tokyo, was accepted on his behalf by His Excellency the Japanese Ambassador.

By the adoption of the report of the Council the proposed institution of a Buchan Prize was approved. This prize will suitably commemorate Dr. Alexander Buchan, the distinguished secretary of the Scottish Meteorological Society whose researches on the climatology of the globe were marked by so much originality and perseverance. The prize is to be awarded biennially to the author of the paper in the Journal of the Society which is adjudged by the Council to be of the highest merit as a contribution to meteorology.

The retiring President, Dr. C. Chree, delivered an address on "Reflections on various subjects including meteorology and sunspots."

The most striking feature of the address was an analysis of certain of the meteorological observations at Kew Observatory with reference to the sunspot cycle. In waggish mood Dr. Chree showed how by skilful selection of the statistics diametrically opposite conclusions could be reached. In his concluding remarks he threw out the suggestion that a study of the weather on days which are magnetically "quiet" or "highly disturbed" should provide the answer to the question whether magnetic disturbances affected the terrestrial atmosphere, and this without waiting for the passage of many sunspot cycles.

Correspondence

To the Editor, *The Meteorological Magazine*

Wind Suction in Lighthouses

THE notes on the above subject (pp. 135 and 285 of vol. 58 1923) have been of peculiar interest to me, because I believe I am right in saying that I originated the method of investigation which has definitely settled the question. That barometer readings at lighthouses were "shaky" had long been more than suspected, and Dr. Buchan and others had concluded that the defects were due to the eddying of the wind at headlands, such as Dungeness. If I remember rightly the lighthouse itself was not suspected to be the cause.

When I became forecaster and inspector, the problem naturally appealed to me, for in the preparation of the synchronous charts the isobars in the vicinity of lighthouses were almost invariably distorted, without any corresponding irregularity in the wind. My own view was that the faulty readings were due to up-draughts and downdraughts in the tall structures—the entrance door at the base open or shut, and the lantern at the summit shut or open to windward or to leeward. I was influenced by this idea when, on superintending the transfer of the meteorological instruments from the old Portland lighthouse on the crest of the hill to the new building practically at sea level close to the Bill, I had the barometer suspended in a recess under the stone stairs at the base. On a subsequent inspection visit I had a number of readings taken under varying conditions, and the results were noted in my report.

But tests at Malin Head on my visit in 1911 were more interesting because the Coastguard watch tower there is not a tall lighthouse structure, but a squat square building of two floors, with a trap door access to the roof, the barometer being suspended in the upstairs room, window facing north. I had the entrance door, the room door, the trap door, and the window opened and shut, and at each operation the ratings in attendance and myself took independent readings of the barometer; in every instance a separate setting of the vernier, and to prevent any possibility of influencing each other we wrote down our readings. A light W.N.W. breeze, force 3, was blowing, and I was surprised that, with such a feeble movement, there was to the unaided eye a perceptible and instantaneous rise or fall of the mercury, which every one of our readings showed to amount to 0.012 in., or 0.4 mb.

This result afforded the explanation of the violent oscillations of pressure shown in the Malin Head barograms whenever high winds prevail, the oscillations exceeding 0·1 in. or 3·4 mb. in severe gales. Before the explanation was known, small secondary cyclones were shown in the isobars over Donegal which had no other existence than in that tiny room on Malin Head.

Hy. Harries.

10, Tennis Road, Hove, January 29th, 1924.

On the Effect of Radiation on the Grass Minimum Thermometer

DURING the winter of 1922-1923 a set of comparisons were made at Benson Observatory, between the grass minimum thermometer and an aspiration psychrometer. The object of the test was to discover if possible how far low readings on the grass are due to direct radiation from the bulb of the thermometer to the sky. To this end the grass minimum was exposed in the normal manner with the bulb about an inch above short grass and was unprotected in any way. The aspiration psychrometer was hung vertically a few feet away on the same grass plot with the air inlet at the same height above the grass as the thermometer bulb. The observations were made on some 12 cold mornings, just before or at about sunrise, and took the form of simultaneous readings made at intervals of a few minutes over periods of about 20 minutes, more or less. The weather conditions were calm or nearly so, and the sky in general clear or not more than half covered. The observations were in general stopped when the effect of the rising sun became appreciable. All the readings taken in the group were meaned.

It was found that after correcting for difference in index error of the two thermometers the grass minimum invariably read lower than the psychrometer, the amount of the difference increasing with falling temperature. A range of from 16° F. to 32° F. approx. was investigated and a rough linear relationship established as follows :—

Grass Minimum. ...	32·0 F.	24·5 F.	17·0 F.
Psychrometer. ...	33·0	26·5	20·0

The individual groups of observations showed some scatter when plotted, but the above law summarises the general result fairly well. At the times the comparisons were made it may be taken that the screen thermometer was on the average about 6° F. above the grass minimum thermometer.

On one occasion at a temperature of 16° F. the psychrometer was also compared by laying it flat on the grass so that the air was drawn in from below the bulb of the grass minimum. It still read higher than the latter by 1·7° F. as against 2·8° F. when hung up for a normal test.

The whole comparison indicates that in clear calm weather the grass minimum thermometer is considerably affected by direct radiation, and that the air round about it in such case is at an appreciably higher temperature than is indicated by the thermometer.

L. H. G. DINES.

Kew Observatory, November 15th, 1923.

Two Hints for Rainfall Observers

MY 5 in. gauge was sold to me with a certificate of accuracy, and I took great care to see that the top was level when it was placed in position ; but, although it was fixed in the ground as firmly as I could fix it without putting it into a concrete bed, I frequently found afterwards that it required relevelling. This happened so often that I began to think that some movement in the soil, such as might be caused by the growth of an extra strong grass or weed root, must be the cause of the trouble, and that, to prevent it, a very considerable bed of concrete would be required. But, early this year, I found that the trouble was due to the fact that the knife-edged ring was not absolutely parallel with the part of the funnel which rests on the lower half of the gauge, the part that is fixed in the ground. The result was that, however carefully it was levelled when last set, it would be off the level if replaced partly turned round. When I found this out, I painted a black straight line down the outside of the gauge to ensure that the funnel would always be put back in the same position. Since then my trouble has ceased. I have tested the gauge repeatedly since then, and have never found it off the level ; but, if I turn the funnel through 180° the edge is 46′ of angle off the level.

I suggest that new gauges if they are not now all tested for this defect should be issued with a vertical black line on both halves, and that observers should be warned to do the levelling with the two halves of the line coinciding and to be careful always to replace the funnel in the same position. With this defect in a gauge, setting the gauge in a concrete block would be apt to prove a trap. If mine had been placed in concrete and carefully levelled, I should, in all probability, never have again tested it to see if it were still in truth and it would have been off the level far more often than not.

Another hint that would probably be of use to many observers is that smearing with vaseline the surfaces of the upper and lower halves of the gauge, where they overlap each other, prevents them from sticking together in frosty weather. Until I found this out I had almost always to relevel the gauge after removing the funnel in frosty weather, and once or twice I had to bring the whole gauge into the house to thaw it. An application of vaseline entirely removed the trouble, and, although made a year ago, has not yet had to be repeated.

T. E. LANDER.

Auchtyfardle, Lesmahagow, Lanarkshire, January 1st, 1924.

NOTES AND QUERIES

A Course of Training for Observers

It is proposed to hold the second course of training for meteorological observers, to which reference was made in the September 1923 issue of this magazine, at Kew Observatory, Richmond, Surrey, during the week April 28th to May 3rd, 1924, both dates inclusive.

The subjects to be dealt with will include the following:—

Meteorological instruments and method of Observation.
Recording of Observations and their transmission to the Meteorological Office.
The Weather Map; charting of observations received from stations by telegraph.
Climatology.

The course is addressed primarily to observers at stations which report regularly to the Meteorological Office, especially those at health resorts. Provided the accommodation is adequate, others will, however, be admitted, at the discretion of the Director. Applications for tickets of admission should be made to the Director, Meteorological Office, Air Ministry, Kingsway, W.C. 2. There will be no fee for the course.

Weather Insurance for Farmers

Amongst the subjects discussed by the Commission for Agricultural Meteorology at the recent Meeting at Utrecht was a principle propounded by Mr. R. A. Fisher, of Rothamsted, that in the collection of statistics the possible application to insurance problems should be the first consideration.

With an insurance policy of the type that Mr. Fisher has in mind a farmer would be entitled to compensation if such weather occurred as would presumably ruin his crop. It would not be necessary for him to prove that it had been ruined. The criterion would be arrived at by the study of the statistics for previous years. For example a drought in spring is known to be very bad for the hay crop. Statistical studies will show which are the weeks of the most importance in any particular part of the country, and the farmer will be able to insure against an absence of rain during those particular weeks. In this particular instance, the statistical material is available already and there would be no great difficulty in arriving at equitable rates of insurance. In general the problem is much more difficult, but the mere effort to state it explicitly is bound to have a steadying influence and should help to define what information about the crops must be collected and collated. It is futile to deplore the little interest taken by farmers in meteorological statistics unless we can assert with conviction that the statistics have a direct application to practical farming.

Readers who are interested in this subject should refer to the article on *Weather Insurance* by Dr. A. H. Palmer in the October issue of Tycos-Rochester. The following is a short extract from this article—"The recent tendency in crop insurance has been towards a blanket policy covering all risks. If the farmer had to take out separate policies against hail, frost, drought, floods, desiccating winds, field fires, insect pests, etc , he would have little margin for profit In most cases a banker advances the insurance premium for the farmer, and naturally he it is who insists upon a single policy to cover all possible risks While no such ideal blanket insurance policy is yet available, progress has been made in the direction of its attainment.

The Chilly South!

THE following paragraph is from an interesting account of the first journey ever made by motor car across the Sahara between Tuggurt (south of Biskra in Algeria) and Tozeur (at the great oasis of El Jerid) in Tunisia. The route is in no part more than a few hundred feet above sea level.

> "Eleven hours—ten hours, even—at this season of the year are too much. There are not so many hours of daylight. And it is cold ; bitterly cold before sunrise and after sunset, and cold all day. Whatever it may be in summer, and though the sun shines brightly from morning till evening, the North African desert at this time of year is a cold region. Even when out of the wind there is always, in spite of sunshine, a chill in the air : and in mid-afternoon after the sun has beaten on it steadily for five or six hours, if you put your hand on the sand it is still as if it were iced. Camels, date palms, dry thorn bushes, and the thirsty Sahara—they do not conjure up images of cold : but anyone who motors over the desert in December or January will need his thickest underclothing, a heavy greatcoat and warm muffler—and still he will be cold." "*The Times*," January 11th, 1924.

Meteorologists would like to have more information as to the cold sand. According to Angot* the range of air temperature in January in the Algerian Sahara is about 22° F. (and this implies strong heating of the air by the sand). It would have been of interest to get actual measurements of the temperature of the surface layers.

* Quoted by Hann, Klimatologie III., 68 (3rd Ed. 1911).

Radiation from the Sky

RADIATION MEASURED AT BENSON, OXON, 1923.

Unit: one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays).

Averages for Readings about time of Sunset.

		Oct.	Nov.	Dec.
Cloudless days:				
Number of readings	n	7	7	8
Radiation from sky in zenith ...	π I	481	424	419
Total radiation from sky ...	J	519	454	448
Total radiation from horizontal black surface on earth ...	X	698	632	628
Net radiation from earth ...	X—J	179	178	180

DIFFUSE SOLAR RADIATION (luminous rays).

Averages for Readings between 9 h. and 15 h. G.M.T.

		Oct.	Nov.	Dec.
Cloudless days:—				
Number of readings	n_0	3	4	4
Radiation from sky in zenith ...	πI_0	21	21	15
Total radiation from sky ...	J_0	34	27	21
Cloudy days:—				
Number of readings	n_1	7	3	6
Radiation from sky in zenith ...	πI_1	73	22	23
Total radiation from sky ...	J_1	63	19	20

Unit for I = gramme calorie per day per steradian per square centimetre.
Unit for J and X = gramme calorie per day per square centimetre.
For description of instrument and methods of observation, see *The Meteorological Magazine*, October, 1920, and May, 1921.

The Long Arm of Coincidence

FOR two stations in Wiltshire the observers have reported that the rainfall for 1923 was exactly the same as for 1922. These are Market Lavington, Wilts (Miss A. Pleydell Bouverie) 30.83 ins., and Tisbury, Wilts (Mr. J. Bristol) 43.61 ins.

Mr. B. Crosbie-Hill, of Leverton Manor, Hungerford, has also found for the rainfall exactly the same amount 29·79 inches in both years. He writes: "You will note in July, 1923, I was away for a considerable time, and consequently could only measure what rain there was in my gauge on my return, adding thereto a little for evaporation. . . . Until I came to add my 1923 figures I was not aware the two years were going to be even very close. . . . Is not my experience unique?"

The Growth of the Daily Weather Map

THE announcement by the Central Physical Observatory, Petrograd, of some changes in the reports issued by wireless telegraphy marks an important step towards the construction of daily weather charts of the Northern Hemisphere. The observations are now issued more promptly than formerly; a message broadcasted at 9h. 15m. G.M.T. contains observations taken at 7h. G.M.T. the same morning, and supplementary observations are issued in a later message at 11h. G.M.T. The network of stations included is extended to Siberia and comprises 73 places ranging from Petrograd and Odessa to Vladivostock.

This issue has already rendered it possible for charts extending three-quarters of the way round the hemisphere to be constructed in the Meteorological Office before noon of the day of observation. If it were now possible to "pick up" the Japanese wireless reports and observations from ships in the Pacific the hemisphere would be completely encircled.

Review

The Mechanical Properties of Fluids. 8vo., $8\frac{3}{4}\times6$, pp. xiv.+ 362. *Illus.* Blackie & Son, Ltd. 20s net.

THE time is opportune for the publication of a book on "The Mechanical Properties of Fluids," and Messrs. Blackie have been fortunate in obtaining the assistance of the experts who contribute the several articles to the work which they publish under that title.

The articles have been written independently, but they do not overlap very much; in fact it might be urged that there should have been more cross-references from one article to another. There is one conspicuous example of such a lost opportunity. In the article on Hydrodynamical Resistance, Prof. A. H. Gibson gives the relation between the drag exerted on a board by an air current passing over it. In the article on "Wind Structure," Dr. Geddes states the formula for the resistance which is offered to the wind as it blows over the countryside. Neither author quotes Taylor's remark that the small scale and large scale observations are in excellent agreement nor mentions that the generalization has been extended to the action of tidal currents on the sea bottom. The subject of tidal currents is curiously enough omitted from the book entirely.

Mr. Taylor's contribution to the book is an account of the determination of the mechanical properties of shafting by the study of soap-films, an achievement which must fascinate every reader. It was a disappointment, however, to find that he had not anything to say about fluid motion in its various aspects. We can but mention the articles by Dr. Allan Ferguson on "Liquids and Gases," by Professor Lamb on the "Mathematical

Theory of Fluid Motion," by Mr. Mitchell on "Viscosity and Lubrication," by Dr. Drysdale on "Submarine Signalling," and by Mr. F. H. W. Hunt on the "Reaction of the air to Artillery Projectiles." We are more concerned as meteorologists with Dr. Geddes's article on "Wind Structure." Dr. Geddes disarms criticism by his concluding remark, "in this brief study some only of the intricacies of the problems of wind structure rather than their solutions, have been placed before the reader." This may be regarded perhaps as a confession that an attempt has been made to cover too wide a field. We are inclined to agree that that is the case. The range of the article is very much the same as that of the one published part of Shaw's Manual of Meteorology (Part IV.), and the substance of that work is compressed into 39 pages.

Attention may be called to one or two cases in which Dr. Geddes seems to us to have fallen into error as he sins in good company. A demonstration of the rule for finding the deflective "force" due to the rotation of the earth is given at considerable length, but it purports to apply to motion on the surface of a spherical globe. Is it necessary to point out that the fact that the level surfaces on the earth are spheroidal should be mentioned explicitly in any proof of the rule in question ? The rule does not hold for a spherical globe. Again, the characteristic equation for the propagation of momentum in an eddying fluid is quoted (Eq. 5, p. 265) without the geostrophic term. The integral of the equation with that term included is the basis of the whole of the following argument, and, as the reader is credited with sufficient mathematical knowledge, the integral should certainly have been set out. Geddes does not seem to have realized that the gradual approach of the actual wind to the "gradient wind" occurs even on the hypothesis of uniform turbulence. The statement "As we ascend above the surface a nearer approach is made to the geostrophic values, largely due to the fact that turbulence tends to diminish with height, its influence being on an average very little felt at 1,000 metres" is misleading.

There are other matters concerning which Dr. Geddes's treatment does not strike us as quite sound but they cannot be dealt with in a short review. The great merit of his article is that it is likely to widen the circle of readers who make a serious study of the mechanics of the atmosphere.

News in Brief

Mr. O. F. T. Roberts, B.A., M.C., Professional Assistant at Porton, has been appointed Cruickshank Lecturer in Astronomy and Meteorology at Aberdeen. Mr. Roberts joined the staff of the Meteorological Office in February, 1921, and was immediately seconded for duty at Porton, where he has devoted some time to researches on the form of smoke clouds in a turbulent atmosphere. Some of his results are published in a paper in Proceedings Royal Society, December, 1923.

A course of five lectures* on Meteorological Optics will be given by Mr. F. J. W. Whipple, at the Royal College of Science, on Monday afternoons, at 3.30 p.m., beginning on Monday, February 18th. The lectures will be illustrated by experiments.

At the Annual Meeting of the Physical Society of London, on Friday, February 8th, the first Duddell Medal was presented to Professor Hugh Callendar. The Medal, which commemorates the inventor of the Oscillograph, is to be awarded to an inventor of scientific instruments of the highest merit. Meteorologists who are famiilar with Callendar's thermograph and radiograph will applaud the choice of the first medallist.

At the recent Exhibition of the Royal Photographic Society, Mr. G. A. Clarke showed several cloud photographs. For one of these, an autochrome slide, representing a sheet of strato-nimbus cloud 20 minutes after sunset, a medal was awarded.

The fifth Meteorological Office Soirée, held on February 8th, 1924, at Australia House, was attended by more than 200 past and present members of the Office Staff and their friends, and a varied programme of music and dancing was provided. Among those present were Sir Napier Shaw, Col. Lyons and Dr. and Mrs. Simpson.

The third Annual Dinner of The Meteorological Office Staff at Shoeburyness, was held at the Queen's Hotel, Westcliff, on January 19th, 1924. The guest of the evening was Capt. D. Brunt, Superintendent of Army Services, and Mr. C. E. Britton was in the chair.

We have received Vol. 1, No. II., of "Rainfall in the Southern Pennines," the organ of the Manchester and Stockport Rainfall Organization. This issue contains the annual summary for the year 1920, compiled by Mr. A. A. Barnes. In addition to the 1920 statistics there is a table showing the rainfall for each year since 1865 at eight places situated in Lancashire and Yorkshire. These tables should be very useful to meteorologists interested in long series of records of weather.

The upper air observations made at Soesterberg, the Dutch aerodrome, have appeared with great regularity in the Upper Air Supplement of the Daily Weather Report in recent years. It is of interest to learn from the official report on the observations for 1921 that during that year a subaltern named Bakkenes made no less than 313 ascents with the meteorograph. The most appropriate comment seems to be "For he's a jolly good fellow."

* *Vide Meteorological Magazine,* vol. 58, Sept., 1923, p. 180.

The Weather of January, 1924

THE first few days of the new year were mild with westerly winds and some rain, but the development of a belt of high pressure over the southern part of the North Sea and adjacent regions during the evening of the 3rd, caused a decided fall of temperature over the east and south-east of the British Isles. This was accompanied by thick fog in many parts of the country, including Ross-on-Wye, where the fog persisted throughout the day. After the 5th, when 55°F. was recorded at Killarney, the colder conditions spread also to the north and west, and temperature remained rather low for about a week. On the 8th a deep depression moving southeastwards over the Atlantic caused north-westerly gales of storm force (Beaufort force 10 and 11), some 800 miles westward of Scilly, and high south-easterly winds or gales in many parts of the British Isles. Snow fell generally on this and the two following days and in some places, including London (Hampstead), "snow lying" to a depth of between 5 and 6 inches was registered. The two coldest days of the month were the 9th and 17th, when at several stations, notably in the east and Midland counties, temperature did not rise above 32° F. all day. At one or two stations on the 9th, *e.g.* Nairn and Leafield, the maximum readings were as low as 27° F. or 28° F. The lowest screen minimum for the month, 11° F., occurred at West Linton on the 10th, and ground frosts were experienced on most nights during the month, among the lowest temperatures being 7° F. at Eskdalemuir on the 9th.

Between the 10th and the 17th there was a short period of mild unsettled weather, when a small depression over Ireland caused heavy rain in the west, 65mm. were recorded at Blaenau (Brecon), and 50 mm. at Rectory Dummanway (Cork) on the 12th, and 57mm. at Tairbull (Brecon) on the 11th. After the 17th, mild weather again set in with much rain at times, and this lasted until the last week of the month, when high pressure spread up from the south and fairer conditions obtained. Thunderstorms were reported at a few places in the South on the 19th.

The rise of the Seine which took place towards the close of December, 1923, continued into January, and at Paris the river reached a level of 24 feet above normal on the night of the 5th to 6th, after which it began to fall. Many streets were flooded, and about 5,000 persons had to leave their homes, while some 10,000 more suffered loss. On January 3rd, Cologne was threatened by Rhine floods, but the danger passed off. Over most of Europe the first half of January was characterised by cold and snowy weather. The Baltic coast of Denmark became ice-bound about the 2nd and shipping was more or less delayed throughout the month. On the 3rd, the ice was five inches thick on the harbours and large steamers were frozen in. Early in the month Danzig was isolated by heavy snow, and railway traffic in Poland was seriously disorganized until the 5th. A report from Berlin, dated the 8th, reports heavy snow in north Germany and much damage by frost, snowstorms and sea-ice. The mouth of the Elbe was covered with floating ice, and there were "icebergs" two or three feet high in the Baltic. The month opened with very severe winter in Austria. In Switzerland the alternation of heavy snowfall with thaw and rain, referred to last month, continued for some days, causing further avalanches, but about the 5th weather conditions inproved, and remained good until the 22nd when there was a further thaw accompanied by rain. In Italy severe cold was reported on the 2nd, again on the 8th, when there was heavy snow in Lombardy, and at the end of the month, when there were deaths from cold at Florence. On the 7th there was a severe storm in Greece, followwed by intense cold. In Russia the end of December and the first week of January had very low temperatures, reaching —40° F. at Blagoveschensk in Siberia. In Finland —50° F. was reached at Sodankylä on the morning of the 22nd. There was a heavy gale at Biarritz on the 8th, and another storm off Portugal on the 14th, and the weather in the North Atlantic was stormy throughout the month.

In North America the weather was very cold. A severe cold wave visited the northern and eastern United States on the 5th. The temperature reached —15° F. as far south as St. Louis, —16° F. at Chicago, where twelve deaths from cold were reported, and —39° F. at Virginia, Minn. Another cold spell was experienced on the 21st, when the temperature fell to 4° F. at New York, and —28° F. further north. On the 27th the temperatures reached —60° F. in northern Ontario, after falling 64° F. in 36 hours.

The special message from Brazil states that in the central districts the rainfall was, on the average, 105 mm. above the normal, and disastrous floods occurred on the Parahyba River. In the northern and southern districts, however, the rainfall was scanty, being 51 mm. and 80 mm. respectively below the normal. Temperature continued one or two degrees above normal. The cane and cotton crops are in better condition in north Brazil and the wheat crop is plentiful. At Rio de Janeiro the mean pressure for the month was 1 mm. above normal, and the temperature 2 degrees below normal.

Rainfall January, 1924: General Distribution

England and Wales	128	per cent. of the average 1881-1915.
Scotland	101	
Ireland	148	
British Isles	125	

Rainfall: January, 1924: England and Wales.

CO.	STATION.	In.	mm.	Per-cent. of Av	CO.	STATION.	In.	mm.	Per-cent. of Av.
Lond.	Camden Square	2·75	70	148	*War*	Birminghm, Edgbaston	2·60	66	129
Sur .	Reigate, Hartswood	2·66	68	118	*Leics*	Leicester Town Hall	2·05	52	...
Kent.	Tenterden, View Tower	2·54	65	118	,, .	Belvoir Castle	1·91	49	108
,, .	Folkestone, Boro. San.	2·23	57	...	*Rut* .	Ridlington	2·23	57	...
,, .	Broadstairs	...	...	...	*Linc*.	Boston, Skirbeck	1·97	50	122
,, .	Sevenoaks, Speldhurst.	2·89	73	...	,, .	Lincoln, Sessions House	1·79	45	107
Sus .	Patching Farm	2·88	73	111	,, .	Skegness, Estate Office.	...	...	...
,, .	Eastbourne, Wilm. Sq.	2·30	59	87	,, .	Louth, Westgate	1·77	45	82
,, .	Tottingworth Park	2·90	74	107	,, .	Brigg	2·17	55	121
Hants	Totland Bay, Aston	2·85	72	123	*Notts*.	Worksop, Hodsock	1·53	39	86
,, .	Fordingbridge, Oaklnds	4·32	110	157	*Derby*	Mickleover, Clyde Ho.	2·29	58	113
,, .	Portsmouth, Vic. Park.	2·67	68	112	,, .	Buxton, Devon. Hos.	4·40	112	98
,, .	Ovington Rectory	3·42	87	127	*Ches*.	Runcorn, Weston Pt.	2·70	69	114
,, .	Grayshott	3·21	81	119	,, .	Nantwich, Dorfold Hall	2·55	65	...
Berks	Wellington College	2·76	70	139	*Lancs*	Bolton, Queen's Park .	3·75	95	...
,, .	Newbury, Greenham	3·45	88	149	,, .	Stonyhurst College	3·86	98	90
Herts.	Bennington House	2·92	74	...	,, .	Southport, Hesketh	2·73	69	107
Bucks	High Wycombe	3·04	77	145	,, .	Lancaster, Strathspey.	3·87	98	...
Oxf.	Oxford, Mag. College	3·41	87	198	*Yorks*	Sedbergh, Akay	4·91	125	89
Nor .	Pitsford, Sedgebrook	2·12	54	114	,, .	Wath-upon-Dearne	1·47	37	77
,, .	Eye, Northolm	1·81	46	...	,, .	Bradford, Lister Pk.	2·64	67	92
Beds.	Woburn, Crawley Mill.	2·25	57	132	,, .	Oughtershaw Hall	5·70	145	...
Cam.	Cambridge, Bot. Gdns.	2·56	65	171	,, .	Wetherby, Ribston H.	2·18	55	106
Essex	Chelmsford, CountyLab	2·65	67	...	,, .	Hull, Pearson Park	1·96	50	109
,, .	Lexden, Hill House	2·31	59	...	,, .	Holme-on-Spalding	2·26	57	...
Suff.	Hawkedon Rectory	2·59	66	149	,, .	Lowthorpe, The Elms.	2·37	60	115
,, .	Haughley House	2·22	56	...	,, .	West Witton, Ivy Ho.	2·91	74	...
Norf.	Beccles, Geldeston	1·87	48	113	,, .	Pickering, Hungate	2·81	71	...
,, .	Norwich, Eaton	2·35	60	120	,, .	Middlesbrough	1·51	38	94
,, .	Blakeney	2·38	61	138	,, .	Baldersdale, Hury Res.	2·54	65	72
,, .	Swaffham	2·27	58	123	*Durh*.	Ushaw College	1·64	42	80
Wilts.	Devizes, Highclere	4·13	105	189	*Nor* .	Newcastle, Town Moor.	2·06	52	101
Dor .	Evershot, Melbury Ho.	...	...	...	,, .	Bellingham Manor	2·72	69	...
,, .	Weymouth, Westham	4·68	119	193	,, .	Lilburn Tower Gdns.	1·92	49	...
,, .	Shaftesbury, Abbey Ho.	4·36	111	168	*Cumb*	Penrith, Newton Rigg.	...	...	...
Devon	Plymouth, The Hoe	5·68	144	172	,, .	Carlisle, Scaleby Hall .	3·34	85	135
,, .	Polapit Tamar	5·70	145	153	,, .	Seathwaite	10·00	254	75
,, .	Ashburton, Druid Ho.	7·18	182	141	*Glam*.	Cardiff, Ely P. Stn.	5·91	150	156
,, .	Cullompton	4·91	125	152	,, .	Treherbert, Tynywaun	10·60	269	...
,, .	Sidmouth, Sidmount	4·27	108	149	*Carm*	Carmarthen Friary	5·61	143	128
,, .	Filleigh, Castle Hill	6·24	159	...	,, .	Llanwrda, Dolaucothy.	7·11	181	134
,, .	Hartland Abbey	4·63	118	...	*Pemb*	Haverfordwest, Portf'd	7·10	180	154
Corn.	Redruth, Trewirgie	6·66	169	158	*Card*.	Gogerddan	...	...	...
,, .	Penzance, Morrab Gdn.	5·65	143	149	,, .	Cardigan, County Sch. .	4·89	124	...
,, .	St. Austell, Trevarna	6·65	169	155	*Brec*.	Crickhowell, Talymaes	6·00	152	...
Soms	Chewton Mendip	4·95	126	129	*Rad* .	Birm. W. W. Tyrmynydd	6·23	158	99
,, .	Street, Hind Hayes	3·74	95	...	*Mont*.	Lake Vyrnwy	5·78	147	102
Glos.	Clifton College	4·98	127	175	*Denb*.	Llangynhafal	2·25	57	...
,, .	Cirencester	4·27	109	165	*Mer* .	Dolgelly, Bryntirion	5·57	141	98
Here.	Ross, County Obsy.	3·84	98	159	*Carn*.	Llandudno	2·04	52	79
,, .	Ledbury, Underdown.	3·79	96	172	,, .	Snowdon, L. Llydaw 9	13·97	355	...
Salop	Church Stretton	2·73	69	108	*Ang* .	Holyhead, Salt Island.	4·81	122	165
,, .	Shifnal, Hatton Grange	2·76	70	142	,, .	Lligwy	4·14	105	...
Staff.	Tean, The Heath Ho.	3·17	81	123	*Isle of Man*				
Worc.	Ombersley, Holt Lock.	2·75	70	143		Douglas, Boro' Cem.	5·55	141	164
,, .	Blockley, Upton Wold.	3·77	96	160	*Guernsey*				
War	Farnborough	3·04	77	141		St. Peter Port, Grange .	4·28	109	146

Rainfall: January, 1924: Scotland and Ireland

CO.	STATION.	In.	mm.	Per-cent. of Av	CO.	STATION.	In.	mm	Per-cent. of Av.
Wigt.	Stoneykirk, Ardwell Ho	5·50	140	186	*Suth.*	Melvich School	2·47	63	75
,,	Pt. William, Monreith	5·49	139	...	*Caith*	Loch More, Achfary	7·68	195	105
Kirk.	Carsphairn, Shiel.	10·73	273	...	,,	Wick	1·96	50	80
,,	Dumfries, Cargen	5·31	135	133	*Ork.*	Pomona, Deerness	3·04	77	88
Dum	Drumlanrig	5·55	141	134	*Shet.*	Lerwick	6·05	154	142
Roxb	Branxholme	3·38	86	123	*Cork.*	Caheragh Rectory	8·56	217	...
Selk.	Ettrick Manse	6·61	168	...	,,	Dunmanway Rectory	10·17	258	163
Berk.	Marchmont House	2·49	63	111	,,	Ballinacurra	6·22	158	156
Hadd	North Berwick Res.	1·87	47	109	,,	Glanmire, Lota Lo.	7·94	202	185
Midl	Edinburgh, Roy. Obs.	2·07	53	118	*Kerry*	Valencia Obsy.	6·54	166	119
Lan.	Biggar	2·83	72	106	,,	Gearahameen	12·00	305	...
Ayr.	Kilmarnock, Agric. C.	5·19	132	152	,,	Killarney Asylum	6·45	164	109
,,	Girvan, Pinmore	6·24	159	132	,,	Darrynane Abbey	4·23	107	84
Renf.	Glasgow, Queen's Pk.	3·68	93	110	*Wat.*	Waterford, Brook Lo.	7·74	197	210
,,	Greenock, Prospect H.	7·36	187	108	*Tip.*	Nenagh, Cas. Lough	4·86	123	123
Bute.	Rothesay, Ardencraig	5·91	150	131	,,	Tipperary	7·31	186	...
,,	Dougarie Lodge	4·33	110	...	,,	Cashel, Ballinamona	6·72	171	177
Arg.	Glen Etive	6·56	167	...	*Lim.*	Foynes, Coolnanes	3·93	100	104
,,	Oban	5·82	148	...	,,	Castleconnell Rec.	4·79	122	...
,,	Poltalloch	5·61	143	112	*Clare*	Inagh, Mount Callan	5·87	149	...
,,	Inveraray Castle	8·73	222	106	,,	Broadford, Hurdlest'n.	4·71	120	...
,,	Islay, Eallabus	5·70	145	122	*Wexf*	Newtownbarry	9·96	253	...
,,	Mull, Benmore	13·60	345	...	,,	Gorey, Courtown Ho.	7·71	196	247
Kinr.	Loch Leven Sluice	3·16	80	100	*Kilk.*	Kilkenny Castle	6·01	153	188
Perth	Loch Dhu	8·45	215	93	*Wic.*	Rathnew, Clonmannon	6·30	160	...
,,	Balquhidder, Stronvar	6·30	160	74	*Cars.*	Hacketstown Rectory	7·88	200	222
,,	Crieff, Strathearn Hyd.	3·89	99	97	*QCo.*	Blandsfort House	6·11	155	186
,,	Blair Castle Gardens	2·57	65	...	,,	Mountmellick	4·47	113	...
,,	Coupar Angus School	2·47	63	104	*KCo.*	Birr Castle	3·95	100	139
Forf.	Dundee, E. Necropolis	2·50	63	128	*Dubl.*	Dublin, FitzWm. Sq.	3·46	88	151
,,	Pearsie House	4·05	103	...	,,	Balbriggan, Ardgillan	3·96	101	173
,,	Montrose, Sunnyside	2·59	66	130	*Me'th*	Drogheda, Mornington	3·66	93	...
Aber.	Braemar Bank	2·09	53	68	*W.M*	Mullingar, Belvedere	4·34	110	135
,,	Logie Coldstone Sch.	1·43	36	65	*Long*	Castle Forbes Gdns.	4·22	107	127
,,	Aberdeen, Cranford Ho	2·21	56	93	*Gal.*	Galway, Waterdale	3·39	86	...
,,	Fyvie Castle	2·20	56	...	*Mayo*	Crossmolina, Enniscoe	...	...	...
Mor.	Gordon Castle	1·25	32	62	,,	Mallaranny	6·18	157	...
,,	Grantown-on-Spey	1·14	29	47	,,	Westport House	4·92	125	106
Na.	Nairn, Delnies	1·63	41	82	,,	Delphi Lodge	11·07	281	...
Inv.	Ben Alder Lodge	4·00	102	...	*Sligo*	Markree Obsy.	5·68	144	146
,,	Kingussie, The Birches	1·86	47	...	*Ferm*	Enniskillen, Portora	4·64	118	...
,,	Fort Augustus	3·25	83	60	*Arm.*	Armagh Obsy.	3·37	86	134
,,	Loch Quoich, Loan	12·00	305	...	*Down*	Warrenpoint	5·66	144	...
,,	Glenquoich	10·47	266	76	,,	Seaforde	6·11	155	194
,,	Inverness, Culduthel R.	1·48	37	...	,,	Donaghadee	4·18	106	165
,,	Arisaig, Faire-na-Squir	4·76	121	...	,,	Banbridge, Milltown	3·69	94	165
,,	Fort William	8·83	224	92	*Antr.*	Belfast, Cavehill Rd.	4·76	121	...
,,	Skye, Dunvegan	5·43	138	...	,,	Glenarm Castle	6·03	153	...
,,	Barra, Castlebay	2·33	59	...	,,	Ballymena, Harryville	4·11	104	111
R&C	Alness, Ardross Cas.	2·40	61	63	*Lon.*	Londonderry, Creggan	3·43	87	95
,,	Ullapool	3·76	96	...	*Tyr.*	Donaghmore	4·66	118	...
,,	Torridon, Bendamph.	8·50	216	90	,,	Omagh, Edenfel	4·77	121	135
,,	L. Carron, Plockton	6·60	168	...	*Don.*	Malin Head	3·18	81	122
,,	Stornoway	4·56	116	88	,,	Rathmullen	3·38	86	...
Suth.	Dunrobin Castle	...	...	...	,,	Dunfanaghy	3·58	91	88
,,	Lairg	2·27	58	...	,,	Narin, Kiltoorish	5·48	139	...
,,	Tongue Manse	2·49	63	63	,,	Killybegs, Rockmount	6·35	161	113

Climatological Table for the British Empire, August, 1923

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 mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible.
London, Kew Obsy.	1014·3	− 1·0	85	43	70·9	53·2	62·1	+ 0·5	56·6	70	5·1	40	− 17	8	8·0	55
Gibraltar	1016·0	+ 0·8	95	65	86·0	69·2	77·6	+ 1·7	69·5	68	2·1	1	− 3	1	...	...
Malta	1014·6	+ 0·2	89	71	84·5	74·5	79·5	+ 1·2	73·0	71	1·6	0	− 3	0	...	...
Sierra Leone	1013·8	+ 0·5	86	69	82·8	72·0	77·4	− 0·8	73·0	81	7·6	554	−348	22	...	...
Lagos, Nigeria	1013·1	− 0·5	85	69	81·6	72·1	76·9	− 0·2	73·5	79	8·3	3	− 65	2	...	...
Kaduna, Nigeria	1015·0	+ 1·2	85	66	80·7	68·7	74·7	+ 0·9	68·8	85	1·9	116	−180	16	...	...
Zomba, Nyasaland	1017·8	+ 1·6	84	50	75·0	55·5	65·3	+ 0·6	...	83	4·0	28	+ 20	5	...	...
Salisbury, Rhodesia	1019·0	− 0·1	85	33	76·4	43·3	59·9	0·0	51·2	53	1·5	4	+ 2	1	...	...
Cape Town	1020·3	+ 0·1	88	39	64·2	48·4	56·3	+ 1·1	53·5	80	4·6	81	− 6	11	...	...
Johannesburg	1021·5	+ 1·2	78	31	68·3	46·7	57·5	+ 3·6	43·5	47	0·9	1	− 8	1	10·1	91
Mauritius	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bloemfontein	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Calcutta, Alipore Obsy.	997·9	− 3·1	96	77	87·1	78·4	82·7	− 0·3	78·7	90	9·2	423	+114	20*	...	...
Bombay	1004·5	− 1·2	87	76	84·2	77·5	80·9	+ 0·2	76·3	85	9·5	221	−139	18*	...	...
Madras	1005·5	0·0	101	75	98·5	79·0	88·7	+ 3·0	74·6	59	6·1	84	− 41	6*	...	...
Colombo, Ceylon	1010·3	+ 1·4	87	70	85·1	76·0	80·5	− 1·0	77·0	74	8·8	208	+123	28	6·1	49
Hong Kong	1002·0	− 3·2	93	74	85·4	77·5	81·5	− 0·6	77·4	84	7·5	871	+506	22	5·1	40
Sandakan	...	...	92	73	88·5	74·3	81·4	− 0·5	† 76·3	†78	...	314	+109	15	...	...
Sydney	1019·2	+ 1·0	80	42	63·3	47·7	55·5	+ 0·5	49·9	67	4·2	104	+ 26	15	6·5	60
Melbourne	1019·0	+ 0·9	69	34	57·8	43·1	50·5	− 0·6	47·4	72	5·5	45	− 1	15	5·4	50
Adelaide	1020·3	+ 1·1	74	39	61·0	45·8	53·4	− 0·5	48·4	67	5·8	57	− 7	15	5·5	51
Perth, W. Australia	1020·3	+ 1·5	77	41	64·2	49·1	56·7	+ 0·7	51·9	72	5·3	99	− 44	17	5·6	51
Coolgardie	1020·7	+ 1·4	79	31	65·2	41·7	53·5	− 0·1	48·1	49	3·5	5	− 21	5	...	...
Brisbane	1019·6	+ 0·6	76	41	68·9	49·0	58·9	− 1·7	54·3	63	3·2	18	− 38	6	8·6	77
Hobart, Tasmania	1014·2	+ 0·6	65	35	56·7	41·7	49·2	+ 1·2	44·5	68	5·5	41	− 6	14	6·0	58
Wellington, N.Z.	1019·1	+ 4·4	61	30	54·0	39·6	46·8	− 1·7	43·0	73	5·0	88	− 28	15	5·8	56
Suva, Fiji	1014·4	+ 0·1	86	63	77·4	68·0	72·7	− 1·0	68·9	80	7·3	160	− 49	20	...	...
Kingston, Jamaica	1014·1	+ 0·4	98	71	92·6	73·9	83·3	+ 1·8	...	65	5·5	20	− 73	7	...	...
Grenada, W.I.	1014·5	+ 1·9	87	72	84·5	74·4	79·5	0·0	75·5	77	4·9	184	− 55	22	...	...
Toronto	1014·2	− 1·2	90	43	76·3	55·2	65·7	− 0·9	58·4	69	3·8	91	+ 21	9	...	...
Winnipeg	1015·1	+ 1·2	91	38	74·8	49·6	62·2	− 0·8	56·2	62	3·1	17	− 43	8	...	...
St. John, N.B.	1013·2	− 2·2	79	42	66·0	49·9	57·9	− 2·7	53·7	82	5·6	103	+ 5	13	...	...
Victoria, B.C.	1016·9	− 0·3	81	49	68·8	53·1	60·9	+ 0·8	56·3	84	3·4	20	+ 3	4	...	...

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen. † Mean of observations at 9h., 15h., 21h., from April, 1923.