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The Winter Weather of December, 1928, January and February, 1929

After a wet and stormy November fairly cold and dry weather set in early in December, as described in the *Meteorological Magazine* for January, 1929. Conditions were not by any means extreme however, for over the British Isles as a whole the average temperature was only 0.6°F. below the normal. The parts of the country where the greatest deficit of temperature occurred were the Midlands and southern England, where a number of stations recorded a mean temperature more than 2°F. below normal, but at none of the low-level stations did the average temperature fall below freezing point. The pressure distribution also was not outstanding. The deviations from normal are shown on the left hand side of figure 1, the characteristics being a belt in which pressure was more than 5mb. above normal, extending across the North Atlantic from New York and Newfoundland to the Azores and the British Isles, and a pressure slightly below normal over Spitsbergen.

January, 1929, has been much more remarkable. The month has been generally cold, and though full details are not yet available, it is safe to say that over the country as a whole it is the coldest month since 1917. The greatest deficit of temperature occurred in southeastern England where some stations recorded a mean temperature more than 3°F. below normal. At Kew Observatory the difference from normal was as much as −3.5°F.,

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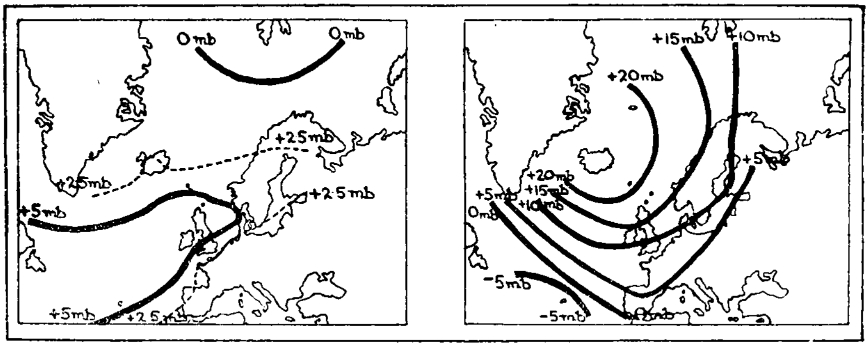
making it the coldest January there since 1895. The pressure distribution has been equally abnormal, this being one of the few winter months on record in which pressure over Iceland has exceeded that over the Azores. For the month as a whole, the mean pressure at Seydisfiord was 1022.0mb., or 23.2mb. above normal, while that at Horta was only 1008.7mb., 11.1mb. below normal. During the 35 years from 1894 to 1928 inclusive, pressure over Iceland exceeded that over the Azores twice in December, once only in January and five times in February, but the only occasions comparable with January, 1929, were the exceedingly cold February, 1895, when the difference amounted to 17.7mb., and January, 1918, with a difference of 9.7mb. A mean monthly pressure of 1015mb. or more is very rare in Iceland in winter, and the record for January, 1929, has been exceeded by only one January since 1846, namely, 1881, when it averaged over 1022mb. at Stykkisholm.

The deviations of pressure from normal over the eastern North Atlantic and western Europe during the first 28 days of



DECEMBER, 1928 JANUARY, 1929

FIG. 1

January, 1929, are shown on the right hand side of figure 1. Unfortunately the illustration had to be prepared before the end of the month, but the addition of the remaining three days makes little difference. The chart bears a certain resemblance to that for February, 1895, illustrated in the *Meteorological Magazine* for May, 1924, p.80, but the area with pressure above normal extends more definitely over the British Isles, and consequently the easterly winds were fortunately neither so strong nor so persistent as in 1895. By a curious coincidence, or perhaps it is more, the pressure map for December, 1928, is almost identical in all respects with that for December, 1894.

There is another aspect of the coldish winter of 1928-29 which is not without interest. A writer in *The Observer*, in the issue for January 20th, calls attention to an apparent 34 year periodicity, presumably a manifestation of the "Brückner Cycle," in these severe winters. January, 1895, was a cold month, and was succeeded in February by one of the greatest frosts of the nineteenth century. In December, 1860, and January, 1861, there was a very cold spell, the minimum temperature at Greenwich falling to 8°F. on Christmas Day and 10° on the 29th. In January, 1826 (a 35 year interval instead of 34) the Thames was frozen to such an extent that some of the bridges were completely blocked with ice. The periodicity is not so complete as it seems at first sight, however, for going back another cycle we find that neither 1791 nor 1792 were especially cold—not nearly so cold as 1795. Again, the coldest winter of the early nineteenth century in London was not 1826 but 1814, while 1838 was colder than either 1826 or 1861. In any case the winter through which we are passing, disagreeable though it may be, has so far not been outstanding compared with some of these giant frosts of the nineteenth century.

The cause of the abnormally high pressure over Iceland is at present a mystery. The northeast trade wind has been abnormally weak, a condition which contributes towards raising pressure over Iceland and depressing that over the Azores, but the northeast trade alone is not a very potent factor. It is more likely that something abnormal has been happening to the ice in the Arctic, but as to that we have no information.

At the beginning of February a large area of low pressure developed over the North Atlantic, and pressure over Iceland fell rapidly, but in the meanwhile an extraordinarily intense anticyclone had developed over northern Russia, pressure reaching nearly 1060mb. over the Urals on January 29th. The anticyclone continued to advance westwards, and has occupied northern Russia and the Baltic region during the first half of February. It is an offshoot of the great winter anticyclone of Siberia, with which it is connected by a ridge of high pressure in about 60°N. latitude, and on its southern side a great current of intensely cold air from Siberia drifted across Europe. The second week of February was accordingly intensely cold over central Europe, and at the time of writing the cold shows no signs of abating. Some of the minimum temperatures quoted in the press are: –67°F. at Ivanov-Voznesensk, northeast of Moscow (the previous lowest for this district being about –50°F.); –40° near Vilna in Poland; –31° in Silesia; –24° in Belgrade; and –15° in Berlin. In over a hundred years no temperature so low as this appears in the official records for Berlin, the previous records being –13°F. in January, 1850, and February, 1855. It must be pointed out however that the temperatures quoted above are not all official figures supplied by the various Weather Services, and some may refer to abnormal exposures. Various other facts however show that the cold is really abnormal. The western Baltic is freezing, and many ships are fast in the ice, and the Danube is frozen for 1,200 miles.

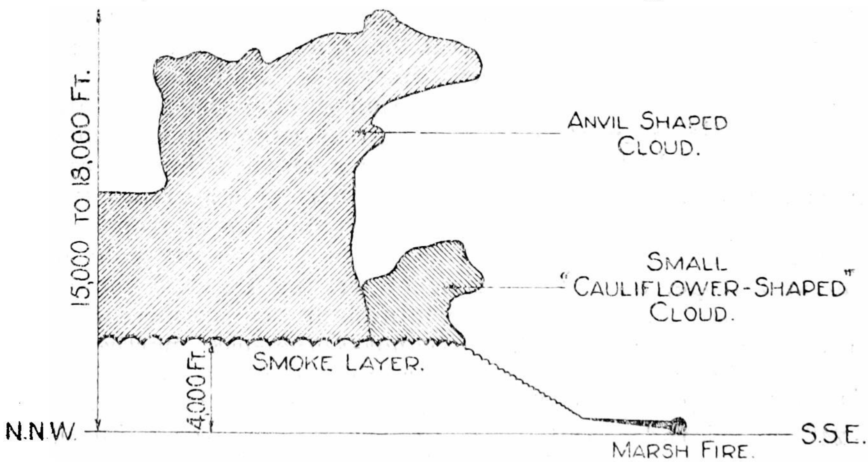
During the end of January and beginning of February a deep depression occupied the eastern Mediterranean, and was associated with several severe snowstorms over the Balkan Peninsula. The railway lines are blocked and three Simplon express trains have been snowed in for more than a week in Thrace, the abnormality of the heavy drifts being perhaps best shown by the fact that the railway authorities possess no snow ploughs.

C. E. P. Brooks.

Formation of a Cumulus or Cumulo-Nimbus Cloud near Basra on November 17th, 1928

The following account of the formation of an isolated cloud of great vertical extent within a few minutes over a marsh fire is based upon information supplied by Mr. F. D. Travers, Pilot of Messrs. Imperial Airways Ltd.

On November 17th, 1928, at 11h. 15m. (G.M.T.) during a flight from Basra to Baghdad a marsh fire was observed in Khor-Abu-Kelim (near Basra) the smoke from which reached a height of about 4,000 feet. On the upper surface of the smoky layer a small "Cauliflower shaped" cloud formed within a few seconds and this small cloud grew within two or three minutes into a large "anvil shaped" cloud whose top was at a height of 15,000-18,000 feet. A sketch of the cloud is given below.



The same thing had been observed to happen some minutes previously over another marsh fire at some distance from the route and apart from these two clouds the sky was cloudless from Basra to Shatt-el-hai (about 130 miles). Between Shatt-el-hai and Baghdadiyeh severe sandstorms and rain squalls were encountered.

Weather conditions in Egypt were very disturbed from November 14th, 1928 onwards due to the presence of a "low" near Greece. A cold front passed Ismailia at 23h. 45m. on the 14th—probably the same discontinuity as was encountered by a Flying Boat between Candia and Aboukir, the crew of which "were drenched with salt water at a height of 1,000 feet." The front was passed by an Imperial Airways Machine at 5h. 45m. (G.M.T.) on the 15th near El Arish, visibility being reduced to 50 yards owing to rising sand. At 10h. 20m. (G.M.T.) the squall reached Gaza and its further progress eastwards was (as is usually the case) held up by the Palestine Hills. The presence of the cold front was, however, responsible for heavy thunderstorms at Ramleh early on the 16th, 19mm. of rain falling within 15 minutes between 4h. and 5h. (G.M.T.). By Saturday, the 17th, cold air had passed Amman (Temp. fell 6°) and had probably penetrated well over southern 'Iraq. The rain squalls and dust storms between Shatt-el-hai and Baghdadiyeh were apparently due to a burst or bursts of cold air and a consequent bending of the "polar front" towards the east. The clouds observed over the marsh fire were formed in the southeast current drawn from the Persian Gulf region.

It would appear that above 4,000 feet the lapse-rate in the current up to a great height was at least equal to the saturated adiabatic rate and that a comparatively small disturbance was sufficient to cause very rapid condensation in a column of air extending from 4,000 to 15-18,000 feet. According to the above report a marsh fire affecting an area of about 40,000 square yards was sufficient.

J. Durward.

OFFICIAL PUBLICATIONS

The following publications have recently been issued:—

International Meteorological Organization, Commission for Synoptic Weather Information. Report of the seventh meeting, London, May, 1928. (M.O.309.)

The particulars of the various proposals which the Commission and its Sub-Commissions had under consideration at its 7th meeting in London in May, 1928, are given in appendices and furnish an excellent index of the activity of synoptic meteorology and of the efforts which the members of the Commission are making to bridge the gap between the relatively simple international arrangements of pre-war days and the world-wide organisation to which the present developments are leading.

One of the most important aspects considered at the meeting in London was that of the organisation of synoptic meteorology of the oceans. The Commission decided that a satisfactory organisation could be achieved only by having ships equipped with properly tested meteorological instruments and making reports at standard times in a uniform code. It was agreed that each nation should undertake to equip a number of ships, proportional to the tonnage of its sea-going mercantile marine, and that the standard hours of observation should be at midnight, 6 a.m., noon, and 6 p.m. (G.M.T.), and it was further agreed that details of the plan for the collection and distribution of observations at sea should be prepared for circulation to the different meteorological services interested.

The question of a universal code for meteorological reports in all countries and all climates is naturally one of great difficulty. The Commission gave provisional approval to a code and specifications designed for world-wide application and for meeting the requirements both of aviation and of general forecasting. Details of the code are included in the Report. Great difficulty has been caused in the past owing to the differences of the unit adopted for the expression of atmospheric pressure. The Commission agreed, practically unanimously, that for international purposes atmospheric pressure should be expressed in millibars, the unit proposed some 20 years ago by Professor V. Bjerknes.

Other resolutions of the Commission concerned the arrangements for the distribution of reports by wireless telegraphy in the European area; for the extension of meteorological stations in the polar regions; and for the arrangements for the exchange of meteorological reports between Europe and America.

GEOPHYSICAL MEMOIRS—

No. 44. The distribution of mean annual maxima and minima of temperature over the globe. By C. E. P. Brooks, D.Sc., and Miss G. L. Thorman, B.Sc. (M.O.307d).

The mean annual maximum of temperature at any place is the average of the highest shade temperatures reached at that place during each of a number of years. It gives approximately the temperature which is likely to be exceeded at that place once in two years. Similarly, the mean annual minimum gives the average of the lowest shade temperatures reached during each of a number of years. These figures, which are of great climatic interest, are given for a large number of places distributed over the world, and are also shown graphically on two world charts. It appears that the highest temperatures are found, not near the equator, but in latitudes 20-30°N. and S., the actual maximum being 125°F. in the Sahara. Mean annual minima are, however, highest near the equator, and on some equatorial islands they are above 70°F. In London the mean annual maximum is 89°F., and the mean annual minimum 20°F. The two maps are conveniently arranged for comparison, which brings out many interesting points.

Discussions at the Meteorological Office

December 10th.—*Measurement of variable velocity relative to air with pitot-static tube.* By K. Wada and S. Nisikawa. (Tokyo, Rep. Aeron. Research Inst. 2, 1927, No. 13, pp. 327-393.) *Opener*—Mr. A. C. Best, B.Sc. Mr. L. F. G. Simmons also spoke on " Recent research work on the Dines anemometer at the National Physical Laboratory."

This paper can be divided into four parts. In the first part the equation of a theoretical pitot-static tube is developed, taking the general form of Bernoulli's equation as basis. Then formulæ are obtained enabling the velocity of air to be calculated from the indications of a pitot-static tube when that velocity is variable. In the second part, the influence of friction in the pipe connecting the pitot-static tube to the indicating part of the apparatus is discussed. It is shown that, in the case of a simple harmonic variation of velocity, the friction reduces the amplitude of variation. A formula for this reduction is deduced. The authors used a diaphragm manometer as indicator. In the third part of the paper, they calculate the amount of the time lag resulting from the volume of the chambers of this manometer.

Finally, experiments are described in which the true velocity of the end of a pendulum, and the velocity indicated by a pitot-static tube attached to the end are compared. Comparisons are given both before and after corrections for the three effects described above, have been applied. It is shown that the corrections bring the true and indicated velocities into very close agreement.

Mr. L. F. G. Simmons, of the National Physical Laboratory, gave a brief account of recent research work in the Dines anemometer. Arising out of a paper by himself and Mr. Johansen on the transmission of air waves through pipes, Colonel E. Gold had suggested that an investigation be made to determine the effects of the length and diameter of the connecting piping on the record of a Dines anemometer, when the actual wind was varied in a known manner. It was soon found that in 50 feet lengths, one-inch piping was greatly superior to half-inch or smaller sizes. In consultation with the Meteorological Office, various other problems were tackled and the main results were as follows:—

(1) For anemometers in which the head and vane were of the order of 50 feet above the recorder, one-inch gas-piping should be used as the connecting tubes.

(2) The bends at the base of the head give rise to eddies which cause serious variations in the suction/pressure ratio according to the direction of the wind. These variations could be eliminated by enclosing the lower part of the head in a cylindrical

shield with conical top suggested by Mr. Giblett. By making the base angle of the cone 57° a fairly close approximation to the Dines factor could be obtained over the working range of velocities. There remained, however, a slight scale effect which was inherent in the design of the instrument.

(3) By staggering the suction holes, variations of the factor due to the distribution of holes and spaces could be rendered negligible.

(4) The question of the effect of the width of the annular space between the outer and inner tubes (near the suction holes) was examined. From the point of view of constancy of factor, no advantage would result from an alteration of the present dimensions of the inner tube, which would alter the annular space into which the suction holes lead. There is some evidence in favour of increasing the outer diameter, in order to secure a more uniform value of the factor over the normal working speed range; but it is anticipated that the experiments at present in progress will show that the same result can be effected by simply enlarging the suction holes, or by replacing the holes by suitably arranged slots.

(5) Leakage of air between the float rod and collar introduced an error which depended upon the size of the pressure and suction pipes. It would be desirable to eliminate this leakage by introducing a liquid seal.

(6) When displaced, the vane was found to execute several oscillations of rapidly diminishing amplitude before coming to rest in the air stream.

The modifications necessitated by the results of the investigation were illustrated by reference to a new anemograph which was on view. These included a shield, staggered suction holes and large unions to permit of the use of one-inch gas piping in place of the half-inch compo piping previously employed.

January 14th, 1929.—*On the formation of surface inversions of temperature with clear skies and land breezes.* By R. Steiner. (Rostock, Wiss, Abh. Luftwarte Univ., Heft 1, 1926.) (In German.) *Opener*—Mr. D. Brunt, M.A., B.Sc.

In his introduction the opener summarised briefly the physical causes of inversions at night. While the earth radiates approximately as a black body, giving radiation whose maximum intensity is at about 10μ, the water vapour in the atmosphere is transparent to a band of wave-lengths from 8μ to 11μ. Thus if at night the earth and the air above it initially had the same temperature, they could not remain in thermal equilibrium, and the earth would cool in virtue of its loss by radiation within the band 8μ to 11μ. The cooling extends gradually upward eventually giving an inversion, but the relative importance of turbulence and radiation in producing the inversion remains unsettled. The opener pointed out that the transfer of radiation can be approximately represented by an equation similar to that for conduction of heat in a solid, and that while radiation strives to produce an isothermal condition, turbulence strives to produce an adiabatic condition. That radiation must be of importance in the phenomena of the lower atmosphere is shown by the fact that in the morning the temperature at the top of the Eiffel Tower starts rising before the lapse rate has reached the dry adiabatic.

In the paper by Steiner the observations of temperature up to about 600 metres refer to occasions when the sky was clear, and the wind had come for long distances over land, mainly from the east. The lapse rate, after being in excess of the dry adiabatic, diminished steadily, giving isothermal conditions up to 600 metres at about sunset, the inversion not forming even at the ground until after sunset. These characteristics were shown by a number of ascents.

Mr. Heywood, of Leafield, showed some diagrams illustrating the formation of inversions ~~at the~~ ground some considerable time before sunset, in definite disagreement with Steiner's scheme of development.

In the course of the discussion it was pointed out that with recording instruments of the usual type ascents made every half-hour gave ample time to avoid errors due to the lag of the instrument. It was also pointed out that the average lapse rate is the same over the whole earth, and at all heights within the troposphere, and is approximately equal to the saturated adiabatic lapse rate, and approximately half-way between the isothermal and dry adiabatic conditions. The practical importance of determining the factors which are effective in producing night inversions, in regard to the forecasting of night frost, was also mentioned, special reference being made to the occurrence of ground frost in a polar current with a strong westerly gradient.

The subjects for discussion for the next two meetings will be :—

February 25th.—*Relations between changes of atmospheric pressure and temperature. A contribution to the question of the "seat" of pressure variations.* By Bernhard Haurwitz (Leipzig, Geophys. Inst. der. Univ. 2nd Series, Bd. 3, H. 5, 1927, pp. 267-336) (in German). *Opener*—Mr. L. Dods, B.Sc.

March 11th.—*Contributions on the mechanism of waterspouts and tornadoes.* By A. Wegener (Met. Zs. Bd. 45, H. 6, 1928) (in German). *Opener*—Mr. M. A. Giblett, M.Sc.

Erratum

January, 1929, page 290, line 34, *for* " 1926 " *read* " 1928."

Royal Meteorological Society

The Annual General Meeting of this Society was held on Wednesday, January 16th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, in the Chair. The Report of the Council for 1928 was read and adopted, and the Council for 1929 duly elected, Sir Richard Gregory, LL.D., being re-elected President.

The meeting began with a pleasant surprise in the form of a short talk by Col. E. Gold on the blizzard and period of intense darkness which had visited London and the neighbouring districts that morning. This is a new departure which it is hoped will become a regular feature of future meetings, which will open with a "five-minute" talk on some recent happening of meteorological interest, or the exhibition of new lantern slides which have been added to the Society's collection.

In presenting the Buchan Prize to Dr. H. Jeffreys, Sir Richard Gregory gave an interesting summary of the development of our knowledge of the atmospheric circulation, beginning with the voyages of Dampier, the dynamical theories of Halley and Hadley and the physical experiments of Robert Boyle and Dalton. For long the thermal theory of cyclones held the field, until it was destroyed by W. H. Dines and sounding balloons. Later came the Bjerknes' conception of the cyclone, in which for the first time depressions of temperate latitudes were regarded as something more than accidental ripples on the general circulation. Finally, Dr. Jeffreys showed that not only were cyclones part of the circulation, but that owing to the presence of friction they were a necessary part. In his reply Dr. Jeffreys said that Dr. F. J. W. Whipple had also added an important step to the theory. He also remarked that there was still plenty to discover about cyclones.

Sir Richard Gregory then delivered an address on "Amateurs as Pioneers."

Though the word "amateur" is commonly used disparagingly to signify a superficial student or worker, its correct meaning is one who loves or is fond of anything, or cultivates a subject as a pastime, as distinguished from one who prosecutes it as a professional occupation. In this sense every scientific worker is an amateur in any field of activity in which he is interested outside that in which he is professionally engaged. Until relatively recent times all scientific societies were organisations of amateurs. At a later stage, when it is found that their inquiries have a practical value, professional institutions are established, and much of the work is taken over by industrial or national services. In the middle of last century James Glaisher formed an organisation of voluntary observers for meteorological records, and the Royal Meteorological Society maintained this service until it was taken over by the Meteorological Office in 1912. The systematic collection of rainfall records which was started by G. J. Symons in 1859 and now includes about 5,000 observers in Great Britain and Ireland, has similarly become part of the organised work of the Meteorological Office. The systematic study of upper air conditions, now carried on for practical purposes of aviation, had their origin in the work of such amateurs as W. H. Dines and C. J. P. Cave. It was an amateur, Benjamin Franklin, who established the identity between the discharge from an electric machine and lightning by his famous kite experiment in 1752. An amateur also, Oliver Heaviside, first showed that there was a conducting layer in the upper air, now called the Heaviside layer, which would reflect electro-magnetic waves; and it is through the action of the ionised layer as a reflector that radio communication around the world has become possible. It was amateurs who first established world communication with short waves, 300 metres or less in length, when such wave-lengths were regarded as useless for commercial purposes. In transport also, through the experiments of Wilbur and Orville Wright, the conquest of the air for the advancement of knowledge and the service of man has been due chiefly to the pioneer work of amateurs. Every encouragement should be given, therefore, to all such voluntary workers in scientific fields.

Correspondence

To the Editor, *The Meteorological Magazine*

Wet Bulb Temperatures as "Thaw Temperatures"

When the ground is frozen in winter the air temperature may rise 3 or 4 degrees (F.) above freezing point without any effective thawing even of the surface of the ground. The explanation of this appears to be that the frozen ground, so long as there is any moisture in it, acts as a wet-bulb thermometer and consequently does not thaw so long as the wet-bulb temperature is 32°F. or less. When there is no longer any moisture in the surface layer, it will no longer remain frozen if the dry bulb is above freezing point, but neither will it have the characteristics commonly associated with a " thaw "—it will be powdery and not muddy. Wet bulb temperatures are therefore of special interest when the dry bulb temperature is near the freezing point.

There is another aspect of this question which has some importance. Until evaporation from the surface layer of the ground is practically complete, the lowest layer of air (and of the surface with which it comes in contact) is being cooled by evaporation; afterwards cooling of this layer (and the surface) is effected practically only by radiation. The cooling by outward radiation from the earth's surface to a clear sky (at temperatures near the freezing point) is only about the same as the cooling due to the evaporation of 2 to 3 millimetres of water per day of 24 hours: (we may take outward radiation to a clear sky to be approximately 25 per cent. of black body radiation at the surface temperature.* Over relatively short periods of time (of the order of a day or less) evaporation may therefore be a more important cooling factor than radiation when the air is dry and there is some wind.

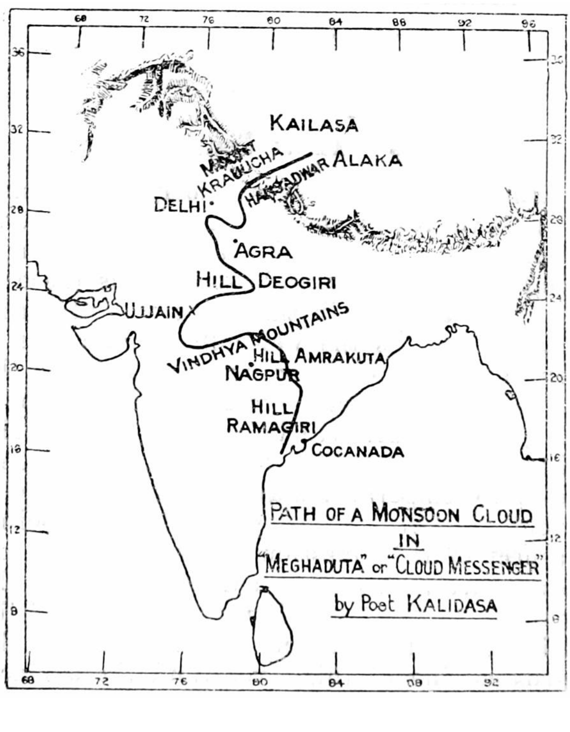
The existence of a snow layer is known to be very effective in reducing the temperature of the surface layers of air; the reason appears to be twofold: (1) it provides for continuous evaporation, and (2) it reflects a much great percentage of the incoming solar radiation than the uncovered surface of the ground. Even in mid-winter in this latitude the incoming solar radiation in the middle of the day more than counterbalances the outward radiation if it is mostly absorbed by the surface, but this may no longer be the case when a large proportion of the solar radiation is reflected.

E. GOLD.

January 7th, 1929.

Ancient Hindu Meteorology

It may be of interest to the modern meteorologist to know that Kalidasa, the celebrated Indian poet and dramatist, who flourished about the beginning of the Christian era, took pains in describing the path of the monsoon cloud in his famous work entitled "The Meghadutam" or "The Cloud Messenger." The chart below, which depicts the path of the monsoon cloud over India according to Kalidasa, has already been published by Krishnamachariar, a south India Sanskrit scholar. That circuitous path near Ujjain will not be



PATH OF A MONSOON CLOUD IN "MEGHADUTA" or "CLOUD MESSENGER" by Poet KALIDASA

* *See London, Q.J.R. Meteor. Soc.*, 39, (1913), *pp.* 258-60.

accepted appears to have been known to the poet; when addressing the monsoon cloud he says in the 27th verse, "though the path is circuitous for thee travelling to north do not miss Ujjain." It may be explained that Ujjain was the capital of the great kingdom of the Vikramas, Kalidasa being one of the nine gems of the court of a Vikrama. The cloud must therefore see this wonderful city and do homage to the king before proceeding north. The following remarks by the poet to the monsoon cloud are interesting:—

Verse 13. "Rest on mountain when thou art much exhausted."

Verse 19. "Rest for a while on Amrakuta hill, get light by the discharge of moisture and then speed on."

Verse 20. "The wind will not be able to move thee full of water."

Verse 22. "Thou wilt be delayed on every mountain."

Verse 56. (After Hardwar at the foot of the Himalayas) "give heavy showers of hail."

Verse 59. "Get compressed against the Himalayas and squeeze through Hansadwara pass near Mount Kraunch."

Verse 62. 63. "On the Kailasa mountain thy body will be congealed within thee and dreadful thunder will accompany thee."

Verse 120. The last verse in which the cloud is blessed by the poet thus, "Having carried my message of love to my beloved at Alaka near Kailasa you are free and mayest thou be never separated from your beloved the lightning in the same unfortunate way as I have been."

It is clear from the above statements that more or less accurate observations of cloud movements during the monsoon were made in India even two thousand years ago. This note may be interesting to students of past climates.

M. V. UNAKAR.

Poona, December 27th, 1928.

Pink Rainbows

The description of the pink rainbow on page 234 of the November issue appears to be similar to several I have noted here and upon one in particular, that on August 28th, 1924, I have made the following note:—

"Brilliant rainbow faded away at sunset and reappeared with secondary in the after-glow in colours such as an ordinary rainbow would have, if seen through orange coloured glasses."

These rainbows appear after sunset in the after-glow when the clouds are very high, and in the instance noted, both ends of the arc were cut off some distance from the horizon. For anyone who has not lived in the tropics it is difficult to realise the brilliance of these after-glows, which under certain conditions and at certain times of year, are fairly common. The blaze of colour that spreads and passes from east to west in the course of a few minutes can never be adequately expressed in words. I take it that the coloured brilliance is due to the sun shining directly on clouds of considerable altitude through a comparatively impure layer of air close to the surface of the earth, and that, if moisture is falling from these clouds, a rainbow naturally occurs, even though the sun may have set some minutes.

R. S. BRETON.

The Siam Commercial Bank, Ltd., Tung Song, S. Siam. *December* 19*th*, 1928.

Winter Fog and Relative Humidity at Three Selected Stations

Defining " Winter " as the months October to March (inclusive) and " fog " as a visibility of less than 1,100 yards, the table attached shows the occurrence of fog with regard to relative humidity during winter at the three stations—Birmingham, Cranwell and Gorleston. For Birmingham the period brought under review stretched from October 1st, 1923, to March 31st, 1927, and the hours of observation employed were those of 7h., 13h., and 18h., G.M.T.; whilst for Cranwell and Gorleston the period was from October 1st, 1922, to March 31st, 1927, and the hours of observation 1h., 7h., 13h., and 18h. The data used were extracted from the *Daily Weather Reports* issued by the Meteorological Office, London. It needs to be noted that in the construction of the table the first of the three relative humidity columns contains all readings below 95 per cent. and the second all readings below 90 per cent. The relative humidities were in every case measured by the use of wet and dry bulb thermometers, and the visibility observations at the sea station, Gorleston, are those taken looking landwards.

	No. of cases of fog	Percentage of such cases when relative humidity was less than		
		95 per cent.	90 per cent.	80 per cent.
Birmingham	220	57·3	30·5	6·4
Cranwell	279	5·1	2·2	0·7
Gorleston	138	21·0	6·5	0·0

The high percentages of fog at the town station—Birmingham—with air that is not saturated, or even approximately saturated, are probably significant from the view point of the effect of smoke when compared with Cranwell, a typically rural exposure. The figures for Gorleston—a seaside station—do not seem to admit of a ready explanation, though condensation upon salt particles is a possible one.

W. H. PICK
R. C. SUTCLIFFE.

NOTES AND QUERIES

Rime at Sealand on December 15th, 1928

The photograph of rime, which forms the frontispiece of this volume, was taken at Sealand Aerodrome, near Chester, on the morning of December 15th, 1928, at 10h. 30m.

The aerodrome stands on a stretch of low-lying sandy land that forms the northeastern corner of Flintshire, and which was formerly the ancient bed of the River Dee and, according to some, also that of the River Mersey. The site of the rain-gauge is only 16ft. above mean sea level. Being low-lying, fogs develop on clear quiet nights, but seldom persist after sunrise owing to the operation of a land breeze from the south-east to the adjacent Dee Estuary and the Irish Sea.

On December 14th the southwestern edge of a Scandinavian anticyclone was irregularly distributed over the British Isles, and except for the usual land breeze in the morning there was no wind for the rest of the day. The temperature at 16h. was 31.3°F. having fallen from 38.6°F. at 13h. and fog had formed before 16h. At 18h. the fog was thick, the visibility being less than 200yds. and the air temperature had dropped to 23°F. The fog continued during the night but was dissipated early the next morning by the land breeze from the southeast and at 7h. visibility was over 1,100yds. During the night the grass minimum fell to 12°F., a temperature shared with Worthy Down. The screen minimum fell to 18°F., which was the lowest screen temperature in the British Isles reported the following morning.

In the photograph the rime-laden foliage faces westnorthwest and lies in the lee of the morning breeze. The road in the foreground is the main Birkenhead-North Wales road, which crosses the railway line by a bridge to the left of the photograph. There is a considerable milk traffic on this road in the early morning, and consequently it shows no indication of frost or frosty precipitation, though the coating on the grass edge below the wooden fence is quite plain. The part of the fence to the right-hand side of the photograph was not so heavily coated as that to the left probably due to the fact that the wood on the left flanks open flat ground to the north and northeast and borders the railway. The trees on the right, as the photograph shows, have the wood behind them, and the small flat-topped tree lying almost on the fence had a thick covering of rime on the wood side, but was almost free from it on the road side. Thus the drift of the fog seems to have been from the northeast. This would be likely to occur as the lowest ground is to the southwest along the artificial banks of the present River Dee. The rime persisted all day, and finally disappeared in the slight sleet on the morning of December 16th.

The photograph was taken by one of the R.A.F. photographic staff at the aerodrome, through the courtesy of Group Captain A. D. Cunningham, C.B.E., Commanding No. 5 Flying Training School, Royal Air Force.

J. J. SOMERVILLE.

The Contrast in the rainfall of Januaries of 1928 and 1929

While the general rainfall over the British Isles as a whole was 202 per cent. of the average in January 1928, that of January 1929 was only 63 per cent. The former month was therefore more than three times as wet as the latter. For the country as a whole January 1928 was the wettest January since comparable statistics became available in 1870, while a smaller fall than that of 1929 has occurred only in the Januaries of 1880, 1881, 1896, 1907 and 1911, when the general falls were 37, 44, 53, 60 and 60 per cent. respectively.

This sharp contrast in the rainfall of two consecutive Januaries, although unprecedented in January, recalls that of the two consecutive months, November and December 1926, which were the wettest and driest months of those names respectively back to before 1870. The total rainfall of November and December 1926 was, however, quite close to the average. The deficiency of January 1929 was appreciably less than the excess of January 1928. Moreover, since 1918 the rainfall of each January, except one, has exceeded the average, the smallest amount being that for 1927 with 97 per cent. of the average. The rainfall of five Januaries during this period has reached or exceeded 140 per cent.

The outstanding feature of the distribution of the rainfall of January 1929, as a percentage of the average, was the gradient from east to west, associated with an unusual frequency of northerly and less frequent westerly winds. There was rather more than the average rainfall along the east coast of England and less than 50 per cent. over most of the western half of Great Britain and of Ireland, with only about 25 per cent. in the Western Highlands of Scotland and in the northwest of Ireland. The rainfall was most remarkable in Scotland where the month was the driest January since that of 1881. At Ardross Castle, in eastern Ross-shire, January 1929, with 0.99in., was the driest January since before 1870. Elsewhere over the

British Isles the Januaries of 1880 and 1881 were most often the driest on record. It is noteworthy that the driest January on record at individual stations has rarely given totals of less than half an inch.

In January 1928 the largest percentage values (of 280 per cent. or more) occurred in the northwest of England and in the Southern Uplands of Scotland. The month was the wettest January on record in these regions as well as in the northwest of Ireland, at Wick in Caithness and at Eallabus in Islay. The weather of the month, unlike that of January 1929, was mainly mild and the number of depressions which passed across or near these islands was unusually frequent.

J. GLASSPOOLE.

Meteorological Exhibits at the Exhibition of the Physical and Optical Societies

The nineteenth annual exhibition of the Physical Society and the Optical Society, held at the Imperial College from January 8th to 10th, 1929, was of more than ordinary interest to the meteorologist. In the Trade Section several new instruments were exhibited for the first time. Among these may be mentioned Messrs. Casella's anemometers, incorporating the "three cup" system designed by Mr. J. Patterson, of Toronto. The cups are 5in. in diameter and are carried on arms giving a centre-to-centre distance from the spindle of 6.3in. The system makes 640 rotations per mile of wind and the "factor" is, therefore, 2.5. One of the anemometers was fitted with a speed indicator, thus incorporating the essential features of the anemometer illustrated on p. 184 of the *Meteorological Magazine* for September, 1927.

Messrs. Negretti & Zambra showed several new instruments, including a new "recording float raingauge." This instrument, which is of imposing dimensions, employs a large float chamber capable of containing 12in. of rain. The float is suspended by a phosphor bronze chain wrapped several times round a brass drum connected to a ratchet wheel on the edge of which are twelve notches. Engaging the ratchet wheel is a pawl attached to the pen arm carriage. Ingenious mechanism is provided for disengaging the pawl when the pen reaches the top of the chart and returning it to the base line. The float chamber is emptied by means of a hand-operated pump and syphon device when nearly full.

The same firm showed a novel type of barograph. The recording pen is attached to a brass frame which carries a group of aneroid boxes connected by a spindle to a heavy brass weight. The frame is balanced on knife edges and its action depends on the change in the centre of gravity brought about by the movement of the weight in response to a change of pressure. The instrument is still in the experimental stage, but the idea seems worth pursuing.

In the Research and Experimental Section, the Meteorological Office exhibited a group of instruments recently developed for testing purposes or for special observational work. These included instruments for testing rainfall measuring glasses and Campbell-Stokes sunshine recorder spheres, a "sky-photometer" for measuring the total illumination of a horizontal surface, an "air-duct psychrometer" for humidity measurements on aeroplanes and a new electrically-operated wind direction recorder.

At the invitation of the Managers, the sky photometer and sunshine sphere testing apparatus were subsequently exhibited at a Conversazione of the Royal Institution on January 25th.

Defects in the Piping of Pressure-Tube Anemometers

Custodians of pressure-tube anemometers or anemobiagraphs for which the tubes connecting head and recorder are made of compo-piping are recommended to examine the piping very carefully for defects at frequent intervals. "Compo" is a soft alloy which will not withstand rough treatment, and cases have occurred where the piping has been pinched and even punctured by the metal straps which are often used to bind the piping to the anemometer mast which supports it. Such straps should be well lined with leather so that they do not bear directly on the compo-piping.

In a recent case an anemometer, which appeared to be working satisfactorily in all other respects, developed a mysterious fault on wet days. This resulted in the collection of sufficient water in the float chamber to raise the level of the water by as much as 1¼in. on some occasions. Although the compo-piping was carefully examined no defect could be detected until the piping was taken down, when it was found that defects had developed in both pipes at two soldered joints near the recorder. Not only did the defects vitiate the record because of the escape of air, but the break on the suction side in particular acted as a collector of rain-water which had trickled down the mast, and in consequence the water found its way into the float chamber in considerable quantity. In another case defective action was traced to the presence of a hole in the suction pipe, caused by chafing against one of the climbing steps on the mast.

It is not an easy matter to test compo-pipes for leaks when they are *in situ*. One method would be to disconnect the pipes top and bottom at the screwed joints where they are attached to the head and recorder, stop them securely at the top by rubber corks and apply pressure at the lower end of each pipe in succession by means of a suitable head of water or mercury in a glass U-tube connected to the lower end by a piece of rubber tube. This method would detect a leak but it would not detect a stoppage in the pipe due to a "pinch" or other cause.

In recent issues of anemometers the compo-piping is replaced by 1in. diameter iron-piping, which is much more durable and satisfactory than compo.

Reviews

Uber wärme Hochdruckgebiete und ihre Rolle im atmosphärischen Wärmehaushalt. By R. Mügge. Leipzig, Geophysikalisches Inst. der Universität. Veröff. 2 Band III, Heft 4, pp. 239-266.

In this paper Mügge first reviews briefly the correlation coefficients obtained between pressure, temperature, etc., in the upper air, and recalls the observed fact that the stratosphere is high and cold over high pressure, and low and warm over low pressure. The paper discusses the possibility of explaining the warm anticyclones which reach great heights as the effect of outbursts of cold air at high altitudes, from the tropics to higher latitudes. The international observations for two days of anticyclonic conditions, viz., May 7th, 1909, and May 19th, 1910, were taken, and vector-mean winds for three levels, 1-4 km., 4-8 km., and 8 km. to the tropopause, were evaluated, and represented graphically. For May 7th, 1909, three charts are reproduced showing the lines of flow in the three layers considered, and it is shown that at each level, there is a point of divergence which is displaced south-south-westward with increasing height. The isotherms for the lower stratosphere indicated an island of cold air slightly southward of the point of divergence in the higher level. The gradient of the isotherms opened out towards the southwest, indicating an outburst of cold air from somewhere westward of the centre of lowest temperature. Generally similar temperature distribution was found on the second occasion, May 19th, 1910.

Mügge regards the outflow of air as being compensated by the subsidence of the cold air from high levels. He computes the outflow across a cylinder of 1,000 km. diameter, and 4 km. high, and computes the downflow through the top of this cylinder as equivalent to a downward velocity of 2·8 cm./sec. over the whole of the top of the cylinder. The data reproduced in the paper do not make it possible to judge how stable or unstable the vertical conditions were over the region in question.

The question of radiative equilibrium, assuming the radiation to be entirely due to water vapour, and to be "grey" radiation, *i.e.*, proportional to the black body radiation for the same wave-lengths, is discussed in detail, and it is shown that the temperature in the stratosphere is determined partly by the incoming solar radiation, and partly by the heat brought into, or removed from, the region, by horizontal winds. Mügge applies this to the discussion of the conditions in the anticyclone of May 7th, 1910, where the mean temperature in the stratosphere was assumed to be — 60°C., in reasonable agreement with the observations. In the absence of any loss of heat by advection, the temperature of the stratosphere demanded by radiative equilibrium is — 45°C. Mügge shows that the loss could be accounted for if the air descending into the lowest 4 km. through each square cm., the top of the cylinder considered in the last paragraph, eventually carried away with it 0·1 calories, which would be equivalent to raising its potential temperature through 4°C. Since potential temperature normally increases with height, the air should not acquire the enhanced potential temperature necessary, in the course of its descent. Mügge suggests that the loss is due to evaporation of water, and shows that the mean rate of evaporation for the earth, if taken to apply to this case, would account for the loss of heat required. To the present reviewer the physical processes involved are not at all clear. It is regretted that the distribution of potential temperature with height was not discussed in greater detail, in view of the difficulty of accounting for the descent of air on a large scale.

Mügge also discusses the latitude variation of the temperature of the stratosphere, and arrives at the surprising result that the atmospheric radiation in polar regions is greater than in tropical regions, a result which is not readily explicable in terms of water-vapour radiation. This portion of the paper should be read in conjunction with Dr. Simpson's recent memoirs on the subject.*

D. BRUNT.

Das Potentialgefälle der Luft in Wahnsdorf. By Hans Goldschmidt. Supplement to Deutsches Meteorologisches Jahrbuch für 1926. Freistaat Sachsen. Jahrgang XLIV, pp. A1—A20. Dresden, 1926.

The above supplement to the Free State of Saxony's Section of the German Year Book for 1926 discusses atmospheric electrical potential gradient records at the meteorological observatory at Wahnsdorf, a few miles north of Dresden, for the period July 1st, 1923, to December 31st, 1926.

The recording apparatus is described in detail, but consists essentially of a Benndorf electrograph connected to a radio-active collector. At first, registration was carried out in an isolated hut, but from May, 1926, a ground floor room of the main building was utilised. The records were standardised to give readings in volts per metre in the open by absolute observations

*London. *Memoirs R. Meteor. Soc.* Vol. II, No. 16 and Vol. III, No. 21.

of the gradient between two wires carrying fuses, 1 metre and 2 metres respectively above the ground. The observations were taken 4—6 times a year on two open sites, one 100 metres to the north and the other 500 metres to the north-east of the observatory. A single exposure factor was used, but it would have been interesting to have results from both sites.

Mean hourly values were measured on the curves for two kinds of days, (1) quiet (q) days, that is days with cloudless or half-covered skies, with an absence of towering cumulus cloud, precipitation, mist, fog, electrified dust, thunder and lightning; and (ii), all (a) days, which included all days of complete record except those on which the insulation was faulty, or when there was charged precipitation. In some months there were only 2 or 3 " q " days and in others none at all, but no indication of the number of days used is given. Mean diurnal inequalities were abstracted for all the months, and for the mean months, seasons and years of the complete years 1924-26. The results are given in 11 pages of tables and graphs.

Generally speaking, the " quiet " day means are higher than the " all " day means, although in summer there is not much difference. The mean values for the three years, 1924, 1925 and 1926 are:—(q) 169, (a) 154; (q) 191, (a) 152; and (q) 174, (a) 141 volts per metre respectively, which are in accordance with places similarly situated to Wahnsdorf. The general variation of the monthly means from January to December is similar to that found elsewhere, being high in winter, (q) 243, (a) 207 volts per metre, and low in summer (q) 115, (a) 108 volts per metre. The mean daily variations for the individual months, however, are not in accord with those from other stations. As generally happens with potential gradient records from new stations, new types of daily variation seem to be supplied according to special local disturbances, and in the case of Wahnsdorf it is the summer variation which is outstanding.

The winter curve is the single wave type, with a minimum at 4h. and a maximum about 21h., such as is found universally over all the oceans and in high northern latitudes all the year round. The warm weather curves are also characterised by a single wave, but while the universal early morning minimum maintains its position, the evening maximum is almost obliterated (the maximum being in the forenoon), while the usual early afternoon minimum, supposed to be due to local effects in the lower layers of the atmosphere, does not appear at all.

The author feels that the exceptional type of summer daily variation at Wahnsdorf must be due to the peculiar position of the observatory, which is on a small plateau 250 metres high sloping away gradually to large tracts of field and forest land in the north; while to the south, about 500 metres distant, it drops down steeply into the Elbe valley. This runs southeast to northwest and is thickly studded with industrial towns. The suggestion is made (only to be rejected afterwards) that strong sunshine stirs up the highly polluted Elbe valley air, which rises up over the observatory and prevents the development of the afternoon minimum. Then in the evening the cooled air recedes, causing a decrease in potential gradient which obliterates the late evening maximum. This explanation is not supported either by solar radiation records or by wind frequency distribution. In summer especially, during the daytime when the gradient is high, clean winds from the north are predominant, while in winter polluted winds from the south are most frequent.

The harmonic analysis of the curves into the first three terms of the usual Fourier Series does not add to the information derived from the curves themselves.

From the summer of 1927 it is hoped to commence registration of the electrical conductivity of the air by the Schering method, and later on that of the radio-active emanation from the ground, in an attempt to explain the peculiar type of diurnal variation of potential gradient in summer. (It might be suggested that records of atmospheric pollution and the numbers of large ions in the air would throw some light on the phenomenon. With our increasing knowledge of atmospheric electricity, it is becoming more and more evident that a true picture of the electrical state of the atmosphere can only be obtained by the simultaneous observation of all the relevant factors.)

R. E. WATSON.

Obituary

Andrew Watt, M.A., F.R.S.E.—Andrew Watt was born in Edinburgh in 1869. He received his education first at Dumfries Academy and afterwards at Edinburgh University, where he took a high place in mathematics and graduated in 1889. After this, in consequence mainly of the state of his health, he made a voyage to Australia. There for some years he taught mathematics in the Scots College, Melbourne. Returning to this country in 1894, he continued in the same profession until 1900 when he joined the staff of the Scottish Meteorological Society as Assistant to the late Dr. Buchan. Shortly after the death of Miss Jessie Buchan in 1905, he became Assistant Meteorological Secretary and on Dr. Buchan's death in 1907, he was appointed as his successor. In the same year he was elected a Fellow of the Royal Society of Edinburgh. For some time prior to that the general work of the Meteorological Society had largely devolved on him. He edited the Society's Journal which maintained a high standard of usefulness until its discontinuance, and not a few of the articles which it contained were from his pen. His chief papers were on rainfall and climate. Occasionally he gave lectures under the auspices of the Society, on subjects of meteorological interest, and the success of these was to him ample reward for the labour that went to their preparation.

In 1920 the climatological work hitherto done by the Society was taken over by the Meteorological Office, and the Society was amalgamated with the Royal Meteorological Society. Mr. Watt loyally assisted in carrying through these changes, though they meant for him a change from a position of comparative freedom to shape his own work to one subject to the restraints of departmental control. In a man of less generosity and loyalty of character, this might have resulted in friction and disappointment, but to his superiors in the Meteorological Service he continued to give of his best with cheerful willingness.

With his marriage to Winifred Attwell there commenced what was probably the happiest period of his life, a period which was terminated by her death in August, 1927, after a prolonged illness. From the stress of this illness and the loss of his devoted companion in life, Andrew Watt seemed never fully to recover, but the sudden nature of his own end was quite unexpected. On Wednesday, January 9th, he had attended to his duties as usual; the same evening death overtook him.

Mr. Watt was approaching the age limit for the Meteorological Service and his friends could have wished that he had lived to complete his full period and to enjoy the leisure of retirement. He is survived by his younger brother, James Watt, C.M.G., and two sisters.

A. H. R. G.

The Weather of January, 1929

Quiet, dry, cold weather with much frost and fog at times prevailed generally during the month. In most parts of the country it was the coldest January since 1917. During the first week the conditions were anticyclonic and the temperature readings low; at several inland places in south Scotland and south-east England temperature did not rise above freezing point for two or three consecutive days. In Scotland the lowest temperatures occurred between the 1st and 4th and in England between the 5th and 8th. The lowest maximum recorded for the month, 24°F., occurred at Renfrew on the 4th and the lowest minimum in the screen, 7°F., at Markree Castle on the 1st. Snow, sleet and hail were recorded locally during this time and became more general on the 5th and 6th, but the amounts measured were small. Much sun was experenced in the north during the first few days, but in the south the whole week was dull. On the 8th, conditions changed in Ireland as a depression approached the northwest coasts. Heavy rain fell in Mayo on the night of the

8th to 9th and precipitation became general over the whole country on the 9th, being mostly in the form of snow or sleet in the north and east, 0.77in. was measured at Rothesay on the 9th. On the 11th anticyclonic conditions became re-established and the winds easterly. These gradually backed to north and snow or sleet showers were experienced in the eastern districts as depressions moved southwards across the eastern North Sea. Snow lying to a depth of 3 or 4in. was reported from Marchmont on the 15th and 16th and from Durham on the 16th. During this time conditions were much milder in the west, where the temperature rose above 50°F. On the 18th these milder conditions spread over the rest of the country and the 19th and 20th were mild sunny days with over 7hrs. bright sunshine at many places and over 8hrs. in the Channel Islands. The next day there was a renewal of the cold weather in the north and east and much fog prevailed on the 21st and 22nd. Heavy rain occurred in the southwest on the 22nd when 1.33in. fell at St. Austell (Cornwall). Cold northerly winds occurred generally between the 23rd and 27th with showers of snow, sleet or rain, but many bright intervals. On the 28th a deep depression approached from the Atlantic with a consequent change to warm southwesterly winds. Temperature rose generally to between 50° and 60° on the 30th and 31st, 61°F. was reached at Phœnix Park, Dublin, on the 30th, while heavy rain fell locally; 2.10in. were measured at Holne (Devon) on the 31st. The total rainfall for the month was below normal except for a small area in northeast England,* while sunshine records were above normal in the west but below normal in the east. The distribution for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	48	+20	Valentia	52	+ 4
Aberdeen	37	—11	Liverpool	37	—18
Dublin	29	—28	Falmouth	63	+ 5
Birr Castle	36	—13	Kew	32	—11

Pressure was much above normal over the whole of western Europe and at Bermuda, the greatest excess being 24.2mb. at Isafjord, while pressure was below normal over the North Atlantic, where the greatest deficit was 11.1mb. at Horta. Temperature was below normal except in the north of Scandinavia and in Portugal, being as much as 6°F. below normal in south Sweden and at Spitsbergen, while precipitation totals were deficient except in Spitsbergen and eastern Sweden.

Heavy and continuous rains accompanied by thunder, snow and hail storms during the first few days of the month resulted in floods in many parts of Italy. The Tiber is reported to

* *See page* 16.

have risen to 50ft., making it the worst flood experienced in Rome since February, 1915. Other large towns to be severely affected were Pisa, Florence and Naples. Cold weather with heavy falls of snow occurred generally over the whole of Europe even as far south as the Riviera during the first half of the month. At Majorca the temperature was almost down to freezing point but the weather was sunny. In Central Europe the snow falls were so heavy that railway and telegraph communications were broken in several places. The ice on the Elbe above Hamburg was so thick that the river could be crossed on foot; navigation on the tributaries of the Rhine also came to a standstill about the 16th. For the first time since 1917 skating was permitted on the lakes in the Bois de Boulogne (Paris) on the 17th and 18th. After a milder spell lasting about three days heavy snow fell generally on the 25th, and as far south as the Riviera on the 25th, 27th, 28th. Severe cold was experienced during this time with violent storms in Yugoslavia.

On the 23rd and 24th after a week of severe weather there was a heavy fall of snow in Jerusalem. Gales and snowstorms accompanied by high tides caused much damage along the northeastern coasts of Japan during the first week of the month.

Extensive bush fires occurred in the central and southern parts of New South Wales between the 12th and 18th, but on the 21st heavy rains were experienced over the State generally except on the Victorian border.

Heavy rains were general throughout southern Rhodesia and the Pungwe areas near the end of the month.

During the first week precipitation was above normal and the weather cold generally in the United States. This was followed by a milder period with varying amounts of precipitation. Later in the month a severe cold spell swept across the north-western districts. Violent windstorms were experienced in Missouri, Indiana and Illinois on the 18th.

Gales were experienced frequently on the western North Atlantic.

The special message from Brazil states that the rainfall in the northern regions was scarce with 1.57in. below normal, irregular in the central regions with 0.16in. below normal and plentiful in the southern regions with 6.54in. above normal. Numerous depressions passed across the country but only two depressions. The rainfall in the south was prejudicial to the crops. Pressure at Rio de Janeiro was 2.4mb. below normal and temperature 0.4°F. below normal.

Rainfall, January, 1929.—General Distribution

England and Wales	71	per cent. of the average 1881-1915.
Scotland...	49	
Ireland	57	
British Isles	63	

Rainfall: January, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Lond .	Camden. Square.........	·96	52	*Leics* .	Belvoir Castle...........	1·27	72
Sur .	Reigate, The Knowle...	1·54	68	*Rut* .	Ridlington	1·40	...
Kent .	Tenterden, Ashenden...	1·38	55	*Linc* .	Boston, Skirbeck	1·96	121
,, .	Folkestone, Boro San.	1·14	...	,, .	Lincoln, Sessions House	1·69	100
,, .	Margate, Cliftonville...	·78	47	,, .	Skegness, Marine Gdns	1·92	111
,, .	Sevenoaks, Speldhurst	1·26	...	,, .	Louth, Westgate	1·63	75
Sus .	Patching Farm	1·46	56	,, .	Brigg, Wrawby St. ...	1·84	...
,, .	Brighton, Old Steyne	1·50	62	*Notts* .	Worksop, Hodsock ...	1·70	96
,, .	Tottingworth Park ...	1·45	54	*Derby* .	Derby, L. M. & S. Rly.	1·27	63
Hants .	Ventnor, Roy. Nat. Hos.	1·69	66	,, .	Buxton, Devon Hos....	2·22	50
,, .	Fordingbridge, Oaklnds	1·38	50	*Ches* .	Runcorn, Weston Pt.	2·03	86
,, .	Ovington Rectory	...	...	,, .	Nantwich, Dorfold Hall	1·69	...
,, .	Sherborne St. John ...	1·33	57	*Lancs* .	Manchester, Whit. Pk.	1·83	73
Berks .	Wellington College ...	1·05	53	,, .	Stonyhurst College ...	2·06	48
,, .	Newbury, Greenham...	1·27	55	,, .	Southport, Hesketh Pk	1·40	55
Herts .	Benington House	1·70	94	,, .	Lancaster, Strathspey	1·89	...
Bucks .	High Wycombe.........	1·39	67	*Yorks* .	Wath-upon-Dearne ...	1·64	85
Oxf . .	Oxford, Mag. College	1·09	61	,, .	Bradford, Lister Pk....	2·20	76
Nor .	Pitsford, Sedgebrook...	1·55	83	,, .	Oughtershaw Hall......	3·14	...
,, .	Oundle	1·06	...	,, .	Wetherby, Ribston H.	2·10	102
Beds .	Woburn, Crawley Mill	1·16	68	,, .	Hull, Pearson Park ...	2·08	116
Cam .	Cambridge, Bot. Gdns.	1·27	85	,, .	Holme-on-Spalding ...	2·08	...
Essex .	Chelmsford, County Lab	1·39	91	,, .	West Witton, Ivy Ho.	1·38	...
,, .	Lexden Hill House ...	1·59	...	,, .	Felixkirk, Mt. St. John	2·94	147
Suff .	Hawkedon Rectory ...	1·85	106	,, .	Pickering, Hungate ...	2·71	.
,, .	Haughley House	1·70	...	,, .	Scarborough	2·30	115
Norf .	Norwich Eaton	1·82	93	,, .	Middlesbrough	2·41	150
,, .	Blakeney.................	...	...	,, .	Balderdale, Hury Res.	1·29	...
,, .	Little Dunham	2·55	131	*Durh* .	Ushaw College	1·99	97
Wilts .	Devizes, Highclere......	1·53	70	*Nor* .	Newcastle, Town Moor	2·61	128
,, .	Bishops Cannings	1·36	59	,, .	Bellingham. Highgreen	1·79	...
Dor .	Evershot, MelburyHo.	1·91	55	,, .	Lilburn Tower Gdns....	2·08	...
,, .	Creech Grange	2·04	...	*Cumb* .	Geltsdale.................	1·38	...
,, .	Shaftesbury, Abbey Ho.	1·32	51	,, .	Carlisle, Scaleby Hall	1·05	42
Devon .	Plymouth The Hoe ..	3·47	104	,, .	Borrowdale, Seathwaite	3·71	28
,, .	Polapit Tamar	2·44	65	,, .	Borrowdale, Rosthwaite	3.38	...
,, .	Ashburton, Druid Ho.	1·37	27	,, .	Keswick, High Hill ...	1·30	...
,, .	Cullompton..............	1·83	57	*Glam* .	Cardiff, Ely P. Stn. ...	1·81	48
,, .	Sidmouth, Sidmount...	2·04	71	,, .	Treherbert. Tynywaun	3·88	...
,, .	Filleigh, Castle Hill ...	1·96	...	*Carm* .	Carmarthen Friary ...	2·63	60
,, .	Barnstaple N. Dev. Ath.	1·91	58	,, .	Llanwrda	1·77	33
Corn .	Redruth, Trewirgie ...	4·21	100	*Pemb* .	Haverfordwest, School	3·61	78
,, .	Penzance, Morrab Gdn.	3·13	83	*Card* .	Aberystwyth	·97	...
,, .	St. Austell, Trevarna...	4·35	102	,, .	Cardigan, County Sch.	1·52	...
Soms .	Chewton Mendip	1·62	42	*Brec* .	Crickhowell. Talymaes	2·10	...
,, .	Long Ashton	1·15	...	*Rad* .	BirmW.W.Tyrmynydd	2·21	35
,, .	Street, Millfield ...	1·36	..	*Mont* .	Lake Vyrnwy...........	2·42	43
Glos. .	Cirencester, Gwynfa ...	1·18	47	*Denb* .	Llangynhafal...........	1·08	...
Here .	Ross, Birchlea...........	·93	38	*Mer* .	Dolgelly, Bryntirion...	2·46	43
,, .	Ledbury, Underdown	1·21	55	*Carn* .	Llandudno	1·10	41
Salop .	Church Stretton.........	1·88	74	,, .	Snowdon, L. Llydaw 9	8·05	...
,, .	Shifnal, Hatton Grange	1·37	70	*Ang* .	Holyhead, Salt Island	2·39	82
Worc .	Ombersley, Holt Lock	1·34	70	,, .	Lligwy....................	1·87	...
,, .	Blockley	1·84	...	*Isle of Man*			
War .	Farnborough	1·75	81	-	Douglas, Boro' Cem....	3·18	95
,, .	Birminghm. Edgbaston	1·26	62	*Guernsey*			
Leics .	Thornton Reservoir ...	1·49	75		St. PeterP't. GrangeRd.	2·50	85

Rainfall : January, 1929 : Scotland and Ireland

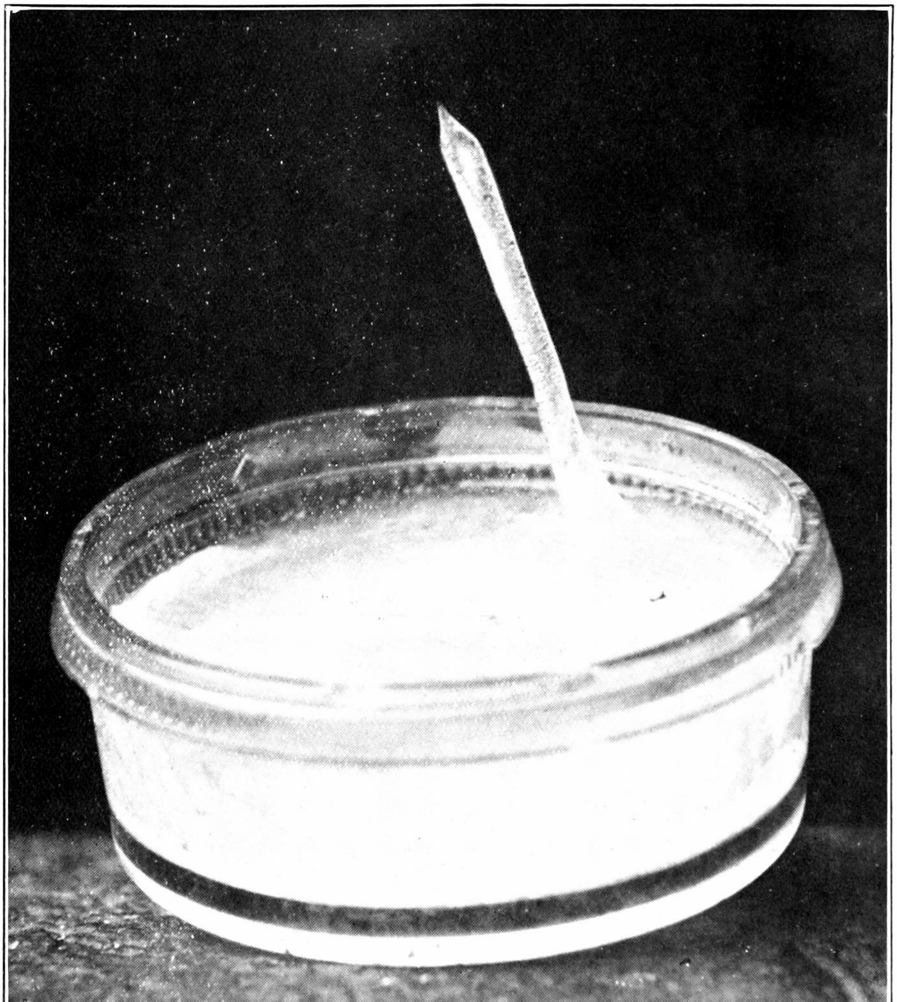
Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	2·42	82	*Suth* .	Loch More, Achfary ...	2·97	41
,, .	Pt. William, Monreith	2·88	...	*Caith* .	Wick	1·28	52
Kirk .	Carsphairn, Shiel.	3·37	...	*Ork* .	Pomona, Deerness	1·35	39
,, .	Dumfries, Cargen	...	...	*Shet* .	Lerwick	2·67	63
Dumf.	Eskdalemuir Obs.	2·21	41	*Cork* .	Caheragh Rectory	3·12	...
Roxb .	Branxholm	1·03	37	,, .	Dunmanway Rectory...	3·29	53
Selk .	Ettrick Manse	...	...	,, .	Ballinacurra	2·73	69
Peeb .	West Linton	1·08	...	,, .	Glanmire, Lota Lo. ...	2·39	56
Berk .	Marchmont House......	2·17	97	*Kerry*.	Valentia Obsy.	3·56	65
Hadd.	North Berwick Res. ...	·90	52	,, .	Gearahameen	4·40	...
Midl .	Edinburgh, Roy. Obs.	·80	46	,, .	Killarney Asylum	1·32	22
Ayr .	Kilmarnock, Agric. C.	1·68	49	,, .	Darrynane Abbey	2·77	55
,, .	Girvan, Pinmore	2·20	47	*Wat* .	Waterford, Brook Lo...	2·48	67
Renf .	Glasgow, Queen's Pk. .	1·33	40	*Tip* .	Nenagh, Cas. Lough...	1·66	42
,, .	Greenock, Prospect H.	2·90	42	,, .	Roscrea, Timoney Park	1·56	...
Bute .	Rothesay, Ardencraig.	2·63	58	,, .	Cashel, Ballinamona...	1·59	41
,, .	Dougarie Lodge	2·57	...	*Lim* .	Foynes, Coolnanes......	1·80	48
Arg .	Ardgour House	3·08	...	,, .	Castleconnel Rec.	1·66	...
,, .	Manse of Glenorchy ...	...	...	*Clare* .	Inagh, Mount Callan...	3·00	...
,, .	Oban	2·53	...	,, .	Broadford, Hurdlest'n.	1·89	...
,, .	Poltalloch	...	...	*Wexf*.	Newtownbarry	2·73	...
,, .	Inveraray Castle...	2·34	35	,, .	Gorey, Courtown Ho ..	2·82	90
,, .	Islay, Eallabus	2·63	56	*Kilk* .	Kilkenny Castle.........	1·67	52
,, .	Mull Benmore	...	...	*Wic* .	Rathnew, Clonmannon	2·43	...
,, .	Tiree	1·98	...	*Carl* .	Hacketstown Rectory..	2·46	69
Kinr .	Loch Leven Sluice......	1·20	38	*QCo* .	Blandsfort House	1·96	60
Perth .	Loch Dhu	...	...	,, .	Mountmellick...........	2·07	...
,, .	Balquhidder, Stronvar	2·42	...	*KCo* .	Birr Castle	1·47	52
,, .	Crieff, Strathearn Hyd.	1·79	44	*Dubl* .	Dublin, FitzWm. Sq...	1·05	45
,, .	Blair Castle Gardens ...	1·36	41	,, .	Balbriggan, Ardgillan.	1·92	84
,, .	Dalnaspidal Lodge ...	2·59	38	*Me'th* .	Beauparc, St. Cloud...	1·79	...
Forf .	Kettins School	1·65	68	,, .	Kells, Headfort	...	...
,, .	Dundee, E. Necropolis	1·25	64	*W.M* .	Moate, Coolatore	1·97	...
,, .	Pearsie House...........	2·68	...	,, .	Mullingar, Belvedere..	2·35	73
,, .	Montrose, Sunnyside...	...	...	*Long* .	Castle Forbes Gdns......	2·50	75
Aber .	Braemar, Bank	1·12	35	*Gal* .	Ballynahinch Castle ...	3·47	56
,, .	Logie Coldstone Sch....	1·50	68	,, .	Galway, Grammar Sch.	2·64	...
,, .	Aberdeen, King's Coll.	1·84	84	*Mayo* .	Mallaranny..............	2·60	...
,, .	Fyvie Castle	3·01	...	,, .	Westport House.........	1·82	39
Mor .	Gordon Castle	1·19	59	,, .	Delphi Lodge	6·09	...
,, .	Grantown-on-Spey ...	1·34	55	*Sligo* .	Markree Obsy............	1·57	26
Na .	Nairn, Delnies	·30	15	*Cav'n* .	Belturbet, Cloverhill...	1·85	62
Inv .	Kingussie, The Birches	·63	...	*Ferm* .	Enniskillen, Portora...	1·33	...
,, .	Loch Quoich, Loan ...	4·00	...	*Arm* .	Armagh Obsy...........	1·30	52
,, .	Glenquoich..............	3·68	27	*Down* .	Fofanny Reservoir......	6·76	...
,, .	Inverness, Culduthel R.	·43	...	,, .	Seaforde	2·35	75
,, .	Arisaig, Faire-na-Squir	2·04	...	,, .	Donaghadee, C. Stn ...	1·98	78
,, .	Fort William	1·99	...	,, .	Banbridge, Milltown...	1·41	63
,, .	Skye, Dunvegan	2·68	...	*Antr* .	Belfast, Cavehill Rd ...	2·15	...
R & C.	Alness, Ardross Cas. ...	·99	26	,, .	Glenarm Castle	2·71	...
,, .	Ullapool	1·37	...	,, .	Ballymena, Harryville	1·95	53
,, .	Torridon, Bendamph...	2·16	23	*Lon* .	Londonderry, Creggan	1·23	34
,, .	Achnashellach	2·85	...	*Tyr* .	Donaghmore	1·98	...
,, .	Stornoway	1·85	35	,, .	Omagh, Edenfel.........	1·48	42
Suth .	Lairg	1·26	...	*Don* .	Malin Head..............	1·37	53
,, .	Tongue	2·08	53	,, .	Dunfanaghy	1·22	...
,, .	Melvich	2·40	73	,, .	Killybegs, Rockmount.	1·36	24

Climatological Table for the British Empire, August, 1928.

STATIONS	PRESSURE: Mean of Day M.S.L.	PRESSURE: Diff. from Normal	TEMPERATURE: Absolute Max.	TEMPERATURE: Absolute Min.	TEMPERATURE: Mean Values Max.	TEMPERATURE: Mean Values Min.	TEMPERATURE: Mean Values ½ max. and min.	TEMPERATURE: Mean Values Diff. from Normal	TEMPERATURE: Mean Wet Bulb	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION: Am'nt	PRECIPITATION: Diff. from Normal	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
	mb	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	in	in.			
London, Kew Obsy.	1014·5	— 0·8	79	46	69·3	54·0	61·7	+ 0·1	55·4	86	5·8	2·59	+ 0·35	16	6·5	45
Gibraltar	1014·9	— 1·8	95	63	85·0	69·7	77·3	+ 1·3	67·6	79	3·6	0·03	— 0·10	1	..	..
Malta	1015·4	+ 0·1	94	71	87·2	74·6	80·9	+ 1·8	74·0	74	1·1	0·00	— 0·14	0	12·4	92
St. Helena	1017·1	+ 3·3	64	52	60·6	53·9	57·3	— 0·6	54·7	94	9·5	2·43	— 1·29	19	..	..
Sierra Leone	1014·4	+ 1·7	86	69	80·4	71·1	75·7	— 2·2	74·1	92	9·7	37·50	+ 0·93	30	..	..
Lagos, Nigeria	1012·6	— 1·0	83	70	80·8	74·5	77·7	0·0	74·2	86	6·7	2·05	— 0·75	13	..	..
Kaduna, Nigeria	1016·3	+ 2·5	87	64	81·6	66·8	74·2	+ 0·3	70·0	89	..	8·92	— 0·76	24	..	..
Zomba, Nyasaland	1018·9	+ 2·1	84	49	73·9	54·6	64·3	— 0·6	..	59	3·7	0·03	— 0·31	2	..	..
Salisbury, Rhodesia	1017·4	+ 0·6	83	34	74·1	45·1	59·6	— 0·6	50·2	45	1·0	0·00	— 0·08	0	10·2	89
Cape Town	1022·3	+ 2·1	82	39	65·6	48·0	56·8	+ 1·2	48·9	81	4·7	2·27	— 1·12	8	..	..
Johannesburg	1024·1	+ 1·4	74	31	63·1	42·6	52·9	— 1·4	40·5	45	2·8	0·46	— 0·05	3	9·2	82
Mauritius	1021·7	+ 1·2	77	58	74·1	62·6	68·4	— 0·1	63·3	76	4·1	1·12	— 1·23	25	8·4	74
Bloemfontein	..	..	78	26	64·8	36·4	50·6	1·6	39·7	60	2·0	0·59	+ 0·12	3	..	..
Calcutta, Alipore Obsy	1001·1	+ 0·1	94	76	89·6	79·0	84·3	+ 1·3	79·9	91	8·7	16·32	+ 3·63	22*	..	..
Bombay	1006·1	+ 0·2	88	73	85·3	76·3	80·8	+ 0·1	76·8	86	8·5	16·65	+ 2·20	27*	..	..
Madras	1005·8	+ 0·3	103	74	94·6	77·5	86·1	+ 0·2	75·5	73	7·2	4·93	+ 0·29	17*	..	..
Colombo, Ceylon	1011·0	+ 1·3	87	73	85·4	77·4	81·4	+ 0·3	76·8	77	8·0	2·12	— 1·01	14	6·2	50
Hongkong	1003·3	— 1·8	92	76	87·5	78·7	83·1	+ 1·0	79·2	85	7·6	12·91	— 1·14	19	6·6	51
Sandakan	..	..	91	71	89·2	74·5	81·9	+ 0·1	77·2	83	..	6·42	— 1·64	13	..	..
Sydney	1016·6	— 1·6	80	44	67·6	50·6	59·1	+ 4·1	52·8	78	4·2	1·41	— 1·60	8	6·5	61
Melbourne	1019·8	+ 1·7	70	33	61·6	43·5	52·5	+ 1·4	46·8	69	4·7	0·82	— 0·99	13	6·1	57
Adelaide	1020·3	+ 1·0	81	35	65·6	46·8	56·2	+ 2·2	49·5	63	4·2	0·77	— 1·74	7	6·9	64
Perth, W. Australia	1017·4	— 1·4	69	41	64·2	50·5	57·3	+ 1·4	53·6	76	6·5	12·21	+ 6·59	26	5·3	49
Coolgardie	1017·7	— 1·6	84	35	68·3	42·8	55·5	+ 1·9	48·2	54	1·9	1·20	+ 0·18	7	..	..
Brisbane	1021·2	+ 2·0	89	42	74·0	51·4	62·7	+ 2·3	55·7	72	2·7	1·05	— 1·08	6	8·0	71
Hobart, Tasmania	1012·4	— 1·2	69	36	57·4	43·1	50·3	+ 2·3	44·7	70	6·1	2·11	+ 0·27	20	5·7	55
Wellington, N.Z.	1015·2	+ 0·1	56	36	52·2	42·7	47·5	— 1·1	45·1	79	7·0	9·34	+ 5·35	16	4·4	42
Suva, Fiji	1015·5	+ 1·2	84	64	77·5	68·6	73·1	— 0·6	69·3	78	7·3	7·18	— 1·06	20	3·9	34
Apia, Samoa	1013·3	+ 1·1	87	70	81·2	73·9	77·5	— 0·3	..	..	1·4	6·02	+ 2·87	16	8·3	71
Kingston, Jamaica	1013·8	+ 0·3	93	68	87·9	72·6	80·3	— 1·2	72·2	86	4·3	12·57	+ 9·02	13	6·9	54
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1015·9	+ 0·5	90	52	80·1	60·9	70·5	+ 3·9	64·2	77	4·2	4·99	+ 2·22	12	9·1	65
Winnipeg	1013·7	— 0·2	92	38	75·1	53·0	64·1	+ 1·1	53·9	87	4·1	3·18	+ 0·74	14	9·4	65
St. John, N.B.	1017·3	+ 1·9	85	49	69·1	56·2	62·7	+ 2·1	59·6	85	7·3	2·87	— 0·99	19	5·6	40
Victoria, B.C.	1018·2	+ 1·0	77	48	65·9	51·9	58·9	— 1·2	54·8	79	4·0	0·23	— 0·42	2	10·2	71

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

facing p. 29



Lewis G. Ball, Photographer, Crawley

A Curious Ice Structure. (See p. 44.)