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Tornadoes in England and Germany, June 1931

By W. H. Pick, B.Sc.

Both England and Germany have experienced lately on different days examples of that rare phenomenon in our latitudes, a tornado. The English visitation caused devastation in Birmingham on Sunday, June 14th, and the German occurrence similar disturbance in the valley of the Else, in Westphalia, during the evening of June 17th. As the two visitations were similar meteorologically in some respects, as well as in the damage caused, it is thought that a treatment of them together may not lack in interest.

From information derived largely from Mr. A. T. Kelley of the Birmingham Meteorological Observatory and from the columns of the *Birmingham Post* for Monday, June 15th, the sequence of events in Birmingham in the afternoon of the previous day appears to be as set out below, all times mentioned being G.M.T. Moderate rain at about 12h. 30m. had ceased just before 13h. 30m., at which hour, however, there became audible the rumbling of distant thunder. At 14h. rain recommenced and thunder became closer and incessant. Forty minutes later the storm broke suddenly with torrential rain resembling that of a cloud-burst and accompanied by almost continuous thunder, lightning and hail. The tornado made its appearance at approximately the same time in the Sparkhill district of the city and travelled rapidly along a track varying

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from a width of nearly 800 yards to one of 200 yards, passing through Greet, Small Heath and Bordesley in a north-easterly direction to the Erdington boundary of the city. Altogether. a scar of some ten to twelve miles in length was left across Birmingham from the south to the north-east, a scar marked by a very great amount of material damage evidenced by broken houses, stripped roofs, windows blown inwards and uprooted trees, and unfortunately by the loss of one life. The storm ceased at about 15h. 15m., giving way to lulling winds and a burst of temporary sunshine. No precise measurements of wind force or other elements are available in the actual tornado during its passage, but it is worthy of mention that at the Birmingham Meteorological Observatory 0.8in. of rain fell in the 40 minutes from 14h. 35m. to 15h. 15m. It is also noteworthy that at Ross-on-Wye just previously between 13h. 48m. and 14h. no less than 0.5in. of rain had fallen, though violent tornado phenomena were not experienced there. The speed of advance of the tornado through Birmingham appeared to be of the order of 30 m.p.h., a figure of the same magnitude as in American tornadoes. Reports were received indicating that the duration of the tornado at any one spot was of the order of two minutes, and that the whirls in the tornado were clockwise in direction.

The synoptic chart for 13h., shown in Fig. 1, reveals the pressure distribution prevailing. A complex series of depressions covered the British Isles, with a well-marked " occlusion " running across the country from northern Ireland to south-east England. This " occlusion " moved rapidly north-eastward, and at 18h. stretched from the Hebrides to the Wash, and it was on it during its passage across Birmingham that the tornado occurred.

It is interesting to record that various other reports have come to hand indicating other exceptional weather happenings along the line of this occlusion. Of these one of the most noteworthy is that of 1.9in. of rain at Walsall measured at the Corporation rain gauge at the Sewage Disposal Works between 14h. G.M.T. and 14h. 45m. G.M.T. Another most interesting report comes from Bembridge, where, to quote the *Isle of Wight County Press*, " the tide rose and fell a distance of four feet, three times, accompanied by whirlwinds."

The German visitation of June 17th was similar in that it, too, was associated with the passing of a well-marked " occlusion." The details of this tornado, about to be given, are derived mainly from *The Times* of June 19th. After a thundery day, there came a sudden and striking darkening of the sky at about 6 o'clock in the evening, local time, and, on the horizon, appeared a funnel-shaped, grey-black cloud which advanced rapidly, accompanied by a noise " like the howl of dozens of sirens." The height of the cloud is given as about 300 feet until it dipped on the town of Plettenberg, which lay wrapped in the abnormal darkness already mentioned. Concurrent with the dipping of the cloud there came the uprooting of trees, and "heavy beams, scaffolding, roofs and fences flew through the air, some of them for a distance of several hundred feet." The

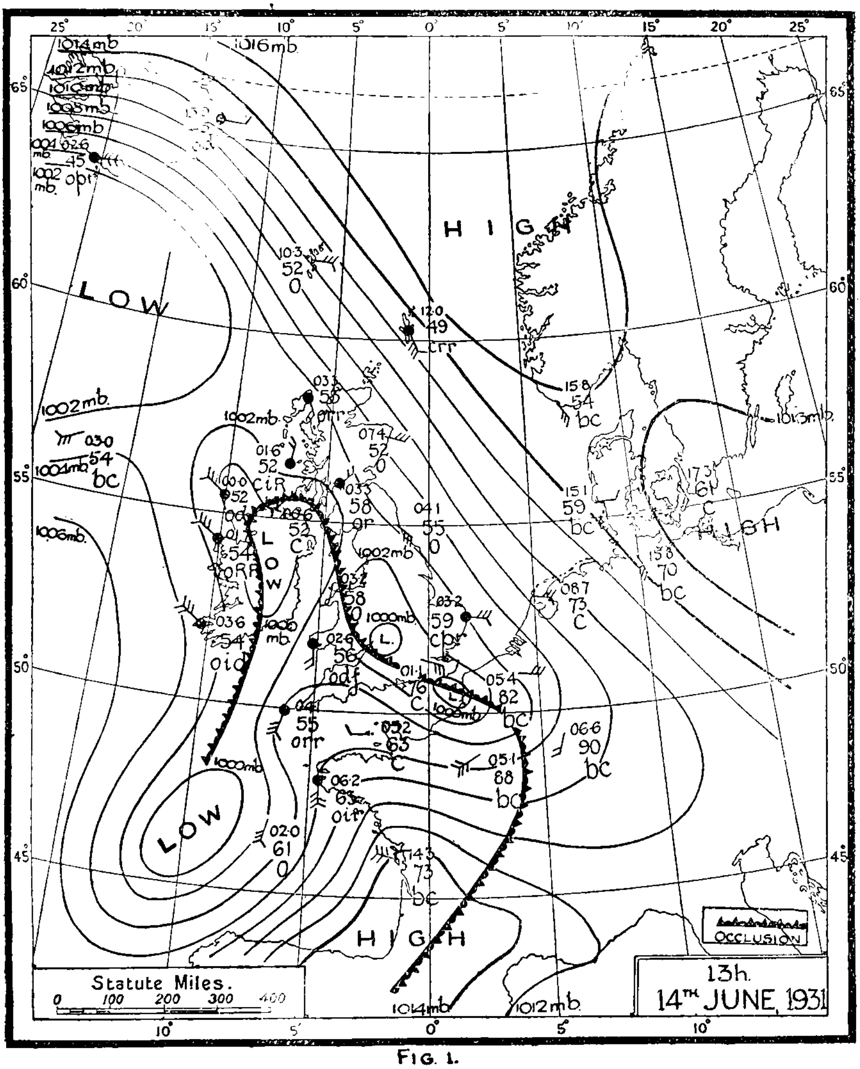

FIG. 1.

turmoil lasted only for a very short time. however, and very soon the whirlwind ceased and the darkness lifted, to be succeeded by torrential rain which added floods to the prevailing distress. Once again, as at Birmingham, loss of life has to be recorded, three persons being killed, two through walls collapsing and one by reason of a hurtling beam. In addition to Plettenberg, Holthausen and Herscheid (also in the valley of the Else) suffered very seriously.

The pressure distribution just preceding this calamity is shown in Fig. 2, which portrays the synoptic chart for 13h. G.M.T. on June 17th. Here again, as in the Birmingham disaster, the essential feature is the passage (in this case eastward) of a well-marked " occlusion." As a contributory cause the exceedingly high temperatures over Germany during the afternoon as shown on the chart reproduced doubtless played their part in adding to the intensity of the phenomena along the " occlusion."

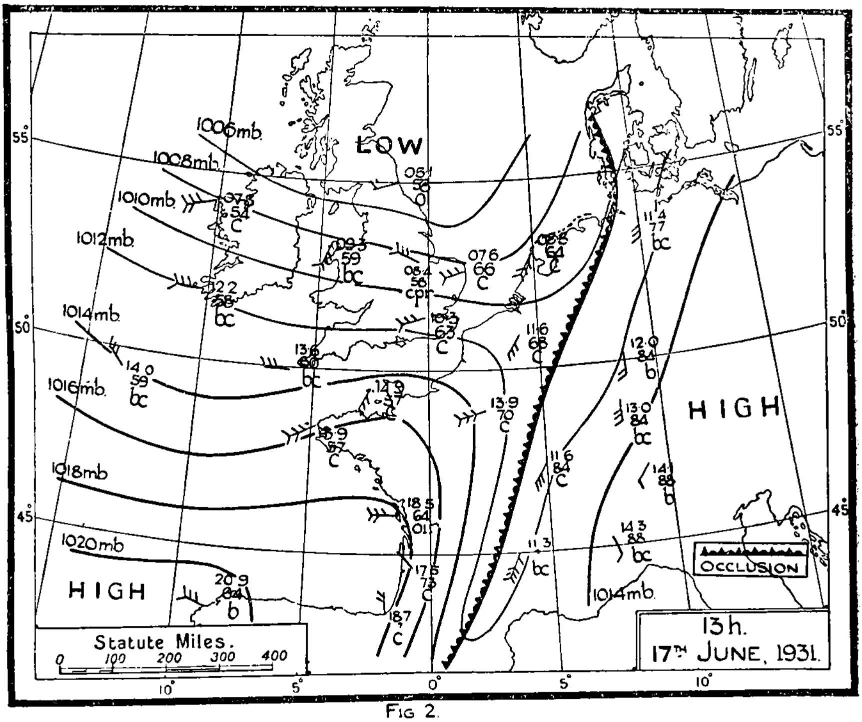

FIG 2.

It is almost inevitable that the Birmingham tornado should lead to comparison with what may be termed the " classical " tornado of the British Isles—that in south Wales and the west of England on Monday, October 27th, 1913, discussed by the late Mr. H. Billett in " Geophysical Memoirs, No. 11." The violence in that tornado was certainly at least equal to that experienced at Birmingham, while the number of deaths was greater, being five. The noise preceding the tornado was equally marked. The thunder, however, appeared to be less intense in the 1913 example as compared with the 1931 case, but the lightning was more marked, it being stated that " the blue lightning was appalling." The rate of advance of the 1913 tornado was 35 m.p.h., a figure comparable with the 1931 one. It is moreover interesting to record that analysis of the charts for the 1913 tornado in the light of the modern Norwegian views seems to show that, as in the recent visitation at Birmingham, the tornado occurred along a well-defined "occlusion" which, in this case, moved quickly northward.

WILLIAM H. PICK.

Extracts from letters describing the weather of Sunday, June 14th, 1931, in the Birmingham and Hereford areas

Neville Hall, Esq., 88, *Bromyard Road, Hall Green, Birmingham.*

"Here in Bromyard Road . . . . at about 3.50 p.m. (S.T.) the rain increased and at 4 o'clock was coming down in torrents . . . . about 3 minutes later we heard a howl as wind makes, and immediately the air was full of twigs, leaves and small branches. Four little girls coming home from Sunday School were blown flat and shot along the wet pavement like bits of paper. My motor cycle and side-car standing in the gutter was turned upside down . . . and a 2-seater coupé . . . was blown backwards . . . . the brakes being on. All our garden fences were flattened."

J. R. Sayers, Esq., 111, *Southam Road, Hall Green.*

"About 4 p.m. . . . . a curious lull in the great black thunderstorm then raging caused me instinctively to run to the window (facing north) and I was just in time to see some 20-ft. high trees shudder and then all bow to the ground, one immediately in front of me . . . . breaking off at the root. Instantly the air appeared full of objects, great and small, flying in a northern direction, broken vegetation, tiles, masonry, &c., my neighbour's garage roof included . . . . my front gate and gate-post was torn away . . . . I estimate that the duration of this great blast of air was 15 to 20 seconds."

Charles Duval, Esq., 67, *Waverly Road, Small Heath.*

"I happened to be looking at the sky at the moment of the tornado's arrival here and saw a small black cloud travelling from the south at a terrific speed. I called my wife to see it, and within a few seconds the wind arrived. Personally I think it had passed us in little over half a minute. The wind stopped my clock at 4.20 p.m., as with the first gust the front door was blown open and it took three of us to close it."

E. Dwyer, Esq., 198, *Monica Road, Small Heath.*

"the whirlwind made its approach . . . . It was similar to the noise of about six aeroplanes in the air together and was like a great black cloud . . . . It did not appear to be travelling at a great rate but had a rolling and twisting appearance."

F. J. Parsons, Esq., The Observatory, Ross-on-Wye.

"The rainfall was terrific (at Ross) . . . . As near as I can calculate from the trace . . . . nearly 13mm. . . . . fell in about 0·2 hours, 13h. 48m. to 14h. 0m. G.M.T.

At Huntley—mid-way between Gloucester and Ross-on-Wye—huge hailstones fell and shattered the windows of a motor-bus."

Robert Gray, Esq., Oaklands, Dorstone, Herefordshire.

"The thunderstorm 12.45 to 4 p.m. S.T. was a very heavy one here . . . . The rainfall during the periods amounted to 0·87 inches; most of this fell between 1.15 and 1.45 (S.T.) and 3.15 to 3.45 (S.T.)."

J. Taylor, Esq., The Council House, Walsall.

"The storm . . . . struck Walsall between 3 p.m. and 4.30 p.m. (S.T.), the storm being at its maximum at approximately 3.45 p.m. (S.T.). During this time 1·9 inches of rain was recorded at the Corporation rain-gauge at the Sewage Disposal Works. A fair amount of damage was done to roads and footpaths by the scour of the water, but no damage of an exceptional nature was done. . . . In Walsall the rain was very intense, but the wind was not exceptionally high and did no damage that I know of."

F. Smith, Esq., 299, Reddings Lane, Sparkhill, Birmingham.

"The tornado appeared from a dense mass of grey clouds . . . . suddenly it appeared to congregate into one huge cloud, all outlying clouds rushing to one spot. This mass of cloud suddenly began to rush across the sky and formulated a funnel which hung suspended from the mass and reached the house-tops. At the same time all sorts of missiles flew upwards towards it. It rushed across faster than I have ever seen clouds move before."

The Detailed Study of Geological Climates

For more than thirty years, Dr. F. Kerner-Marilaun has been a student of geological climates, and has published the results of his researches in a long series of important papers. He has now presented us with a considered survey of the subject, including much new matter, in a single volume.* Dr. Kerner-Marilaun is especially qualified for such a study, for though professionally a geologist (he is head of the Austrian geological service) and a palæobotanist, he is also a competent meteorologist with a unique knowledge of the geographical basis of climatology. He is well known as the greatest living exponent of the effect of the distribution of land and sea on climate, and his book naturally has a strong geographical bias, though other aspects are not neglected.

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*Paläoklimatologie. By Dr. Fritz Kerner-Marilaun. pp. VIII + 512, *Illus.* Berlin. Gebrüder Borntraeger, 1930.

The basis of palæoclimatology is the collection of evidence as to past climates—a somewhat obvious truism which, however, many theorists have been in danger of forgetting. Hence the first part of the book is concerned with the geological material, consisting mainly of fossil plants and to a less extent animals, fossil soils and terrestrial deposits. The method is simple; such remains must be regarded as analogous to those forming at present, and the climatic conditions of the latter must be determined as closely as possible. The difficulties multiply, however, when this principle comes to be applied in practice. The identification of fragmentary remains of plants is often doubtful; the fossil species differ from the existing ones and may have required different climatic conditions for their development. Insufficient information is available on many subjects, for example, given a sufficiently high temperature, how would different plants withstand the long polar night? The inorganic deposits are in some ways more hopeful, for we may assume that the physical conditions required for the formation of some particular type do not change, but here we are faced by the difficulty that the character of the older deposits may have been obscured during subsequent geological periods. Thus, many of the identifications of glacial tillite from early geological periods are very doubtful. Some of the conclusions rest on negative evidence, for example, red deep-sea clays are rare in the older deposits, and this is regarded as evidence that the temperature of the bottom of the ocean was higher than at present. The study of soils is especially difficult; the climatic conditions necessary for particular types can only be expressed in complicated formulæ, which are of little help to the palæoclimatologist.

In spite of these difficulties, it is easy enough to obtain a superficial measure of success, to fill in the blank spaces of the ancient continents with primeval forests, grasslands, deserts and ice-sheets. But this is not enough; for a scientific study we require to know as nearly as possible the actual distribution of temperature and precipitation in winter and summer. And here we meet two further difficulties; first that our isolated finds may not be typical, or may reflect the climatic conditions of an earlier time, as do relict floras, and secondly, that they may be only approximately of the same age. The latter is an especial difficulty in dealing with fossils, for under the influence of a rapid climatic change a species or assemblage of species may migrate through many degrees of latitude, and as the fossils are often our only means of age determination, the impression may be given of a widespread flora and a uniform climate. By this time the reader is thoroughly despondent, feeling that all research into past climates is vanity. The author has perhaps overstated the case, for the following chapters contain many neat examples of a sufficiently precise determination of climatic conditions, especially in the later geological periods. As an example we may quote Heer's summary of the climatic conditions of central Europe during the upper Miocene. In March there were frequent storms and thunder rains, for the deposits contain associated flowers and leaves of trees on which these organs unfold in early spring, accompanied by broken off twigs. The frequent occurrence of fruits of willow, poplar and elm, which ripen in May, suggests windy weather in this month. Fine calm weather in summer is inferred from the finding of whole swarms of flying ants and gnats, which danced on the shore of the lake on mild summer evenings, until a land breeze carried them over the water where they perished. The autumn and winter also were calm, for the spherical fruits of the plane and amber-tree are found with the leaves and flowers, showing that they must have remained on the trees throughout these seasons.

The author next approaches the subject from a different angle, namely, the evaluation of the geographical and other factors which modify the local or general climate, and this part of the book will be of great interest to meteorologists. The discussion is remarkably thorough; beginning with the influence of height above sea level, he discusses the factors of land and sea distribution, now and formerly, the factor of latitude and the "solar climate," the effect of variations in the eccentricity of the orbit and other astronomical conditions, the possible effect of variations of solar radiation and the part played by the varying transmission of the sun's rays through the atmosphere, as modified by volcanic dust. The effect of high ground is especially important, and here we are seriously handicapped by the lack of information as to the height of the mountain ranges in the earlier geological periods. The Pleistocene topography can be inferred from the present, while it is believed that during the Mesozoic and early Tertiary there were no high mountains.

The study of palæogeography, or the reconstruction of the distribution of land and sea during former geological periods. has now become a highly specialised branch of geology, with an elaborate technique, and numerous charts representing all periods from the Cambrian onwards are available for study. For the earlier periods the results are necessarily rather speculative, in fact many of the charts express rather a chain of ideas than the results of observation, but nearer the present the broad outlines at least are known, and in places the details have been filled in. Especially important is the diagnosis of ocean currents, which are described as the real heat carriers, far outweighing currents of air. Generally speaking, the author estimates that the distribution of climate (including rainfall as well as temperature) is controlled as much by land and sea distribution as by latitude, for even the isotherms are at present so eccentric that thermal arguments for movements of the pole have little weight, while the isohyets show scarcely any relation to latitude, and there is no reason to suppose that the present is abnormal in either of these respects.

Since merely qualitative statements are of little use, however, a large part of the book is occupied in the development of definite quantitative methods of calculating this geographical effect. Briefly, it is divided into two parts, the "eurymorphogenous" or distant, and the "stenomorphogenous," or local. The "distant" effect envisages the conditions over the whole globe, the presence or absence of polar ice, the existence and direction of ocean currents, the heating or cooling effect of large continents to the south or north. Its calculation cannot be carried out mechanically, but the author is able to lay down some general principles, chief among which is that of "akryogeny" or the absence of ice. According to this theory, the low Arctic temperatures which exist at present are in a very large measure due to the existence of a large sheet of floating ice, and if in any way this ice could be swept away, the akryogenous winter temperature would be only about 3°C. below the freezing point of sea water. This, of course, would cause the ice to form again, so that the akryogenous temperature is merely an abstraction, but if owing to a more favourable land and sea distribution, such as would be brought about by the opening of a second broad channel between the equatorial and arctic oceans, a greater supply of heat than at present were carried to the Arctic ocean, the akryogenous temperature would rise above the freezing point, and the ocean would remain open throughout the year. Now the reconstructions do show such favourable conditions during many geological periods, especially the Jurassic and Eocene, and these are precisely the periods in which rich floras extended to high northern latitudes, and in which there is no trace of Arctic ice. The conclusion, which represents the combined work of Kerner-Marilaun and myself, appears inescapable, namely, that these periods, to which geologists have given the name "pliothermal," were really non-glacial.

Such a revolutionary change as the abolition of the Arctic ice, however, must have world-wide effects, and accordingly Kerner-Marilaun calculates the hypothetical non-glacial temperatures of a water hemisphere in all latitudes, figures which he requires as a basis for his studies of the "distant" effect of the land and sea distribution. Actually he obtains for the pole under average astronomical conditions a January temperature of -5°C., which is only 3°C. below the freezing point of sea water. Since almost the only geographical situation for a polar ocean which is definitely less favourable than a continuous water surface over a whole hemisphere is for it to occupy a basin entirely shut in by land, the predominance of mild polar climates in geological time is to be expected. The zonal temperatures on a water hemisphere give a measure of the heating or cooling effect produced by ocean currents which traverse the parallels of latitude. Thus it is calculated that the passage of a current from the Indian Ocean through the Mediterranean would raise the winter temperature of southern Europe by 5.5°C.

The " local " land and sea effect at any point is calculated from the percentage of land within a certain distance of the point, generally within circles of 5, 10 and 20 degrees radius. The formulæ are based on a long series of calculations employing data for Europe and the Mediterranean, and are therefore not of universal application, but as they are employed mainly for studies of conditions during the Tertiary in Europe, this is not a disadvantage. For more extended studies, however, formulæ would be required built on a broader basis.

The calculation of the distribution of rainfall from the land and sea distribution is even more difficult than that of temperature, but the author gives us the results of some experiments in this direction in which he calculates for the Mediterranean district the percentages of the year's rainfall occurring in the winter and summer quarters. It is interesting to note that while the winter percentage at any point can be calculated directly from the percentage of sea within 10 and 20 degree circles round the point, the summer percentage can only be derived indirectly through a calculation of the pressure distribution.

The effect of the astronomical co-ordinates (eccentricity, &c.) cannot be incorporated directly into the calculations, because of the impossibility of knowing in which part of the cycle any pre-glacial deposit was formed, but the limiting values of the astronomical effects calculated by Spitaler are employed to provide limits of the possible departure from the temperatures calculated from the land and sea distribution only. Possible variations of solar radiation are necessarily left out of account entirely in the first approximation, but a correction is made for the interception of the sun's rays by volcanic dust. When all this has been done, we have an estimation of what the climate ought to have been, which we can compare with the climate deduced from the fossils and nature of the rocks. We have, in fact, the two sides of an equation; if they agree, we may assume that our calculations are approximately correct, if they differ, either there is some mistake in our calculations or inferences, or there is some additional term which we have not taken into account.

As his first example Kerner-Marilaun gives a calculation of the January and July temperatures at Messel near Darmstadt in Germany during the Eocene. We may copy his tables, which are of exceptional interest:—

	January.	*July.*
Present temperature	0·5°C.	20·0°C.
Corrections for:—		
Decrease in surrounding land	+1·5	−1·0
Increased warmth of Gulf Drift ... ... (Akryogenous effect)	+4·0	−4·0
Drift from Indian Ocean	+5·5	—
Sea covering of Asia Minor	—	+0·5
Effect of Obic Sea	+2·0	—
Effect of elevation (200m.)...	−1·5	−1·5
Volcanic dust	−0·5	−0·5
Astronomical effects (Spitaler)	+1·0 to −2·5	+2·0 to +0·5

The net result is that according to the earth's astronomical situation at the time, the temperature lay between 13·5 and 10°C. in January and between 23·5 and 21°C. in July. From the plant remains and the nature of the deposit the temperature is calculated as 13·5°C. in January and 20°C. in July. The two sides of the equations agree within the limits of probable error, and it is not necessary to bring in unknown influences such as a change of latitude or of solar radiation.

Not all the examples given agree so well, and it is not yet possible to say whether the discrepancies are due to errors in the interpretation of the geological data, to errors in the calculated temperatures, or to some additional, unknown factor such as a change of solar radiation. Only by the comparison of a number of determinations from widely different latitudes can this uncertainty be determined, and these are not yet available. Nevertheless, the author foreshadows the time when, from a large number of such calculations in different geological periods, it may be possible to construct a history of solar radiation, and of its distribution over the earth's surface.

The great stumbling block of most theories of past climates is the late Palæozoic glaciation of the tropical continent of Gondwanaland. Kerner-Marilaun, basing his calculations on a reconstruction by Frech, cools the plateau by a cold current from the north, which gives a July temperature of less than 15°C. at sea level in latitude 25°N. This seems too high for extensive glaciation, though he points out that glaciers in New Zealand and Alaska extend into nearly the same summer temperature. Here questions of contemporaneity between the fossiliferous deposits of Eurasia and the tropical boulder clays are important, and until these have been settled, further progress will be difficult. In this connexion he makes the interesting remark that the *Glossopteris* flora which developed during the glaciation of the southern hemisphere is too rich to represent an impoverished glacial assemblage, but gives rather the impression of the evergreen flora of middle southern latitudes.

It is to be hoped that the book, difficult though it is, will be widely read by meteorologists, who may thus realise that the problems of palæoclimatology are as much meteorological as geological, and offer them many opportunities for research. The present is the key to the past, but we may venture to hope that in return the past will supply the key to some of the still unsolved riddles of the present.

C. E. P. Brooks.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, June 17th, in the Society's Rooms at 49, Cromwell Road, South Kensington, Mr. R. G. K. Lempfert, M.A., F.Inst.P., President, in the Chair.

The following Memoirs were discussed :—

No. 26. S. Chapman, F.R.S.—A theory of upper-atmospheric ozone.

The main part of the paper consists of a discussion of the daily and annual variations of the ozone content of the atmosphere in any latitude up to about 50°. The ozone is treated as if it were uniformly spread through a layer of air 10Km. thick, having the same density as the air at the level of maximum ozone density. Convection and diffusion of ozone are neglected. The thermal decomposition of ozone ($2O_3 = 3O_2$) is discussed, and estimated to be negligible, except possibly in connexion with an eleven-year (sunspot) variation of ozone.

No. 29. C. K. M. Douglas, B.A.—On the relation between temperature and pressure in the troposphere.

It is shown that the high correlation co-officients between pressure and temperature high up in the troposphere are closely related to the constancy of the lapse-rate of temperature. The correlation between the mean temperature of the column up to 9Km. and the temperatures at 3 and 6Km. are very high. Some factors tending to produce a constant lapse-rate are discussed. It is previously shown that the observed pressure-temperature correlations do not necessarily imply a " solid current " or " barotropic " motion, but are consistent with very large changes of wind direction with height, provided that these are spread through most of the troposphere and not concentrated at a surface of discontinuity.

Groups of extreme cases show that when the barometer at sea level is very low or very high the troposphere contributes about half the deviation from the mean. Both cyclones and anticyclones can be grouped into systems largely confined to the troposphere, and systems extending to the stratosphere. The argument in favour of an advectional theory is developed.

Correspondence

To the Editor, *The Meteorological Magazine.*

Thunderstorms on June 14th, 1931

On Sunday, June 14th, the day when the tornado swept across the Midlands,* thunderstorms and squalls were experienced generally over the rest of the British Isles.

Mr. B. P. Granger of Cloud House, Attenborough, Notts, writes that "On Sunday, June 14th, 1931, a series of thunderstorms passed over this station in rapid succession during the afternoon. Thunder was heard almost continuously from about 13h.-17h., while the lightning was frequent, one flash striking a tree about two hundred yards to the south of the station.

About 15h. large hailstones began to fall, being of a size almost unknown in this district. The average size measured an inch in diameter, while several measured one and a half, and one that I picked up measured fully two inches in diameter and weighed nearly an ounce. In shape, to give a fairly practical comparison, it resembled a piece of sugar-candy, and as an illustrative comparison it resembled a picture of a hailstone shown in figure 54, page 131, in Loomis's Treatise, but naturally on a small scale. Another piece of hail resembled a pear in shape, was flat, and had a round hole in the ice about in the middle. There were several others that were merely slabs of ice.

As it was nearly calm at the time little damage was done, a few glasshouses having some glass broken.

Before the hail began a roar was most distinctly heard in the air overhead, like the sound of water passing over a weir. I noticed this roar on the night of February 11th, 1931, before hail which fell during a line-squall. The squall had been in progress for about ten minutes, accompanied by thunder and lightning, when this roar became very audible, then down came the hail, and in about five minutes the ground was covered to a depth of nearly two inches."

Mr. R. T. Andrews, of Larkhill, Salisbury Plain, writes that thunder was heard at intervals throughout the day and two thunderstorms passed almost directly overhead, the second thunderstorm being "accompanied by torrential rain, at 12h. 30m. hail fell for a short time, the hailstones being about $1\frac{1}{4}$ inches in circumference." Between 13h. 15m. and 13h. 25m. a squall passed overhead during the passage of which the temperature fell 6° F. "While the thunderstorms were in progress each flash of lightning was followed by a tinkle of the telephone bell in the office."

Mr. A. E. Moon, of 39, Clive Avenue, Hastings, writes that though there was a sharp thunder shower between 10h. 10m. and

* See page 125.

10h. 30m., the morning and early afternoon were mainly sunny and warm. At 14h. it was still bright and the temperature had risen to 76·4°F., but " between 14h. 30m. and 14h. 45m. the wind rose very suddenly in a squall approaching gale force. It remained very strong for some time after the squall and then slowly moderated. . . . Temperature had by 15h. fallen to 60·0°F. and a few minutes later to 59·0°F., but about 16h. the sky cleared and the temperature rose slightly."

Mr. H. L. Wright, of Eskdalemuir Observatory, writes that " In the evening of Sunday, June 14th, 1931, rainfall of an intensity unparalleled within living memory occurred in the valley of the Esk and its neighbourhood. At the Observatory it was a warm, humid day with light breezes from between SSE. and NE. The sky was almost completely covered with stratus clouds, but a background of alto-stratus could be seen through rifts in the stratus. The relative humidity rose from 66 per cent. at 9h. to 96 per cent. at 11h., and remained above 95 per cent. from 13h. to 19h.

About 18h. there was a succession of bright flashes of lightning followed, betweeen five and ten seconds later, by loud peals of thunder. An intense gloom occurred and indoors it became so dark that it was impossible to read with ease. The rate of rainfall increased suddenly to an average of nearly 40mm./hr., and this persisted for about 20 minutes. At 18h. 30m. a line squall occurred, the wind veering from E. to W. and increasing in strength from force 2 to force 5 in a gust. This was the occasion of a further heavy burst of rain and an instantaneous rate of 115mm./hr. was recorded by the Jardi rate-of-rainfall recorder. The rain showed no signs of abating until 19h., and by this time 31mm. had fallen in the hour.

At about 18h. 20m. the Davington Burn, a small hill stream, began to overflow its banks in the village of Davington nearby, and continued to rise until 19h. 30m., eventually flooding cottages in the village. At 18h. 45m. the Esk, which is joined by this burn about 200 yards below Davington, burst its banks and began to flood the fields. Breaches further upstream followed in quick succession until a point was reached where the river bends. The rupture of the banks here led to the formation of a torrent pouring down the valley in a wide stream, carrying hayricks and wooden sheds as far as two or three hundred yards, sweeping livestock before it, and razing stone walls to the ground. Just before it reached Davington, where it was diverted towards the main stream, there was a uniform sheet of water about 400 yards wide. At Eskdalemuir, three miles further downstream, greater havoc was wrought. A farmer who was endeavouring to rescue some cattle became surrounded by the torrent and lost his life. In one place six or seven tall fir trees were seen to be uprooted in quick succession and carried away. Numerous wooden suspension bridges across the river, and even three reinforced concrete bridges, were speedily and completely demolished.

Associated with a flash of lightning and a particularly loud thunderclap which occurred about 18h. 5m. was a set of circumstances related to me independently by three people. In Davington a low rumbling noise was heard, distinct from the thunderclap and described as more similar to the sound associated with an earth tremor; the windows of the Observatory were heard to rattle; and most curious of all was the experience of Mr. L. H. J. Stone, of the Observatory. He was bicycling along the road to the south, about four miles from the Observatory, when a blinding flash of lightning occurred and immediately afterwards he was thrown off his bicycle, but suffered no serious injury. It seems probable that these three events were synchronous and are possibly due to an air wave set up by the thunderclap. Mr. Stone estimated the height of the cloud at 100 feet. At the Observatory the cloud height at the time was 300 feet.

A disturbance on the micro-barogram is shown at this time, but the amplitude is not much greater than that of similar disturbances earlier in the day, and is much smaller than that which occurred at the time of the line squall. Presumably, however, a great deal of the energy of the wave would have been spent by the time its front reached the Observatory."

Limits of Visibility

I remember seeing, some 25 years ago, from the slopes of Kirikee Hill, Co. Wicklow, Holyhead Island with the South Stack light, Braich-y-pwll and Snowdon behind them, all roughly due east, Snowdon 90 miles, the others some 25 miles less. These are probably visible from any eastern slopes of the Wicklows on a clear day.

Will any Richmond (Surrey) reader tell us whether Hindhead is often visible now from the Terrace? (30 miles, 218° or S. 38° W.). I saw it many times many years ago, but have failed to do so lately even on days when Nettlebed Hill, Oxfordshire (33 miles, 285° or N. 75° W.) is quite plain. Is it because I cannot get to Richmond now in the morning hours (the afternoon sun being almost in the same direction) or is increasing atmospheric pollution the cause? The square tower of Hampton Church (4 miles, 225° or SW.) acts as a guide and the neighbouring chimney of the Metropolitan Water Board at Hampton, no longer burning smokeless coal, affords another guide and a possible explanation of the disappearance of Hindhead.

The tower on Leith Hill (but no more of the hill) used to be visible from the path through Hampton Churchyard, and I have often seen the beacon fire there on occasions of national rejoicings, &c. It is due south, 17 miles, and would be visible now but for the growth of the trees on a river island.

J. C. RIDGWAY.

31, *Belgrade Road, Hampton, Middlesex. May 23rd,* 1931.

Northerly Winds at Lerwick

During the course of another investigation it was found necessary to obtain a ten-year mean of the frequency of winds from a northerly direction at Lerwick in the Shetland Isles. The observations used were chosen from 7h. data and were extracted from the annual summaries of the *Monthly Weather Report* for the years 1917-23 and 1928-30. The method adopted was to report as a northerly wind all winds from north-westerly, northerly and north-easterly directions. These were added together to give (T) the total number of northerly winds for each month of the year and so on for each of the ten years investigated (see table). The average frequency for any month in the year was also obtained.

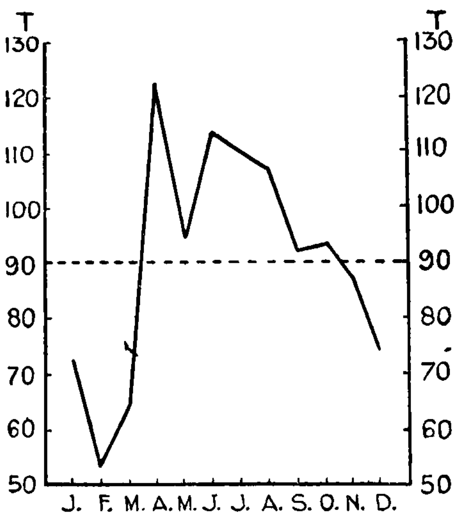


TABLE.

Month.	(T.)
January	73
February	53
March	64
April	122
May	94
June	113
July	111
August	107
September	92
October	93
November	87
December	74
Mean	90

The results plotted in diagram form show that, during the months of April-October inclusive, winds from a northerly direction were in excess of the ten-year mean whilst during the remaining months of the year the frequency was markedly below the average value. Assuming that this is a true representation of affairs, the obvious explanation seems to be that there is a greater tendency for high pressure to form westwards of the British Isles during the summer months than in the winter half of the year. Furthermore the table shows that the month of April has a greater frequency of northerly winds than any other month. If this fact has real significance, the result may be the consequence of some special feature of the pressure distribution in our neighbourhood just when the first tendency occurs for the more frequent formation of the western high-pressure area.

That there is any relation between the above and the spells of cool easterly weather which we experience annually every spring is open to doubt. The results are none the less interesting since they present evidence of a definite activity of the atmospheric circulation from the poles at a time when we are led to look for a polar source of the supply of air to our neighbourhood.

JOHN HARROWER.

95, St. John's Road, Corstorphine, Edinburgh. May 11th, 1931.

Some relationships between the weather of July and of August in London over a long period

In an interesting note in the *Monthly Weather Review* for August, 1930, p. 332, it is stated that "there seems to be a well-marked tendency for abnormal Iowa (U.S.A.) weather in July to perpetuate itself through August."

This statement prompted the thought that there may a similar perpetuation of July weather in London, and this present note, using data for Kew, examines the matter for the three elements of rainfall, sunshine and mean maximum temperature.

The table below gives the number of cases when the rainfall, sunshine and mean maximum temperature of August were similar and dissimilar to that of the preceding July:—

Table I. No. of Cases.

July below normal	Following August below normal	Following August above normal	July above normal	Following August below normal	Following August above normal
Rainfall, 1866-1930.					
36	24	12	29	12	17
Sunshine, 1881-1930.					
29	18	11	21	9	12
Mean Monthly Maximum Temperature, 1871-1930					
32	21	11	28	11	17

The normals employed for each of the three elements considered were those for the period 1881-1915, published by the Meteorological Office in "The Book of Normals."

It remains to state that in the case of each of the three elements, rainfall, sunshine and mean maximum temperature. there is a distinct tendency—though only a tendency—for August to repeat the conditions of the immediately preceding July. This is an interesting result and one that is confirmatory in some degree of the results obtained for Iowa (U.S.A.) mentioned in the opening paragraph.

WILLIAM H. PICK.

April 13th, 1931.

[An alternative way of treating this problem is to consider the frequency with which the general pressure distribution over north-west Europe is the same in July and August. For this we may use the ten major types described by Brooks and Quennell.* During the 58 years from 1873 to 1930 the type in August was the same as that in July on 12 occasions, while if the succession of types is governed purely by chance the frequency would be between 7 and 8. Taking only the larger groups, I, characterised by high pressure near the Faroes, and II, characterised by low pressure in the same region, we find that the same group occurred in both months on 34 occasions, opposite groups on 24.

The most frequent cause of the persistence of similar weather conditions in summer appears to be the establishment of a type marked by pressure below normal near or over the British Isles, with pressure above normal directly to the south-east.†—Ed., *M.M.*]

Old Sussex Weather

Reading in "Old Sussex Diarists," by A. J. Rees (Bodley Head, 1929), I came across some interesting entries of a meteorological character, notably in extracts from the diary of Richard Stapley, Esq., Hickstead Place, Twineham, Sussex, who wrote 1682-1724 :—

"1696/7. In June and July there was such abundance of rain that ye rivers and low meads were extraordinary much flouded; abundance of grasse drove in ye rivers, insomuch yt people pulled it out and made dung therewith."

"1698/9. Mem. Tuesday May 3rd in ye evening fell a great snow wch was not gone in many places all ye next day: & there was a very great frost for several nights. The snow lay on ye hills on Thursday morning in several places.

Mddm, in April the same year on Crawley ffair day, there was a very great hail shower whose stones were judged to be two inches about.

In many places ye snow lay above a fortnight, as an ye hills and in drifts and in liew places."

This entry is particularly interesting in the view of the lateness of the date, which it must be remembered is, of course, Old Style.

1703/4. July 29th. "a very great floud" and "August

London, Meteorological Office, Geophysical Memoirs, No. 31.

†*London, Meteorological Magazine*, 63, 1928, p. 291.

1st on Sunday morning a terrible tempest and rain wch was a bigger water in ye south river than ye former wch did abundance of damage and harm.''

CICELY M. BOTLEY.

Guildables, 17 *Holmesdale Gardens, Hastings*. *March* 19*th*, 1931.

NOTES AND QUERIES

Unusual Gustiness at Cardington on the night of February 25th-26th, 1930

In an article by Mr. C. S. Durst under the above heading, in the *Meteorological Magazine* of August, 1930, the author points out that anemobiagraph traces show a large gustiness coincident with a temperature inversion. The inversion is shown on the temperature gradient recorder at Cardington as persisting throughout the day up to a height of at least 150 feet. The synoptic charts and upper air observations at Duxford suggest that Leafield and Cardington were in the same air stream, and hence should be under the influence of similar conditions. At Leafield (12 miles west of Oxford) the temperature gradient recorder showed, in the early afternoon, a lapse indicated by a temperature difference of 1°F. in the first 40 feet; followed by a small lapse of about 0.5°F. in the next 60 feet interval; and surmounted by approximately the adiabatic lapse rate up to 285 feet. The lapse reached its maximum value as given above between the hours of 12h. and 14h. G.M.T. on the 25th. The inversion set in at 15h. G.M.T. in the lowest layers, and by 22h .G.M.T. had reached its maximum, giving 2°F. difference in the first 40 feet interval, 0.5°F. in the next 60 feet, and practically zero gradient from 100 feet up to 285 feet.

The anemometer traces for 50 feet and 310 feet, and the Baxendell trace for 50 feet showed a maximum gustiness in the early afternoon, and a minimum gustiness between 22h. and 23h. G.M.T., the latter corresponding to the maximum recorded inversion. Similar conditions were recorded at Porton up to a height of 60 feet. Thus at Porton and Leafield the gustiness during the whole period followed the usual laws, large gustiness being connected with large lapse rates, and small gustiness with inversions.

The most surprising part of Mr. Durst's paper is the persistence of the inversion during the day. Measurements of the vertical temperature gradient in the surface layers of the atmosphere have been recorded at Porton since 1922 and at Leafield since 1925, and there has been no record of an inversion persisting throughout the day. Temporary inversions lasting from 15 to 20 minutes do occur during the passage of fronts. Mr. Durst explains the persistent inversion by the presence of a warm south-easterly current flowing over previously cooled ground. If such conditions produce an inversion during the day, then an inversion should be recorded every time cyclonic conditions cause the onset of a warm current on a morning following a clear calm night, when outgoing radiation—the most efficient cooling agent—has lowered the ground temperature.

The essential difference between the temperature gradient installation at Cardington and those at Leafield and Porton is in the housing of the resistance elements. At Cardington these are housed in small Stevensen screens, while at Leafield and Porton the elements are housed in carefully designed anti-radiation housings, which are mechanically aspirated, the rate of aspiration being 5-6 m/s. at Leafield and 3 m/s. at Porton. A definite steady aspiration is essential before one can place any reliance on the records obtained from these electrical temperature recorders.

E. Ll. Davies.
H. Garnett.

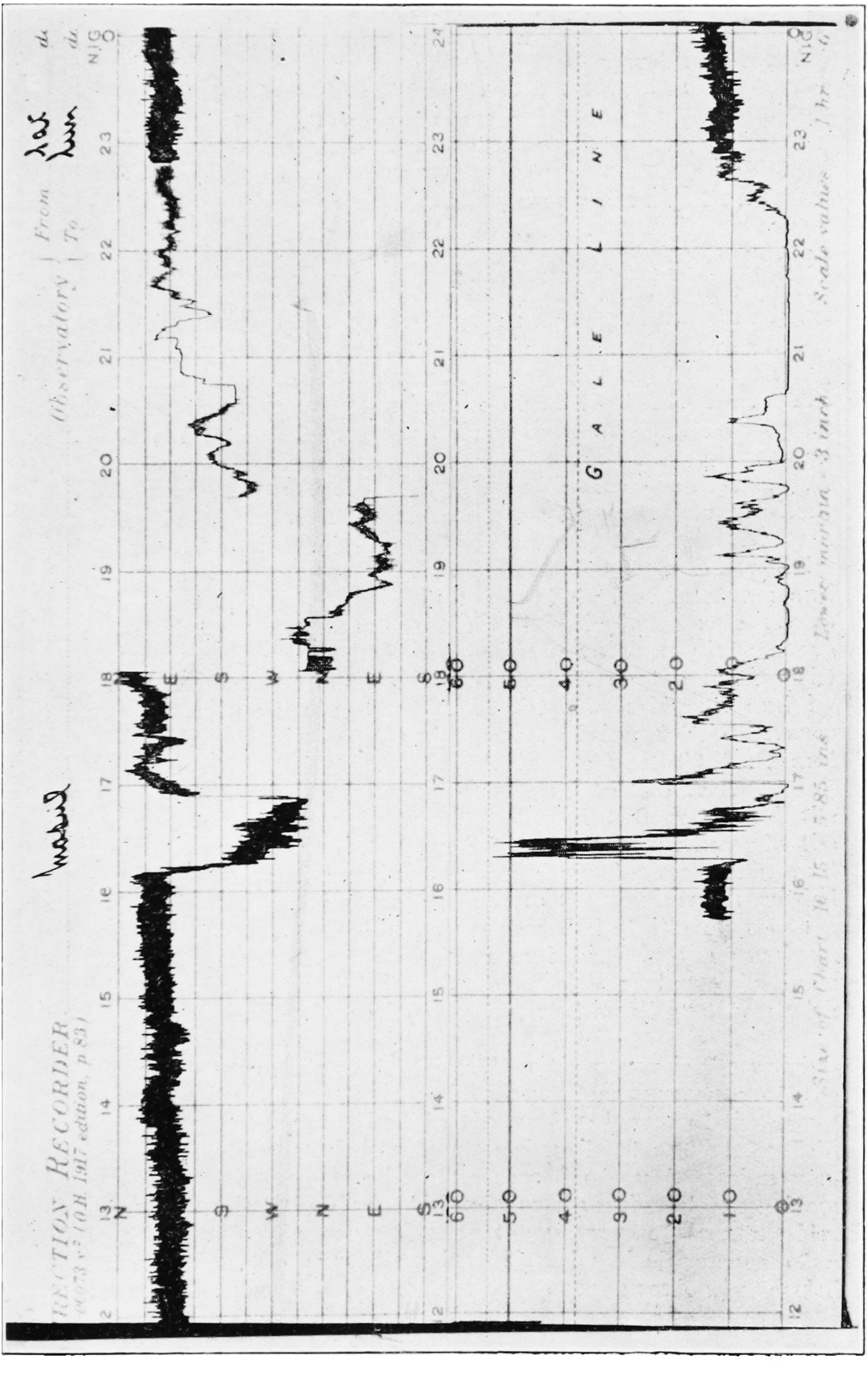
Report on Line Squall observed at Mosul, April 11th, 1931

On April 10th a depression centred over Cyprus was approaching Iraq. Winds became south-easterly to east in the centre and south, causing a dust storm at Diwaniyah during the evening, followed by slight rain. Slight showers occurred in the early morning at Mosul. On the 11th the depression was centred over Syria, with a " V "-shaped secondary over Iraq. Thunderstorms were experienced in the centre and south accompanied by heavy rain and squalls, the wind reaching gale force in the evening. Dust storms preceded the thunder at Hinaidi and Diwaniyah.

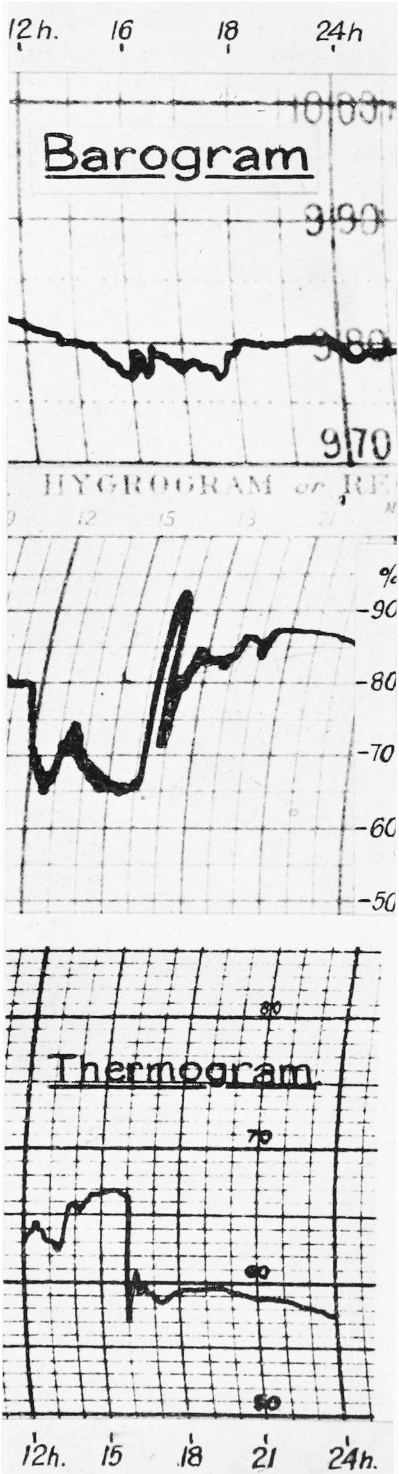
At Mosul on the 11th rain commenced in the early morning and continued throughout the day. At approximately 13h. 20m. G.M.T. a thunderstorm was observed approaching the station from south-east, accompanied by a dense mass of yellowish cloud, which decreased the visibility to about 1,000 yards. As the cloud approached it was noticed that there was very heavy precipitation, and the approach was very rapid.

At this stage the barograph was behaving very erratically and subsequently rose and fell 2mb., immediately rising 2·5mb. and again falling 2·5 mb., all in the space of a few minutes. The temperature (see Thermogram) recorded a fall of 10°F. in two minutes; the wind suddenly veered from ENE. to SSW., with gusts of 40 m.p.h. and 54 m.p.h., and a mean wind velocity of 45 m.p.h. over a period of ten minutes was recorded.

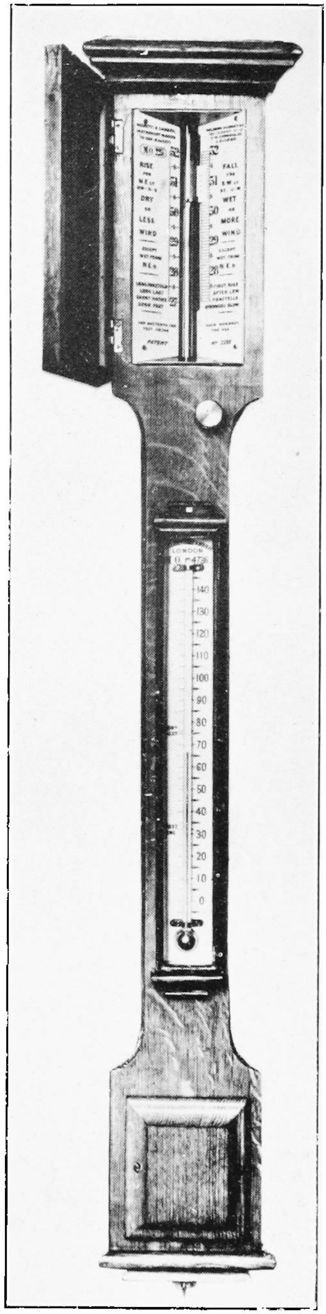
As the squall passed over the station very heavy rain fell (21mm. in 10 minutes) and appeared as a solid sheet of water, and was driven with such force that there is no doubt that a true record was not obtained. This rain was accompanied by



ANEMOGRAM, MOSUL, APRIL 11TH, 1931



Autographic records,
Mosul, April 11th, 1931



Fishery Barometer

heavy thunder and continuous vivid lightning flashes, the visibility being about 50 yards with partial darkness. Some idea of the intensity of the squall may be gained from the fact that within a few minutes from comparative calm a corrugated iron roof was lifted bodily from the Corporals' Mess and deposited some 30 yards distant. Both short and long wave steel masts of the W/T station were blown completely away.

The squall was observed to travel in a north-easterly direction, eventually disappearing in the hills. This is borne out by the fact that 30 hours of heavy rain was reported at Diana.

Although it was apparent that dangerous phenomena were imminent, no warning could be despatched as the W/T were out of communication for about two hours previously, owing to electrical disturbances, which in itself constituted sufficient warning of the proximity of a storm.

W. THOMAS.
L. ROUGIER.

Fishery Barometers

From time to time fishery barometers become available for disposal by the Meteorological Office. These are mercurial barometers in wooden or steel frames, which have been lent for the use of fishing communities. They are at the present time gradually being replaced by barographs. Arrangements have been made to dispose of these barometers *in situ* at a price of 10s. each as and when they become available.

Those desirous of purchasing should send in their names to the Superintendent of the Instruments Division, Meteorological Office, Exhibition Road, London, S.W.7. As the instruments become available they will be offered in turn to those whose names are received by the Superintendent. The barometers are in different ports and villages, and the purchaser would be required to pay the cost of transport of the barometer and to make his own arrangements for this.

The general type of instrument in a wooden case is illustrated, but the Meteorological Office cannot undertake that an instrument will conform exactly to the illustration nor accept any responsibility for the condition of the instrument. Intending purchasers would, however, be informed whether the barometer offered to them was in a wooden or a steel case.

Reviews

The Literature of Climatology. By Robert De C. Ward. Reprinted from Ann. Ass. Amer. Geog., March, 1931, pp. 34-51.

Prof. R. de C. Ward has performed a useful service to those interested in meteorology by producing this guide to climatological literature. The more important books and papers are discussed under nine heads: tabulated meteorological data, descriptive climatology, general climatology, human, medical and agricultural climatology, changes of climate, atlases and bibliographies.

Aviation Instrument Catalogue. pp. 16, *Illus.* Short and Mason, Ltd., Walthamstow, London. 1930.

A catalogue of instruments for aviation has recently been received from the well-known firm of Messrs. Short and Mason, Ltd., who point out in the preface that they have been manufacturers of aneroid barometers for 70 years, and have been pioneers in the production of height measuring instruments for aircraft. A full range of altimeters and altigraphs suitable for aircraft is described in the catalogue. Particulars are also given of meteorological instruments for installing at air ports, including cup anemometers, wind vanes and airmeters, barographs and thermographs. The barographs include the so-called microbarograph, which gives a very sensitive record of pressure on an open scale and was developed by Short and Mason, Ltd., some years ago. Of particular interest to meteorologists is the inclusion in the catalogue of the Dines balloon meteorograph and Baker release attachment for releasing the meteorograph from the balloon at a predetermined pressure.

The catalogue which is printed in English, French and Spanish, consists of 16 pages, and is in loose-leaf binding so that if additional sections are added at a future time, they can readily be included.

Books Received

Summary of the meteorological observations made at the meteorological stations in the Netherlands West Indies during 1929. Compiled by the Royal Dutch Meteor. Inst., The Hague, 1930.

Report on rainfall registration in Mysore for 1929. By C. Seschachar, Bangalore, 1930.

Thermometric lag. By Negretti and Zambra, London, 1930.

Obituary

Major Thomas Ford Chipp, M.C., D.Sc.—We regret to hear of the unexpected death on June 28th, 1931, of Major Chipp, Assistant Director of the Royal Botanic Gardens, Kew, at the early age of 45. Although his life work was botanical, his experience in several parts of the Empire had convinced him of the importance of climatology in limiting the plant provinces, and he frequently corresponded with the Meteorological Office on the subject. In March, 1930, he carried out botanical explorations in the Sahara and took meteorological instruments with him; his observations were published in the *Meteorological Magazine* for July, 1930. He leaves a wife and young daughter.

We also regret to learn of the death on June 9th, 1931, at the age of 82 of Mr. W. F. Denning, a leading authority on meteors, and discoverer of several comets. In 1898 he was awarded the Royal Astronomical Society's Gold Medal for his meteoric observations and other astronomical work.

News in Brief

Staff News.—Air Ministry Tennis Tournament. Ladies' Singles, winner, Miss Geake; Singles, runner-up, J. Glasspoole.

The retirement is announced on February 20th, 1931, of Mr. Wilson Lloyd Fox from the Honorary Secretaryship of the Observatories Committee of the Royal Cornwall Polytechnic Society after 54 years' service. For many years the Observatory work at Falmouth has been under his charge. He is succeeded by Mr. H. D. Gardner, M.Sc.

The Weather of June, 1931

Pressure was above normal from north-east Canada and Newfoundland across Greenland to Spitsbergen and Iceland, over central and southern Europe and the Mediterranean, and over Mexico, the greatest excesses being 8·8mb. at Julianehaab and 4·6mb. at Cagliari. Pressure was below normal over Alaska, southern Canada, most of the United States and of the North Atlantic, including the Bay of Biscay and over northern and western British Isles, Scandinavia and north Russia, the greatest deficits being 9·1mb. at Kuopio and 4·6mb. at Point Barrow. Temperature was below normal over Scandinavia and the northern British Isles, but above normal in Spitsbergen, central Europe and England. The deficit in Sweden decreased from 7°F. in Norrland to 2°F. in the south-west. Rainfall in Sweden was nearly twice the normal in Norrland, but deficient elsewhere being only 33 per cent of the normal in the district of Uppsala

Cool unsettled weather prevailed generally over the British Isles except in the south, where conditions were mostly warm and often sunny, during the early part of June. Towards the end of the month fine warm weather tended also to spread northwards. Widespread thunderstorms occurred on several days and mist was frequent round the coasts. Rainfall totals were above normal except in the south-east. From the 1st-12th an extensive low pressure area was maintained from the Mid-Atlantic across the British Isles giving cool easterly winds in the northern districts while warmer conditions were enjoyed in the south. Secondary disturbances from the south-west brought rainy periods to most districts with heavy falls in the west and north, notably on the 2nd when 2·20in. fell at Killybegs (Donegal). Widespread thunderstorms occurred on the 5th, following a fine warm day in England and Ireland when 70°F. was exceeded locally and sunshine records reached 12-14 hours. The storms were accompanied by heavy rain in the Midlands and Ireland, 2·10in. fell at Rathnew (Wicklow), 1·66in. at Hatton Grange (Shropshire), and were followed by a marked drop in temperature, places in the north having maxima below 45°F. on the 6th, 43°F. being registered at Eskdalemuir and 44°F. at Edinburgh and Marchmont. Sunshine was variable in amount and location; over 14 hours was registered at Mallarany on the 12th. Severe thunderstorms with heavy rain occurred over most of the country on the 14th, when a deepening depression moved in from the south-west; 2·52in. fell at Eskdalemuir,* 2·20in. at Blackpool. Birmingham experienced a destructive tornado.† In the south-east the day was very warm, maxima reaching 80°F. at Greenwich and 81°F. at Croydon, the highest temperature for the month. From the 15th-19th there was a period of cooler weather as a complex area of low pressure passed across the country, rain fell at times in most places and there were local thunderstorms but bright periods. Subsequently a belt of high pressure extended from the Azores to central Europe, bringing fine warm weather generally until the end of the month. There was a temporary change to cool weather on the 24th and 25th, and occasionally the depressions near Iceland moved far enough south to cause rain in the north and west and on the 24th even in the south-east, but the amounts measured were usually small. The sunniest days in the south were the 26th and 27th, in the north, the 24th and 25th; Deerness had 16·6hrs. and Aberdeen 16·3hrs. on the 25th. Temperature rose above 70°F. at numerous places on the 21st-23rd and 27th-28th. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	..	..	Liverpool	140	—60
Aberdeen	153	— 31	Ross-on-Wye	181	—16
Dublin	133	— 56	Falmouth	197	—24
Birr Castle	132	— 32	Gorleston	204	— 6
Valentia	93	— 95	Kew	174	—25

The special message from Brazil states that rainfall was irregular in the northern and southern regions and scarce in

* See page 137. † See page 125.

the central region, the averages being 0·12in. and 0·20in. above normal and 0·98in. below normal respectively. During the later part of the month five anticyclones passed across the country and a depression was situated over the coast. Rainy cold weather prevailed generally during the month on the south, where frost was affecting the grazings and crops. At Rio de Janeiro pressure was normal, and temperature 0·5°F. above normal.

Miscellaneous notes on weather abroad culled from various sources.
A heat wave held Spain in its grip during the week ending the 14th, but showed signs of breaking on the 15th. On the 14th the French pleasure steamer, *Saint Philibert*, foundered off Saint Nazaire during a sudden storm and 342 people were drowned. On the 17th a whirlwind swept up the Valley of the Else in Westphalia.* The high passes on the Great Dolomite Road were free of snow on the 9th and the road over the Great Saint Bernard Pass on the 24th (*The Times*, June 9th-24th).

The Monsoon was steadily advancing up the Malabar coast on the 9th and reached Bombay, where temperatures had previously been 3° to 4°F. above normal, on the 12th; the rain area worked steadily inland after this. Only 2¾in. of rain, however, fell in Bombay, and temperature continued above normal for about 10 days (*The Times*, June 13th-24th).

A tornado struck north Adelaide on the morning of the 11th doing much material damage (*The Times*, June 12th).

The drought in the Prairie Provinces continued until about the 10th, when rain fell generally. Between then and the 27th rain fell at times bringing relief, but the amounts were not sufficient to repair the continuous deterioration through drought, insect plagues, &c., which have been in progress for some time past. The heavy rains varying from 1-3in. which fell on the 29th came too late to help the crops in most districts except the fodder crops, but helped save some of the live stock (*The Times*, June 6th-July 1st). Temperature was above normal over the western part of the United States throughout the month and over the eastern part during the later half of the month. Very high temperatures were registered towards the end of the month, Tuma, Arizona, recorded 112°F., and Huron, south Dakota, 106°F. on the 27th. Many people died from the heat in the south, south-west and middle-west States. Rainfall in the United States was mainly below normal. (*Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin and Daily Weather Map.*)

Rainfall, June, 1931—General Distribution

England and Wales	148	per cent of the average 1881-1915.
Scotland	193	
Ireland	174	
British Isles	165	

* See page 126.

Rainfall: June, 1931: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	1·41	70	*Leics* .	Belvoir Castle	2·28	119
Sur .	Reigate, Alvington	1·56	75	*Rut* .	Ridlington	2·32	122
Kent .	Tenterden, Ashenden	·86	45	*Linc* .	Boston, Skirbeck	2·48	136
,, .	Folkestone, Boro. San.	·87	...	,, .	Cranwell Aerodrome	2·85	170
,, .	Margate, Cliftonville	·48	27	,, .	Skegness, Marine Gdns	1·89	105
,, .	Sevenoaks, Speldhurst	1·48	...	,, .	Louth, Westgate	2·63	122
Sus .	Patching Farm	1·69	84	,, .	Brigg, Wrawby St.	3·62	...
,, .	Brighton, Old Steyne	1·34	74	*Notts* .	Worksop, Hodsock	3·54	179
,, .	Heathfield, Barklye	1·94	92	*Derby* .	Derby, L. M. & S. Rly.	3·32	147
Hants .	Ventnor, Roy. Nat. Hos.	1·59	87	,, .	Buxton, Devon Hos.	5·76	179
,, .	Fordingbridge, Oaklnds	2·94	159	*Ches* .	Runcorn, Weston Pt.	5·65	219
,, .	Ovington Rectory	1·84	79	,, .	Nantwich, Dorfold Hall	4·74	...
,, .	Sherborne St. John	1·58	74	*Lancs* .	Manchester, Whit. Pk.	5·59	211
Berks .	Wellington College	1·26	58	,, .	Stonyhurst College	6·91	225
,, .	Newbury, Greenham	1·81	83	,, .	Southport, Hesketh Pk	5·91	272
Herts .	Welwyn Garden City	1·34	...	,, .	Lancaster, Strathspey	6·75	...
Bucks .	H. Wycombe, Flackwell	1·51	...	*Yorks* .	Wath-upon-Dearne	4·73	213
Oxf .	Oxford, Mag. College	3·70	174	,, .	Bradford, Lister Pk	5·16	219
Nor .	Pitsford, Sedgebrook	1·83	95	,, .	Oughtershaw Hall	7·36	...
,, .	Oundle	1·61	...	,, .	Wetherby, Ribston H.	4·38	209
Beds .	Woburn, Crawley Mill	2·83	144	,, .	Hull, Pearson Park	3·45	167
Cam .	Cambridge, Bot. Gdns.	...	...	,, .	Holme-on-Spalding	5·23	...
Essex .	Chelmsford, County Lab	1·25	66	,, .	West Witton, Ivy Ho.	4·80	235
,, .	Lexden Hill House	·95	...	,, .	Felixkirk, Mt. St. John	4·76	217
Suff .	Hawkedon Rectory	1·56	75	,, .	Pickering, Hungate	4·07	192
,, .	Haughley House	·99	...	,, .	Scarborough	3·79	206
Norf .	Norwich, Eaton	2·19	113	,, .	Middlesbrough	3·29	174
,, .	Wells, Holkham Hall	1·33	68	,, .	Baldersdale, Hury Res.	..	...
,, .	Little Dunham	1·45	65	*Durh* .	Ushaw College	3·95	183
Wilts .	Devizes, Highclere	2·62	116	*Nor* .	Newcastle, Town Moor	2·84	131
,, .	Bishops Cannings	3·07	127	,, .	Bellingham, Highgreen	4·69	203
Dor .	Evershot, Melbury Ho.	3·48	153	,, .	Lilburn Tower Gdns.	4·03	195
,, .	Creech Grange	2·69	117	*Cumb* .	Geltsdale	5·21	...
,, .	Shaftesbury, Abbey Ho.	4·15	179	,, .	Carlisle, Scaleby Hall	6·12	243
Devon .	Plymouth, The Hoe	4·05	188	,, .	Borrowdale, Seathwaite	11·75	180
,, .	Polapit Tamar	3·59	167	,, .	Borrowdale, Rosthwaite	10·67	...
,, .	Ashburton, Druid Ho.	...	...	,, .	Keswick, High Hill	7·40	...
,, .	Cullompton	3·01	142	*West* .	Appleby, Castle Bank	4·62	202
,, .	Sidmouth, Sidmount	3·62	172	*Glam* .	Cardiff, Ely P. Stn.	3·58	144
.	Filleigh, Castle Hill	3·33	...	,, .	Treherbert, Tynywaun	8·45	...
,, .	Barnstaple, N. Dev. Ath	3·17	142	*Carm* .	Carmarthen Friary	4·09	142
,, .	Dartm'r, Cranmere Pool	5·90	...	*Pemb* .	Haverfordwest, School	2·37	88
Corn .	Redruth, Trewirgie	3·11	125	*Card* .	Aberystwyth	4·04	...
,, .	Penzance, Morrab Gdn.	3·67	165	,, .	Cardigan, County Sch.	2·32	...
,, .	St. Austell, Trevarna	3·37	130	*Brec* .	Crickhowell, Talymaes	5·00	...
Soms .	Chewton Mendip	3·68	124	*Rad* .	Birm W. W. Tyrmynydd	4·00	122
,, .	Long Ashton	3·50	138	*Mont* .	Lake Vyrnwy	...	...
,, .	Street, Millfield	2·82	132	*Denb* .	Llangynhafal	4·64	222
Glos. .	Cirencester, Gwynfa	3·77	157	*Mer* .	Dolgelly, Bryntirion	7·29	209
Here .	Ross, Birchlea	3·35	154	*Carn* .	Llandudno	3·02	149
,, .	Ledbury, Underdown	3·44	152	,, .	Snowdon, L. Llydaw 9	15·85	...
Salop .	Church Stretton	5·57	230	*Ang* .	Holyhead, Salt Island	4·10	191
,, .	Shifnal, Hatton Grange	4·85	218	,, .	Lligwy	4·03	188
Worc .	Ombersley, Holt Lock	3·89	172	*Isle of Man*			
,, .	Blockley	4·30	...		Douglas, Boro' Cem.	6·00	248
War .	Birminghm, Edgbaston	3·59	155	*Guernsey*			
Leics .	Thornton Reservoir	2·57	119		St. Peter P't. Grange Rd.	1·39	75

Rainfall: June, 1931: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per cent. of Av.
Wigt	Pt. William, Monreith	5·31	226	*Suth*	Loch More, Achfary	6·37	172
,,	New Luce School	4·68	162	*Caith*	Wick	...	...
Kirk	Carsphairn, Shiel	8·89	223	*Ork*	Pomona, Deerness	2·06	112
Dumf	Dumfries, Crichton, R.I	6·14	...	*Shet*	Lerwick	2·49	140
,,	Eskdalemuir Obs.	10·25	325	*Cork*	Caheragh Rectory	4·08	...
Roxb	Branxholm	5·68	252	,,	Dunmanway Rectory	4·34	124
Selk	Ettrick Manse	8·59	238	,,	Ballinacurra	3·39	130
Peeb	West Linton	5·94	...	,,	Glanmire, Lota Lo.	4·32	160
Berk	Marchmont House	4·49	194	*Kerry*	Valentia Obsy.	5·80	181
Hadd	North Berwick Res.	4·31	260	,,	Gearahameen	7·00	...
Midl	Edinburgh, Roy. Obs.	4·25	230	,,	Killarney Asylum	5·07	174
Lan	Auchtyfardle	5·13	...	,,	Darrynane Abbey	6·19	197
Ayr	Kilmarnock, Agric. C.	...	...	*Wat*	Waterford, Brook Lo.	2·64	98
,,	Girvan, Pinmore	4·26	147	*Tip*	Nenagh, Cas. Lough	4·44	181
Renf	Glasgow, Queen's Pk.	5·25	227	,,	Roscrea, Timoney Park	3·71	...
,,	Greenock, Prospect H.	7·01	213	,,	Cashel, Ballinamona	2·80	122
Bute	Rothesay, Ardencraig.	6·39	208	*Lim*	Foynes, Coolnanes	4·13	160
,,	Dougarie Lodge	4·66	..	,,	Castleconnel Rec.	4·90	...
Arg	Ardgour House	9·75	...	*Clare*	Inagh, Mount Callan	5·48	...
,,	Manse of Glenorchy	8·60	...	,,	Broadford, Hurdlest'n.	3·99	...
,,	Oban	4·09	138	*Wexf*	Gorey, Courtown Ho.	2·60	107
,,	Poltalloch	5·51	181	*Kilk*	Kilkenny Castle	3·01	124
,,	Inveraray Castle	7·02	177	*Wic*	Rathnew, Clonmannon	4·44	...
,,	Islay, Eallabus	...	...	*Carl*	Hacketstown Rectory	4·80	171
,,	Mull, Benmore	13·30	..	*Leix*	Blandsfort House	4·42	170
,,	Tiree	3·90	...	,,	Mountmellick	5·55	...
Kinr	Loch Leven Sluice	4·76	217	*Off'ly*	Birr Castle	4·01	174
Perth	Loch Dhu	8·45	203	*Kild'r.*	Monasterevin	4·24	...
,,	Balquhidder, Stronvar	6·31	...	*Dubl*	Dublin, FitzWm. Sq.	3·69	189
,,	Crieff, Strathearn Hyd.	7·16	271	,,	Balbriggan, Ardgillan.	4·39	218
,,	Blair Castle Gardens	4·32	218	*Me'th*	Beauparc, St. Cloud	6·09	...
Angus	Kettins School	3·99	213	,,	Kells, Headfort	5·80	219
,,	Dundee, E. Necropolis	4·50	250	*W.M*	Moate, Coolatore	4·38	...
,,	Pearsie House	5·82	...	,,	Mullingar, Belvedere	5·42	209
,,	Montrose, Sunnyside	4·17	251	*Long*	Castle Forbes Gdns.	4·76	185
Aber	Braemar, Bank	2·65	135	*Gal*	Ballynahinch Castle	7·54	213
,,	Logie Coldstone Sch.	3·34	171	,,	Galway, Grammar Sch.	4·46	...
,,	Aberdeen, King's Coll.	2·98	174	*Mayo*	Mallaranny	6·77	...
,,	Fyvie Castle	3·94	188	,,	Westport House	4·57	169
Moray	Gordon Castle	2·44	120	,,	Delphi Lodge	10·23	178
,,	Grantown-on-Spey	2·64	117	*Sligo*	Markree Obsy.	5·97	198
Nairn	Nairn, Delnies	3·16	179	*Cav'n*	Belturbet, Cloverhill	5·10	209
Inv	Kingussie, The Birches	2·97	...	*Ferm*	Enniskillen, Portora	5·55	...
,,	Loch Quoich, Loan	10·25	...	*Arm*	Armagh Obsy	5·00	198
,,	Glenquoich	8·89	181	*Down*	Fofanny Reservoir	7·08	...
,,	Inverness, Culduhtel R.	3·44	...	,,	Seaforde	5·59	202
,,	Arisaig, Faire-na-Squir	4·52	...	,,	Donaghadee, C. Stn.	3·78	162
,,	Fort William	6·40	...	,,	Banbridge, Milltown	4·33	...
,,	Skye, Dunvegan	5·21	...	*Antr*	Belfast, Cavehill Rd.	5·50	...
R & C.	Alness, Ardross Cas.	3·85	170	,,	Glenarm Castle	5·91	...
,,	Ullapool	3·28	143	,,	Ballymena, Harryville	4·46	153
,,	Torridon, Bendamph.	...	...	*Lon*	Londonderry, Creggan	6·76	240
,,	Achnashellach	6·09	...	*Tyr*	Donaghmore	...	...
,,	Stornoway	3·12		,,	Omagh, Edenfel	5·90	209
Suth	Lairg	3·48	172	*D.n*	Malin Head	4·89	...
,,	Tongue	3·07	150	,,	Dunfanaghy	4·87	...
,,	Melvich	2·93	...	,,	Killybegs, Rockmount	6·04	159

Climatological Table for the British Empire, January, 1931:

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 Clou'd Am'nt 0—10	PRECIPITATION: Am'nt in.	PRECIPITATION: Diff. from Normal in.	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Per-cent-age of possible
London, Kew Obsy.	1013·0	− 4·6	53	27	43·5	34·2	38·9	0·0	36·0	89	7·5	1·07	− 0·69	19	1·7	21
Gibraltar	1020·2	− 1·0	72	38	62·4	48·0	55·2	+ 0·4	48·1	82	3·4	1·28	− 3·78	8	..	..
Malta	1013·5	− 3·5	68	43	59·2	51·3	55·3	0·0	51·5	79	7·5	7·69	+ 4·48	19	4·6	47
St. Helena	1013·6	+ 0·8	70	57	67·1	59·6	63·3	− 0·7	60·7	93	9·3	2·44	..	19	..	..
Sierra Leone	1012·3	+ 1·5	91	68	86·7	72·6	79·7	− 1·6	74·7	78	2·6	1·62	+ 1·21	2	..	..
Lagos, Nigeria	1008·9	− 1·0	92	74	88·5	77·2	82·9	+ 2·0	78·1	87	7·4	0·94	− 0·13	6	..	..
Kaduna, Nigeria	1014·8	+ 0·1	96	..	91·5	..	..	..	69·1	69	..	0·00	0·00	0	..	..
Zomba, Nyasaland	1008·8	+ 1·4	82	61	77·6	65·3	71·5	− 1·3	..	82	8·6	15·06	+ 3·96	27	..	..
Salisbury, Rhodesia	1007·9	+ 1·9	85	55	78·3	61·0	69·7	0·0	63·5	74	7·5	8·82	+ 1·50	22	6·3	48
Cape Town	1012·8	− 0·6	100	59	84·4	64·6	74·5	+ 4·6	65·7	67	2·1	0·00	− 0·68	0	..	..
Johannesburg	1011·4	+ 0·8	87	50	73·9	55·5	64·7	− 2·0	57·9	77	6·5	8·56	+ 2·39	20	6·4	47
Mauritius	1012·2	+ 0·3	89	73	85·1	74·5	79·8	+ 0·5	76·3	77	7·1	11·80	+ 4·04	25	6·9	52
Calcutta, Alipore Obsy.	1015·4	+ 0·2	88	53	81·8	59·5	70·7	+ 4·1	60·0	86	1·9	0·06	− 0·36	0*	..	..
Bombay	1012·8	− 0·8	94	63	87·0	68·9	77·9	+ 2·4	66·0	71	0·9	0·00	− 0·10	0*	..	..
Madras	1013·7	− 0·4	86	64	84·1	68·8	76·5	+ 0·3	70·4	79	4·5	0·05	− 1·09	0*	..	..
Colombo, Ceylon	1011·3	+ 0·5	92	68	87·1	72·6	79·9	+ 0·4	73·7	74	4·7	4·25	+ 1·00	11	6·9	58
Singapore	1010·3	..	92	71	87·2	73·3	80·3	− 0·4	..	..	..	11·56	+ 1·68	23	5·1	42
Hongkong	1019·0	− 0·7	79	40	66·5	57·2	61·9	+ 1·7	57·1	75	6·4	0·33	− 0·96	4	5·2	48
Sandakan	..	..	89	73	86·3	74·8	80·5	+ 0·7	77·3	83	..	10·14	− 9·26	8	..	..
Sydney, N.S.W.	1010·6	− 1·8	97	60	79·4	65·0	72·2	+ 0·6	65·8	64	5·9	2·02	− 1·65	17	8·2	58
Melbourne	1012·3	− 0·6	91	49	74·7	54·1	64·4	− 3·0	57·1	61	7·4	1·25	− 0·64	12	6·4	44
Adelaide	1014·5	+ 1·5	103	51	81·9	59·9	70·9	− 3·0	57·7	39	5·4	0·64	− 0·08	7	9·4	67
Perth, W. Australia	1014·4	+ 1·9	104	51	86·0	63·1	74·5	+ 0·7	63·6	48	2·0	0·03	− 0·31	2	11·6	83
Coolgardie	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Brisbane	1011·5	+ 0·2	100	67	88·9	71·7	80·3	+ 3·1	71·9	61	5·5	4·54	− 1·96	10	8·2	60
Hobart, Tasmania	1006·4	− 3·9	86	43	67·0	50·6	58·8	− 3·2	51·2	53	6·2	1·25	− 0·58	16	7·6	51
Wellington, N.Z.	1008·8	− 4·5	70	45	64·2	53·8	59·0	− 3·5	55·6	73	6·3	3·84	+ 0·51	13	8·1	55
Suva, Fiji	1009·7	+ 2·2	89	70	86·5	75·5	81·0	+ 1·1	76·2	78	6·4	10·42	− 1·01	25	7·8	60
Apia, Samoa	1006·1	− 1·8	87	73	84·4	76·7	80·5	+ 1·5	77·3	84	7·4	17·20	+ 0·15	22	5·2	41
Kingston, Jamaica	1014·3	− 0·8	89	67	85·8	69·8	77·8	+ 1·0	68·0	85	2·1	0·85	− 0·11	5	9·3	83
Grenada, W.I.	1013·2	+ 0·4	90	71	86·5	73·5	80·0	+ 2·9	73·8	76	4·7	2·43	− 1·95	16	..	..
Toronto	1016·2	− 1·7	45	0	31·6	18·2	24·9	+ 2·7	21·0	75	7·6	2·62	− 0·17	11	2·8	30
Winnipeg	1016·2	− 4·7	39	−13	17·2	2·7	9·9	+13·8	..	..	5·7	0·26	− 0·65	8	2·0	23
St. John, N.B.	1011·0	− 4·5	41	− 6	27·4	12·2	19·8	+ 0·6	14·2	61	5·0	4·41	− 0·39	16	4·2	46
Victoria, B.C.	1015·3	− 0·7	56	37	47·0	41·6	44·3	+ 5·3	42·8	95	8·6	4·66	+ 0·12	23	1·7	19

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