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Temperature Observations in Fog at Kew Observatory

By L. H. G. DINES, M.A.

Observations in fogs have been made at Kew Observatory by means of a small captive balloon and meteorograph from the year 1924 onwards. The methods adopted are described in Captain Entwistle's paper on Fog.* No summary of the data obtained has heretofore been published, and this note is based on an examination of a number of observations made during the winter seasons up to the present time.

The primary object of the observations has been to provide immediate information for the use of the Aviation Services Division as to the thickness of the fog layer existing, and to this end the record is examined as soon as possible after the balloon has been hauled down, a rapid estimate made of the probable height of the top of the fog and the result telephoned to London at once. In these circumstances minute considera-tion of the peculiarities of the records is not possible, and as it has been felt better to err on the safe side it has been customary to report the height at which, from a consideration of the record, it was certain there could not be any fog existing, rather than give a lower height about which there might be an element of doubt. It follows therefore that the data so obtained are probably somewhat higher than the actual tops of the fogs as they would have been seen from a manned balloon.

* *Aeronautical Reprints.* No. 28 Royal Aeronautical Society.

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In trying to measure the temperature and relative humidity at different levels on the occasion of a fog the main difficulty is connected with the sluggishness of the recording instruments. In foggy weather inland the wind at all levels in the fog is always very light, so that the natural ventilation of the meteorograph is poor. To compensate for this it is necessary to prolong the duration of the observation, and by so doing, reasonably accurate estimates of the temperature can be obtained. The measurement of the relative humidity, however, presents greater difficulty; this is unfortunate from the present point of view, because upon it largely depends the accuracy with which the true upper limit of the fog can be determined. A hair hygrograph is sometimes very sluggish in its response to changes in the relative humidity, and the degree of sluggishness seems to be by no means a constant quantity. The standard method of observation has been to allow the balloon to rise as fast as possible and then to pull it down again very slowly, basing all data on the record made during the descent. As the balloon comes down and the height above the top of the fog decreases, the relative humidity commonly shows a steady increase, but owing to the uncertain lag it is almost impossible to decide at what precise point the saturation of the fog was reached.

Results.—The changes of temperature with height generally take the form of a marked inversion, which has always been assumed to be situated near the upper limit of the fog. Originally the meteorograph was not provided with any cover, and if the sun were shining it could heat up the thermograph freely; the question was raised as to whether the inversion might not be largely fictitious and mainly due to insolation. Since the winter of 1928-9 a polished cover has been used which greatly reduces such a possibility, but large inversions have still been found, though not perhaps quite so large as was formerly the case. It is not always possible to raise the meteorograph to the top of the inversion and therefore the magnitude of the latter cannot always be measured precisely, but judging from data obtained since the polished cover was fitted the mean value must exceed 10°F. and the maximum may reach 17°F.

It is now quite clear that the inversion is a real phenomenon, but for the reasons which have been stated above it is difficult to correlate the changes of relative humidity with it, and it is in particular not easy to say whether the inversion takes place entirely above the limit of the fog, or whether there is sometimes an inversion inside the fog.

At first it was tacitly assumed that the latter might occur, though from the physical point of view it seems improbable; the upper limit of the fog was then assumed to be near the upper part of the inversion, not at its base. This procedure had the merit of safety for the purpose in hand, in that it denoted an upper limit beyond which the observational evidence of relative humidity commonly gave good reason for thinking that the fog did not exist, but further examination of old records suggests that it is not correct; it now appears much more likely that the upper limit of the fog is reached near the base of the inversion. The latter conclusion was reached mainly from a consideration of two specific occasions, viz., October 6th, 1927, and December 4th, 1925, when it happened, either by accident or design, that the balloon in its descent through the region of the inversion was periodically allowed to rise a little again before continuing its descent. On the latter occasion the traces of height, temperature, and relative humidity all oscillate in unison right through the inversion, effectively disposing of all question of lag of the hygrograph: in the former the oscillations though less pronounced are still there, and it is clear in both cases that saturation was not reached till some point near the base of the inversion. Further evidence to the same end is provided by the fact that apparently in no recorded case has the hygrogram indicated saturation on the descent before the base of the inversion was reached, or nearly so. These conclusions suggest a modification of the routine of observation for the future, which will largely get over the difficulty occasioned by the lag of the hygrograph. See *Appendix*.

Below is given a table of the heights of the upper limit of fog as estimated at the time on a number of occasions when observation was made at Kew Observatory. In studying it two points have to be remembered; firstly, that nearly all the observations were made at about 10 a.m., that is after the sun had risen, so that it is probable that the fog had been a little thicker

Date			Height of top of fog ft.	Date			Height of top of fog ft.
January	4th	1924	950	February	22nd	1928	320
,,	30th	,,	300	,,	23rd	,,	above 950
December	10th	,,	375	October	3rd	,,	150
,,	11th	,,	650	November	5th	,,	150
January	12th	1925	above 700	,,	6th	,,	600
December	4th	,,	600 at 10h.	,,	10th	,,	250
,,	4th	,,	525 at 14h.	December	18th	,,	750
November	25th	1926	400	November	15th	1929	700
February	11th	1927	750	,,	18th	,,	750
,,	14th	,,	600	February	14th	1930	650
October	6th	,,	500	December	5th	,,	950
November	8th	,,	700	,,	6th	,,	1,050
,,	22nd	,,	800	,,	9th	,,	400
,,	26th	,,	350				

at an earlier hour. Secondly and against this is the fact mentioned above that there has been apparently a systematic tendency to place the top of the fog somewhat too high. Perhaps therefore we shall not be far out in stating that the maximum thickness of fogs at Kew Observatory is approximately indicated by the figures in the table. It is definitely noticeable that very few fogs indeed exceed a thickness of 1,000 ft., the average being about 570 ft.

A fall of temperature in the air from the ground upwards in a fog is a very common feature, but not universal. It does not extend to the top of the fog and the lapse rate is generally less than the dry adiabatic, but on one occasion (October 6th, 1927) apparently a lapse rate of about that magnitude was indicated over a layer 200 ft. thick. It must be remembered that the temperature changes to be measured are so small that the instrument is not capable of providing data accurate enough to decide such a point, unless the routine of the observation were specially designed to that end, which has not so far been done.

Appendix.—It is probable that more precise information of the changes in relative humidity above a fog can be obtained by modifying the method of using the balloon and meteorograph. It is proposed to adopt the following procedure for trial in future:—

(1) Send the balloon up as rapidly as possible to the maximum height.

(2) Pull back again at about the rate of 250 ft. per minute.

(3) Examine the record and note approximately the height of the inversion, if any.

(4) Send the balloon up again as fast as possible to a point above the upper limit of the steep negative lapse rate and leave it at that height for about four minutes.

(5) Wind it in at about 120 ft. per minute for one minute, let it out at once about 40 ft. in half a minute, wind it in again for one minute, let it out 40 ft., and so on, till the observer is reasonably sure that he is through the inversion, then wind steadily home at about 120 ft. per minute.

The Significance of Nephoscope Observations

Although observations of upper cloud movements are regularly taken as routine observations whenever the opportunity presents itself, at the moment the significance of the upper cloud movements as indicating the upper winds are not by any means fully understood. Douglas* has mapped the upper wind circulation for a typical Norwegian cyclone, while the tabulations given by Pick and Bowering† indicate that neither the direction or speed of the upper clouds provide the forecaster with altogether reliable information as to the subsequent movement to be expected from the depressions with which the upper winds are associated.

*London, *Q.J.R. Meteor. Soc.*, 48, 1922, p. 342.

†London, *Q.J.R. Meteor. Soc.*, 55, 1929, p. 71.

As to their bearing on the subsequent behaviour of anticyclones there appears to be even less information. In the British Isles, where there is very marked preponderance of SW to W winds at the higher levels, it is only infrequently that very marked changes in direction occur and help to focus attention on their significance.

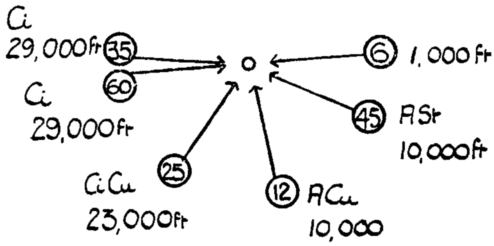
For this reason the changes in the upper winds during the period September 30th to October 2nd are of interest when considered in relation to the changes in the surface pressure distribution, and it is the purpose of this note to set out, side by side, the relevant details of the two sets of changes.

For several days previous to September 30th, a large intense anticyclone had been maintained between Scotland and Iceland with little change. The distribution was associated with considerable low cloud, particularly over eastern and southern England, although on September 30th a few nephoscope observations of high cloud were possible. Fortunately these were widely distributed and showed, in conjunction with other data, a solid easterly current of moderate strength from the surface up to the cirrus level. Evidence of this sort that the anticyclonic circulation extends to great heights is generally accepted as an additional indication that the distribution is stable, although in this case a secondary centre off Portugal to a large low-pressure area between the Azores and Spain was definitely encroaching northwards. Late that same afternoon, however, an isolated nephoscope observation from Mount Batten, Plymouth (the observation was subsequently confirmed) showed that the wind at the cirrus level had in the space of a few hours changed to southwest and was blowing at 90 m.p.h.

There was no important change at the alto-cumulus levels on the following morning (October 1st), and at 7 a.m. the alto-cumulus at Valentia and at Rennes (Brittany) was from east-southeast. But by 10 a.m. the alto-cumulus at Tours was moving from 230° at a speed of 42 m.p.h., although the secondary disturbance was swinging northeast and the surface observations showed that it was no longer a source of potential danger to western and southern Britain. At 6 p.m. on the same evening the cirrus movements at Calshot were from a little north of west, while the surface observations indicated rather a southeastward extension of the anticyclone, more than any general movement of the system.

On the morning of October 2nd the main anticyclonic centre was definitely being transferred southeastwards towards Germany, more by a very marked increase of pressure in that area than by a definite movement of the system as a whole, since an intensive ridge was still maintained to the south of Iceland and westward to mid-Atlantic. By 10 a.m. the thick low cloud sheet over east and southeast England was breaking up, revealing a wealth of higher cloud strata of which observers were quick to avail themselves. It is interesting at this stage to digress somewhat and deal in more detail with the observations over south-east England, since they not only bear on the general situation but they also give a very complete picture of the air currents from the surface up to the cirrus level, which is not often so clearly indicated.

The relevant observations which are given in detail below include the pilot balloon ascent at Croydon and 5 nephoscope observations, the whole showing a continued and complete veer of the wind through 180° from a light easterly wind at 1,000 feet to a strong west wind at the highest cirrus level. In the diagram the winds at the various levels are represented by the arrows which blow with the wind, the speeds being shown in m.p.h. in the circle on the tail. The average height of the cloud types observed are also shown for reference :—

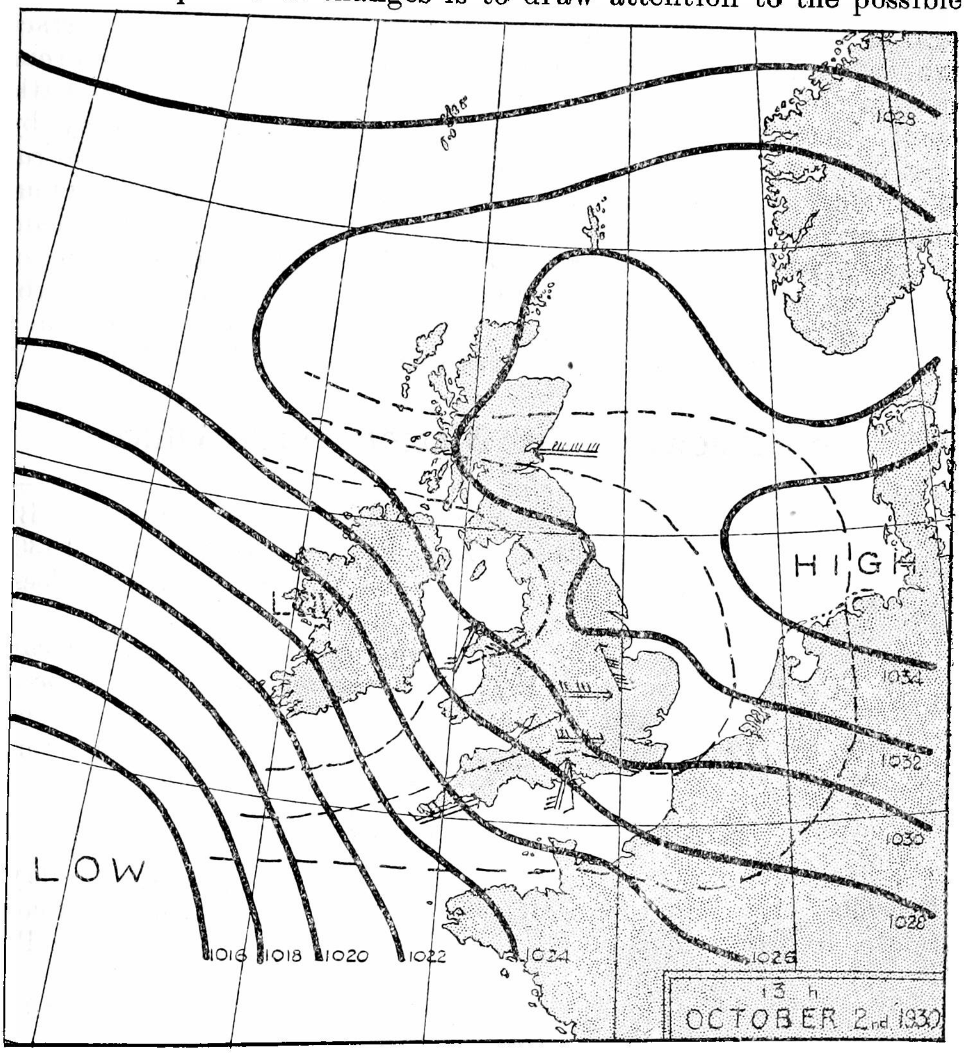


Croydon	pilot balloon ascent, wind	from 80° at 6 m.p.h. at 1,000 feet.	
Felixstowe ...	neph.	alto-stratus	from 120° at 45 m.p.h.
Worthy Down ...	neph.	alto-cumulus	from 160° at 12 m.p.h.
Worthy Down ...	neph.	cirro-cumulus	from 220° at 25 m.p.h.
Croydon	neph.	cirrus	from 260° at 60 m.p.h.
S. Farnborough...	neph.	cirrus	from 270° at 35 m.p.h.

The anticyclone was now definitely moving southeast and by 1 p.m. the centre was over eastern Germany, and as the 10 a.m. nephoscope observations show, the westerly component was making itself felt at much lower levels over southern England. Over Scotland, however, a nephoscope observation of cirrus at Leuchars (Fifeshire) at 10 a.m. showed that in the highest levels there the wind was still due east. By evening the upper winds over southern England, at least down to the alto-cumulus level had become generally southwest to west, and thereafter the process of replacing the easterly winds by westerly winds at still lower levels continued uninterruptedly during the subsequent period. The outstanding change in the surface distribution at this stage however was not the mere withdrawal of the high pressure centre, but the rapid decay of the whole intensive anticyclonic system indicated at the surface by the marked and sustained fall in pressure over practically the whole of Europe which set in during the morning of October 3rd.

The chart reproduced is that showing the surface distribution at 1 p.m., October 2nd, and with it has been incorporated a selection of the nephoscope readings taken between 9 a.m. and 1 p.m. on that date. Single arrows refer to Alto-type clouds and double arrows to Cirro-type clouds; the speed is indicated by the number of flèches. An indication of the probable pressure distribution at the cirrus level is superimposed.

It is not to be expected that one particular case such as this can, of itself, provide even a useful clue to the problems confronting us, and the only object in setting out the foregoing detailed sequence of changes is to draw attention to the possible



significance of the upper wind changes. Apart from considerations of the temperatures of the various air masses involved and their admitted relation to the wind in the higher levels of the troposphere, one feels that the pressure distribution at these levels as indicated by the winds aloft should not be overlooked. In this case, as late as the morning of October 2nd there was definite evidence that the east winds still prevailed at the highest levels across northern Britain, although for the past 36 hours westerly winds had been indicated at the cirrus level over southern England. We have thus evidence of at least a low-pressure trough, if not a complete cyclonic circulation, at a height of approximately 29,000 feet superimposed on an equally definite anticyclonic distribution at the surface, while later events rather suggest, in a way, the propagation downwards of the high level "depression," if the term is applicable in the usual sense. Was the upper "trough" or "depression" an initial stage of the shallow low-pressure system on the surface which covered the country before the advance of a more vigorous system from the Atantic destroyed its identity? There is little doubt that the true position is that expressed so concisely by Sir Napier Shaw in the October number of the *Meteorological Magazine* and less explicitly by Capt. Douglas in the previous number "that anticyclones and cyclones are not two problems but two aspects of a single problem," and that the solution of many of the problems of meteorology will be found not in the study of either depressions or anticyclones separately but in a combined study of the two systems as one complete whole.

F. H. DIGHT.

Discussions at the Meteorological Office

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

January 26th, 1931.—*Outlines of a dynamical climatology.* By Tor Bergeron (Meteor. Zs. Braunschweig, 47, 1930, p. 246-64) (in German). *Opener*—Mr. S. T. A. Mirrlees, M.A.

February 9th, 1931.—*The flights and attempted flights across the North Atlantic in 1927 from the meteorological aspect.* By Ph. Wehrlé and A. Viant (Paris, Off. Nat. Météor., Mem. No. 19, 1928) (in French). *Opener*—Mr. J. S. Farquharson, M.A.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, December 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 Buchan Prize of the Royal Meteorological Society for 1931 has been awarded to Charles Ernest Pelham Brooks, D.Sc., for papers contributed to the *Quarterly Journal* and *Memoirs* of the Society during the years 1925-9.

John Glasspoole, M.Sc., Ph.D.—Heavy falls of rain in short periods (two hours or less).

A knowledge of the frequency of occurrence of unusually heavy rains is of considerable practical importance, especially in the design of sewers for the discharge of flood water. Schemes for the disposal of flood water are costly and the engineer has to balance probability delicately against possibility, and to seek the solution which will give a reasonable degree of immunity from flooding at a reasonable cost. The paper gives details of intense falls in 10, 15, 30 and 60 minutes as recorded in seven years at 14 stations distributed over the British Isles. This is a more detailed examination than has been carried out previously. The paper shows, for example, that at Camden Square (London) ·16 inch or more has fallen in 10 minutes on 22 occasions in seven years, and that on the average of the 14 stations ·80 inch or more has occurred in an hour once in seven years.

It is often reasonable to provide for all except the two or three highest storms during seven years, and details are therefore given, of the heaviest, second heaviest and third heaviest rains in specified times at each station. A summary is included of earlier work on the subject. A very full discussion followed the paper, showing the interest with which it was received, especially by water engineers.

M. T. Spence, B.Sc.—The factors affecting visibility at Valentia Observatory.

This paper analyses by means of frequency tables the relationship at Valentia between visibility and (*a*) cumulus cloud, (*b*) wind force, (*c*) humidity. It is found that visibility is better when there is cumulus cloud in the sky than when there is not, that visibility deteriorates with increasing wind force and improves with decreasing relative humidity down to comparatively low values of humidity. The relationship between visibility and cumulus cloud is regarded as showing that visibility at Valentia is generally better in air of polar origin than in air of equatorial origin : further support for this view is derived from a paper by Dines and Mulholland in which it was shown that northerly winds gave generally better visibility than southerly winds at Valentia. The deterioration of visibility with increasing wind force is not due to the stronger winds being land winds, nor to their being more humid than the lighter winds; it is concluded, therefore, that sea spray, the amount of which varies with wind force, gives rise to the greater obscurity with strong winds. It is suggested that improving visibility with drier air at comparatively low values of relative humidity may be associated with slow evaporation from the hygroscopic nuclei.

Correspondence

To the Editor, *The Meteorological Magazine.*

Glazed Frost ?

At Golders Green this morning the water deposited from the fog on trees, shrubs, twigs, had frozen. The resulting ice was quite transparent. It was not a continuous coating, but just drops like frozen dewdrops. The drops looked exactly like water, and one could only tell that they were ice by actually touching them.

The temperature on an openly exposed thermometer was 31°F. I do not know what the correction to the thermometer is: it is probably small. Usually when ice is deposited from fog it is rime and white. I do not know whether this water was deposited as water and froze afterwards, or whether it was actually deposited from super-cooled drops. I rather suspect the former, but the immediate point which arose was—is this glazed frost?

E. GOLD.

December 5th, 1930.

[I once saw the same phenomenon on head grass-stalks by the side of the path leading to Kew Observatory, and was much struck by it at the time. I recollect the circumstances quite clearly, and the appearance was exactly as described above. In particular I am quite certain that there was no continuous coating of ice.

The definition of "glazed frost" in the *Observer's Handbook* lays stress on the presence of a "smooth coating of ice covering trees, etc.," and it is doubtful, therefore, whether the phenomenon could be fairly described as glazed frost. On the morning in question glazed frost was reported at Harrow, so one might perhaps deduce that glazed frost is a more advanced stage of the phenomenon.—E. G. BILHAM.]

A Super-cooled Cloud

A sounding balloon sent up from Kew Observatory at 18h. on September 27th last yielded an interesting example of a cloud of supercooled water drops. The recording instrument was fitted with a hair hygrograph and the record shows that it entered a dense cloud at a level of about 2,000 dynamic metres (2,040 metres), the temperature being about 271°A. The thermograph evidently became covered with a layer of water, which remained unfrozen till the level of 2,750 dynamic metres was reached with an air temperature of 266·5°A. At that point the water suddenly froze, bringing the apparent temperature up instantaneously to 272°A. Almost immediately afterwards the balloon emerged from the cloud and the thermograph, wholly or partially covered with ice, must have functioned somewhat like a wet bulb. The record shows definite signs of this, and there is further evidence that the ice soon evaporated in a dry region above the cloud.

It is interesting to have this evidence of a supercooled cloud and that water can collect on a solid body without freezing down to as low a temperature as 6·5°A. below the freezing point.

L. H. G. DINES.

Kew Observatory, Richmond. November 19th, 1930.

Peculiar Cloud Phenomena

I was much interested in the note under the above title on page 215 of your October issue. Was this not a sort of "water-spout" on land? The description seems to tally so well with what we saw from this island when looking in the direction of Naples on the afternoon of September 15th.

In that case the evil-looking parent cloud was a long one, covering perhaps ten or fifteen miles, very slowly drifting in an easterly direction, although there was over all the surrounding sea at the time practically a dead calm. The black shafts descended in four different places, at intervals of a few miles, and we were at first struck by what we took to be just a rain storm concentrated in such a small pour. But then below it was seen to be a white disturbance in the sea reaching up to join with the black arm descending from above. The black thing was in each case just like the sleeve of a giant's coat without the hand showing, rather like an elephant's trunk, as your observer describes his.

The whole performance took about a quarter of an hour or twenty minutes. The black cloud seemed to contemplate other descents which failed to mature, and drifted along towards Naples and Vesuvius coming from a westerly direction.

M. Rawnsley.

Dil-Aram, Anacapri, Italy. November 7th, 1930.

Waterspout at Cape d'Aguilar Wireless Station, Hongkong

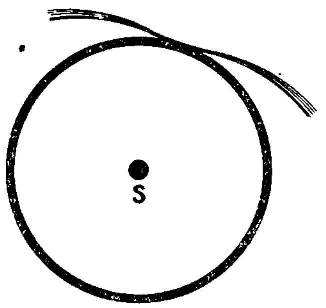
At 10.30 a.m. on September 29th, a waterspout was observed in the bay near the pier at Cape d'Aguilar. The spout and spray were in a column about 50 feet in diameter and 200 feet high when first seen by Mr. Merriman and myself. The station and quarters were hurriedly secured in readiness, but the whirlwind on reaching the shore travelled slowly to the O/C.'s bungalow carrying with it some seaweed, branches, and actually a few fish. On reaching the bungalow the whirlwind paused and halted short of the front door. It then turned, skirted around the house without touching it, and on its way across the back garden raised the dustbin vertically to a height of about 50 feet and carried it slowly into the bay on the Shek-O side of the station. The whirlwind then climbed the side of d'Aguilar Peak in a northwesterly direction.

J. Key.

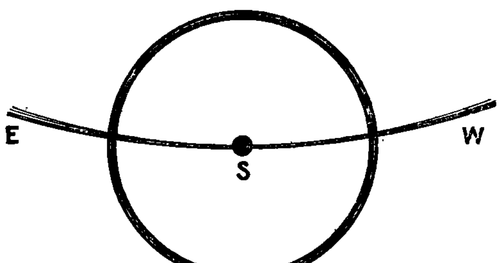
Cape d'Aguilar Wireless Station, Hongkong. September 29th, 1930.

Halo Phenomena

On Sunday, October 19th, 1930, at 11.15 (G.M.T.) a faint halo of 22° was visible with a bright inverted contact arc a little to the west of the zenith of the halo, with its ends curved down towards it. By 11.40 the ends had become less curved, forming a more or less straight band, but still retaining the inward curvature. The intensity of the whole phenomenon varied with the amount of cloud covering that portion of the sky, the halo of 22° increasing in brightness as cloud increased. The prismatic colours at the junction of the arc and the halo were unusually bright, especially when first noticed, with a thin film of cirro-nebula covering that portion of the sky. (No apparent parhelion was observed at the contact arc.) The arc attained its maximum brightness with the highest type of cloud, namely, cirro-nebula, which first made its appearance as a whitish haze at about 11.15 but decreased with the advance of a lower stratum of cirro-stratus from the south-southwest.



11-15



12-50

By 12.00 the whole phenomenon had almost disappeared except the bright junction of the arcs which were now much less intense. By 12.15 no trace of a halo could be seen although the sky in the vicinity of the sun appeared to be clearer than at 11.40, but this may have been accounted for by a lower type of cirriform cloud which did not give rise to halo phenomenon, the cirro-nebula having temporarily cleared away.

At approximately 12.50 an arc of a white parhelic circle passing through the sun and extending towards the east and west was visible together with a faint halo of 22°, but both became rapidly obscured by a layer of cirro-cumulus cloud, the parhelic circle being visible through the cloudlets until a thicker stratum of cirro-cumulus completely covered the whole southern portion of the sky. The sun was again visible as a faint blur through stratus at 13.30, but no halo was visible except a faintly coloured corona, and rain was just beginning to fall from an increasing lower stratum of cloud. The wind was mainly light from a southeasterly direction during the morning and continuing so throughout most of the day.

The whole of the above interesting formations were observed with a black mirror, a very excellent means of observing halo phenomena. I am only an amateur observer, but noticing these very interesting phenomena I thought that it might be of interest as from this district. The two diagrams, taken from sketches drawn while observing the phenomena give a slight idea of the appearance of the halos. A. MOON.

39, *Clive Avenue, Clive Vale, Hastings.* *October* 21*st*, 1930.

Cyclones and Anticyclones

In the October, 1930, number of the *Meteorological Magazine* Sir Napier Shaw makes some interesting remarks about the production of velocity in the atmosphere. In this connexion, the atmospheric waves which circulate in the southern hemisphere would, in my opinion, well repay detailed study by European meteorologists. The more experience one has in these regions the more impressed does one become with the regularity of this feature of the general circulation. The cyclone has played far too prominent a part in meteorological literature. Even Sir Napier Shaw says that " a cyclone will be dug on the left-hand side . . . . . of any current of air in the atmosphere except indeed at the Equator." That seems to me to be far too sweeping a statement. EDWARD KIDSON.

Meteorological Office, Wellington, New Zealand, November 24*th*, 1930.

NOTES AND QUERIES

"Flattish" Hailstones Observed in Thunderstorm over Mt. Olympus, Cyprus

At Cyprus on September 12th, 1930, flat and other peculiar-shaped hailstones were observed by numerous spectators up Mt. Olympus, about 6,000 ft. above sea level.

During the early part of the day the weather showed no unusual symptoms, being fine during the forenoon with a moderate southerly breeze at sea level. During the forenoon slight cumulus cloud commenced to form over the land, principally on the westward side. One observer stated that at about 14h. (East European time) he was sitting inside a tent when he noticed a roaring sound which had been going on for about 10 minutes; he imagined the noise to be rather like what Niagara Falls would sound like from a distance of about 3 miles. The occupants of the tent went outside and noticed a large thunder cloud in the vicinity from the edge of which some hailstones fell amongst them. No thunder or lightning was observed and the cloud gradually moved away. He states that the hailstones were flattish or rather like the underside of a button, and in size about the circumference of a penny. The four local residents with him at the time had never previously seen hailstones of a similar type or heard a noise to correspond to the roaring sound.

Another observer about two miles distant and approximately 400 feet higher up, states that at 14h. a violent hailstorm occurred, accompanied by thunder and lightning which lasted about a quarter of an hour. There were a few round hailstones of normal size and some others of peculiar shape, like teeth, with needle-sharp points, but for the most part they were "flattish," rather like an acid drop and about the circumference of a shilling. He cut open a round one and found the usual formation which he described as like a section of an onion. The "flattish" ones when cut open at the sides or centre appeared as one piece of solid ice. The hailstones did not melt rapidly and when they did commence to do so, the flat ones dissolved first from the centre and eventually left a ring of ice on the outside which was the last to go.

H. MOORHEAD.

The Rainfall of 1930

The rainfall of 1930 over the British Isles as a whole was 115 per cent of the average, thus continuing the remarkable run of wet years already experienced. The last dry year was 1921, since when the accumulated excess of rainfall over the British Isles as a whole has amounted to 90 per cent of the average annual amount. In the last nine years we have received therefore nearly as much rain as falls on the average in 10 years. So long a run of wet years has not occurred since the nine years 1875 to 1883. The accumulated excess during this period was slightly less than that just recorded, being 82 per cent. It is noteworthy that from 1884 to 1902, the rainfall exceeded the average in only five out of 19 years.

The excesses of the last nine years, over the 35 years' average 1881 to 1915, were more pronounced in the summer, the mean percentage excess in the summer months being 13 compared with 8 in the winter. During this period March was the only month in which the mean rainfall of the nine years was less than the average amount (actually 77 per cent), June and December gave the average amount, while January and September were the wettest months, each with 129 per cent of the respective averages. The mean rainfall of the remaining months during the last nine years was between 110 and 115 per cent of the average amounts in each case.

Compared with 1929 the rainfall of the year 1930 presents few points of outstanding interest. Mention may be made, however, of the following incidents. The thunderstorm near Ilkley on April 25th was remarkable in that about 1·84in. of rain and hail fell there in 30 minutes. The thunderstorm rains from June 12th to 19th were also remarkable, especially near Wormwood Scrubs on the 17th, and near Deptford on the 18th. The cyclonic rains of July 20th to 23rd near Whitby were, on the other hand, notable for their persistence. During these four days as much as 11·97in. was recorded at Castleton, in the Yorkshire Wolds. Much damage by flooding resulted in the Esk and Leven Valleys, and an unusual occurrence was the use of the Whitby lifeboat at Ruswarp, two miles inland, where it was launched from its carriage over flooded fields for rescue work. The rainfall at Ross-on-Wye for the period October, 1929, to January, 1930, is also worthy of comment. The total rainfall was 26·88in., or within 1·5in. of the average rainfall for a whole year, and the rainfall was greater than that of any other four months experienced at that station since records began in 1818.

Over the British Isles as a whole, there were five consecutive wet months from July to November. The rainfall during March, April, May and December was in each case fairly close to the average amount. January was unusually wet, while June and especially February were dry. The period February to July was noteworthy for the deficiency of rainfall in Scotland, while there was a remarkable run of six wet months from July to December in Ireland. Provisional general values for the rainfall of 1930, expressed as percentages of the average 1881 to 1915 are:—England and Wales 117, Scotland 110, Ireland 114, British Isles 115. Over the Britsh Isles as a whole 1930 was therefore not quite as wet as 1924, 1927 or 1928. The general percentage values for 1922 to 1929 are given for comparison:—100, 114, 117, 104, 103, 118, 118 and 101.

The total rainfall was less than the average over only a small part of the British Isles. Small deficiencies occurred in the Thames Valley between Newbury and Windsor, in the English Lake District, near Crieff and Grantown-on-Spey, and along the northwest coasts of Scotland and of Ireland. There was rather less than 90 per cent in part of Co. Donegal and over the Outer and Inner Hebrides. Falls of more than 120 per cent were widespread. Such large excesses occurred in the Devon-Cornwall peninsula, over a broad belt stretching across the Pennines from Gloucester and Snowdonia in the west to Flamborough Head and Newcastle in the east, in the southeast of Ireland from Cork to the Wicklow Mountains, in Connemara and locally in Scotland, in Bute, near Dundee, Aberdeen and Eskdalemuir Observatory, Dumfriesshire. Falls of more than 130 per cent were confined to England, Wales and Ireland, and occurred in the northeast of Wales from Flint to Montgomery, in the Wicklow Mountains, and locally near Ashburton, Birmingham, Bradford, the Yorkshire Wolds and Sunderland. Falls of

140 per cent and more were probably confined to the region near Whitby, where the rainfall of July 20th to 23rd was so remarkable.

J. GLASSPOOLE.

Reviews

(1) *Die Münchener Registrierballonfahrten im Jahre* 1928, by P. Zistler and H. Zierl. (2) *Die Temperaturverhältnisse der freien Atmosphäre über München*, by P. Zistler. (3) *Statistische Ubersicht über die Münchener Registrierballonaufstiege*, by P. Zistler. (4) *Singularitäten im jährlichen Witterungsverlaufe von München*, by A. Schmauss. (5) *Klimatologie von Bayern: Erstes und letztes Auftreten bestimmter Temperaturtagesmittel im Jahresverlaufe*, by A. Huber. (6) *Die luftelektrischen Verhältnisse am Zugspitzgipfel in* 2960*m*, by P. Lautner. (7) *Beiträge zum Strahlungsklima der Zugspitze*, by H. Lipp. Deutsch. Meteor. Jahrb. Bayern, 1928.

These papers deal with various aspects of meteorology in south Germany. Paper (1) gives a list of the individual results of registering balloon ascents carried out at Munich in 1928; (2) and (3) summarise the results of all the Munich ascents from 1906-14 and 1922-8, in regard to the temperature distribution and to general wind conditions, respectively. In all 404 ascents are included, of which 318 reached the stratosphere. No attempt is made to theorise, but the completeness of the information presented makes these papers very useful to anyone investigating upper air conditions.

Paper (4) deals with Munich observations over 45 years, from which mean values of the meteorological elements are determined for each day of the year. The elements considered are temperature, wind direction, pressure, precipitation, and weather variability, the last being determined from precipitation figures alone. With such long-period averages it might be expected that the probability curves for any element would be fairly smooth functions of the day of the year; this, however, is found not to be the case, as several irregularities, or singularities, occur. Perhaps the most striking of these is the result that rain appears just twice as likely to occur on August 17th as on August 10th.

Paper (5) is the fifth of a series of papers which began in 1909 dealing with the climatology of south Germany, A rather novel method is used here in presenting the seasonal variations of mean temperature throughout Bavaria, based on long-period observations from 69 stations. The method of representation is to give tables showing the first and last occurrence of daily mean temperatures (in intervals of 5°C.) at different stations, with certain other immediately connected information. A series of eight maps gives a geographical picture of the results for daily means of 15°C. and 20°C. The results presented in this way are likely to be of more convenient application in regard to phenology and agriculture than the more customary mean temperatures and maps of mean isotherms.

Paper (6) comprises an account, including a description of the instruments used, of a series of measurements of the elements of atmospheric electricity carried out at the peak of the Zugspitze over a three-year period (but especially 1927-8), a discussion of the results, their dependence on meteorological conditions, and a comparison with similar measurements at Munich and Potsdam.

The Zugspitze solar observatory is to South Germany what the Mt. Wilson observatory is to Arizona, and publication (7) deals with the results of a year's observations (1926-7) of the direct solar and diffuse sky radiation at the level of the observatory (2962m.). Transmission coefficients of the atmosphere are determined (the derivation of a formula for transmission in terms of air mass and water-vapour content is interesting), and the effects of cloudiness considered. On this last point one would have preferred that contemporaneous sunshine records had been available; as it was, the means for 1911-20 had to be used. The paper is naturally primarily concerned with the local conditions at the Zugspitze, but it is very comprehensive, and contains more than 160 references to other publications. A. F. CROSSLEY.

Correlation between Weather and Crops with Special Reference to Punjab Wheat. By Rao Saheb Mukund V. Unaker, B.A. Ind. Meteor. Mem., Vol. XXV, Part IV, 1929, pp. 145-60, 2 plates. Calcutta, 1929.

It is the practice of many Government Departments to issue at intervals during the growing season estimates of the area sown and the probable yield of the principal crops. These estimates are mainly based on reports received from crop observers and are subject to modification, with the advance of the growing season. The method is a subjective one depending as it does on personal experience and judgment and many attempts have been made to supplement and perhaps in course of time replace the present method by an objective one based on mathematical formulæ embodying the results of research into the relation between weather and crops. Valuable contributions in this direction have already been made by various investigators, notably Shaw, Hooker and Fisher in this country, Wallén in Sweden, Jacob in India, and Moore, Bradford Smith, Kincer and Mattice in America.

The present note is a preliminary attempt to determine by the method of correlation the influence of weather conditions on the area sown and the yield of wheat in the Punjab, and thus to derive formulæ for predicting during each month of the growing season, October to March, the crop prospects. Using data for 35 years, the author calculates the correlation between temperature (using Lahore maximum temperatures) rainfall, and (in the absence of data giving actual consumption of water through irrigation canals) Indus river levels on the one hand, with area sown, gross out-turn and out-turn per unit area on the other. Due allowance is made for secular increase in area sown and net yield owing to general agricultural development.

The author finds that with regard to area sown the most important rainfall is that of September, the correlation coefficient being +0·61, Indus river levels are important too, the correlation with area sown being +0·60 for September, +0·51 for October and +0·41 and +0·29 respectively for November and December. There is a negative correlation between maximum temperatures and area sown indicating that high temperatures in the growing season are unfavourable.

With regard to gross out-turn high coefficients are obtained with Indus river levels, the values ranging from +0·39 in December to +0·72 in March. The influence of rainfall is most marked in September, December and March (correlation coefficient +0·44 in each month).

The author subsequently proceeds to the evaluation of total correlation coefficients between the departures of Punjub wheat data from adopted normals and departures of the combined meteorological elements. The total correlation coefficients are given in a table together with the partial correlation coefficients on which they are based. Regression equations are obtained and the calculated values of departures from the adopted normals of area sown at the end of October, gross out-turn at the end of January and March and out-turn per unit area at the end of March compared with the actual values during each of 35 seasons. Curves are given, the total correlation coefficients between the actual and calculated curves ranging from 0·67 (gross out-turn at end of January) to 0·75 (gross out-turn at end of March).

Finally, the author compares estimates determined meteorologically and the official forecasts with the final official returns of area sown and out-turn during each of the twelve seasons commencing 1913-4. In the case of area sown, the meteorological estimates at the end of October gave a correlation coefficient of +0·77 with the final official returns and the official forecasts at the end of January a coefficient of +0·91; in the case of gross out-turn, the meteorological estimates at the end of January and March gave coefficients of +0·60 and +0·65 respectively, the coefficient given by the official forecast by the middle of April being +0·86. The author concludes: "Thus meteorological determination though fairly good is not so accurate as the official estimate; but the chief merit of the former is that it is known much earlier and is consequently of great agricultural interest."

P. I. MULHOLLAND.

Obituary

We regret to learn of the death in London at the age of 54 of Vice-Admiral Sir Charles Royds, Assistant Commissioner of Metropolitan Police, who from 1901-4 served as first lieutenant and meteorologist of the "Discovery" in the British Antarctic Expedition.

We also regret to learn of the death, on January 3rd, 1931, at the age of 60, of Mr. William D. Christmas, of Harpenden, whose articles on the yearly and monthly reports and statistics of the weather and especially the rainfall from Rothamsted Experimental Station in *The Times* were well known.

News in Brief

It was announced in the list of New Year Honours that Sir Richard Gregory, D.Sc., LL.D., Emeritus professor of astronomy, Queen's College, London, Editor of *Nature*, has been made a Baronet.

Dr. Hugo Eckener, of Friedrichshafen, has been elected President of Aeroarctic (Gesellsch. z. Erforsch. d. Arktis, mit Luftfahrzeugen), in succession to the late Dr. Fridtjof Nansen.

Errata

December, 1930, p. 255, line 42, *for* "(Fig. 3)" *read* "(Fig. 2)"
December, 1930, plate facing page 255, titles under both Fig. 1 and Fig. 2 *for* "December 2nd, 1930," *read* "December 2nd, 1929."

The Weather of December, 1930

The month of December was mainly rather mild with frequent mists and fogs and a lack of sunshine in many districts. At the beginning of the month a ridge of high pressure across the country gave quiet, dull and dry weather with fog becoming general between the 4th and 6th, keeping the day temperature below the freezing point locally in the English Midlands on the 5th and 6th. The 4th was a sunny day in eastern England and the 3rd in northwest Ireland, 6·9 hrs. being recorded at Gorleston, Clacton, Felixstowe and Margate on the 4th, and 5·5 hrs. at Mallarany (Co. Mayo) on the 3rd. The slow advance of a trough of low pressure from the Atlantic on the 6th preceded a period of unsettled weather, cyclonic conditions continuing until about the 16th. Precipitation though frequent during this period was generally slight in amount except on the 10th and 15th, when 4·10in. fell at Fofanny (Co. Down), 1·75in. at Tynywaum (Glamorgan), and 1·54in. at Newburgh (Dorset) on the 10th, and 1·02in. at Mallarany (Co. Mayo) on the 15th. There were also periods of welcome sunshine, notably on the 9th and 14th. Day temperature did not rise above the freezing point in parts of Scotland and the English Midlands on the 10th and 15th. The sharpest frost of the month was registered on the morning of the 10th, when temperature on the ground fell to 10°F. at Eskdalemuir and 11°F. at Huddersfield, and in the screen to 15°F. at Eskdalemuir and 19°F. at Renfrew. Snow and sleet were general in the Midlands and Scotland from the 9th-12th, and again on the 15th and 16th. Strong winds were associated with the passage of a secondary depression on the 11th. Mist was frequent during this period and developed into widespread fog in the east and Midlands, as anticyclonic conditions became established about the 17th. With the westerly winds temperature rose generally, especially in the north and west, where 57°F. was recorded at Dublin and 56°F. at Aberdeen on the 18th. From the 16th-22nd. the rainfall was practically confined to the west and northwest of the country. The 21st was a sunny day over England, but on the 22nd, when the anticyclone was centred over the country, fog was general and temperature low. From then until the end of the month depressions of increasing intensity approached and crossed the country from the Atlantic bringing generally unsettled weather, heavy rain or snow at times but periods of bright sunshine, with temperature above normal. The Christmas period was mainly mild with rain at times and bright sunshine, although snow fell heavily in parts of northeastern England on the 26th. Gales occurred generally in the west and north on the 26th and 27th and over southern districts on the evening of the 28th; 78 m.p.h. was registered in a gust at Tiree on the 27th and 68 m.p.h. at Scilly on the 28th. Rainfall was heavy in the west and north on th 28th, when 3·25in. fell at Borrowdale (Cumberland) and 2·94in. at Penrhyn (Carnarvon). The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	25	+ 2	Liverpool	28	—15
Aberdeen	38	+ 2	Ross-on-Wye	31	— 9
Dublin	44	— 4	Falmouth	58	+ 3
Birr Castle	41	— 2	Gorleston	41	— 4
Valentia	41	0	Kew	22	—15

Pressure was above normal over northern and eastern Europe, the greater part of the Atlantic and the western United States, the greatest excesses being 11·5mb. at Waigatz, 7·5mb. at Horta, and 5·6mb. at 50°N., 120°W. Pressure was below normal over Iceland, the greater part of the British Isles, southwest Europe (except Portugal), eastern United States, Alaska, and parts of Canada, the greatest deficits being 9·0mb. at Reykjavik, and 3·9mb. at Brest. Temperature was generally above normal over western Europe, as much as 7°F. in Norrland (Sweden). Except for Switzerland, Dalecarlia (Sweden) and parts of the British Isles rainfall was above normal.

The Seine continued to rise during the night of the 1st-2nd, but afterwards fell rapidly. Thick fog occurred in the Meuse Valley from the 4th-6th, during the prevalence of which 67 people died and 150 became ill. The causes of this fatal fog are at present under investigation by the authorities. A violent snowstorm occurred in central Spain on the 17th, while 3in. of snow (the first this winter) fell in Berlin on the same day. During a dense fog in the Kattegat the *Oberon* and *Arcturus* came into collision and many people were drowned. The sea was frozen as far as the horizon at Parnu on the 17th. Thick fog occurred over Holland and northwest Germany on the 19th, 20th and 21st. A thaw set in, in Switzerland on the 27th, but snow was again falling on the 29th.

A severe storm raged between the Balearic Islands and Algeria from the 17th to 20th, doing much damage to shipping especially along the Algerian coast. All telegraphic and telephonic communications were interrupted in Algeria. The total rainfall for Algiers for December was more than twice the normal, and extensive floods occurred in the department of the Oran.

Moderate to heavy rain fell in Victoria and New South Wales, and light to moderate rain in the first part of the month in South Australia and parts of West Australia.

Navigation closed at Quebec on the 23rd. Temperature was mainly above normal in the United States during the first part of the month, but fell considerably below normal during the later part except in the Missouri and Upper Mississippi Valleys and the Lake Region. Rainfall was generally deficient except along parts of the Atlantic coast. Temperature was above normal in the Argentine except during the last week, while precipitation was in excess in the south but near normal in the north.

The special message from Brazil states that the rainfall in the northern regions was generally scarce with 1·81in. below normal, in the central regions irregular with 0·59in. above normal, and in the southern regions plentiful with 2·64in. above normal. Four small anticyclones passed across the country. Crops were generally in good condition, except the cane and cotton crops of the northeast, which were suffering from lack of rain. At Rio de Janeiro pressure was 0·5mb. above normal and temperature equal to normal.

Rainfall, 1930—General Distribution

	Dec.	Year.	
England and Wales ...	99	117	per cent of the average 1881-1915.
Scotland	97	110	
Ireland	101	114	
British Isles	99	115	

Rainfall: December, 1930: England and Wales

Co.	Station	In.	Per-cent of Av.
Lond .	Camden Square.........	1·95	82
Sur .	Reigate, Alvington.....	2·40	75
Kent .	Tenterden, Ashenden...	2·81	90
,, .	Folkestone, Boro. San..	2·72	...
,, .	Margate, Cliftonville...	1·78	78
,, .	Sevenoaks, Speldhurst	2·40	...
Sus .	Patching Farm.........	3·41	101
,, .	Brighton, Old Steyne..	2·49	80
,, .	Heathfield, Barklye....	3·85	104
Hants.	Ventnor, Roy. Nat. Hos.	3·58	109
,, .	Fordingbridge, Oaklnds	4·05	102
,, .	Ovington Rectory.......	4·48	113
,, .	Sherborne St. John.....	2·86	87
Berks .	Wellington College.....	2·45	85
,, .	Newbury, Greenham...	3·46	108
Herts .	Welwyn Garden City...	2·35	...
Bucks.	High Wycombe..........	3·58	122
Oxf . .	Oxford, Mag. College..	2·80	121
Nor .	Pitsford, Sedgebrook...	2·05	85
,, .	Oundle..................	1·59	...
Beds .	Woburn, Crawley Mill	2·28	97
Cam .	Cambridge, Bot. Gdns.	1·86	96
Essex .	Chelmsford, CountyLab	2·37	107
,, .	Lexden Hill House....	2·04	...
Suff .	Hawkedon Rectory.....	2·26	93
,, .	Haughley House........	2·06	...
Norf .	Norwich, Eaton...... ...	1·91	73
,, .	Wells, Holkham Hall	1·57	76
,, .	Little Dunham..........	2·24	92
Wilts.	Devizes, Highclere......	3·28	107
,, .	Bishops Cannings.......	3·36	102
Dor .	Evershot, Melbury Ho.	5·49	106
,, .	Creech Grange..........	5·27	119
,, .	Shaftesbury, Abbey Ho.	3·63	100
Devon.	Plymouth, The Hoe....	4·78	96
,, .	Polapit Tamar..........	...	...
,, .	Ashburton, Druid Ho.	...	...
,, .	Cullompton.......	4·50	103
,, .	Sidmouth, Sidmount...	4·02	102
,, .	Filleigh, Castle Hill....	6·70	...
,, .	Barnstable. N. Dev. Ath.	6·04	136
Corn .	Redruth, Trewirgie.....	3·92	63
,, .	Penzance, Morrab Gdn.	4·43	78
,, .	St. Austell, Trevarna...	5·30	87
Soms .	Chewton Mendip........	4·64	86
,, .	Long Ashton............	3·73	97
,, .	Street, Millfield	3·03	...
Glos. .	Cirencester, Gwynfa....	3·60	107
Here .	Ross, Birchlea...........	2·53	85
,, .	Ledbury, Underdown..	3·36	120
Salop .	Church Stretton.........	4·48	133
,, .	Shifnal, Hatton Grange	2·89	112
Worc .	Ombersley, Holt Lock	...	...
,, .	Blockley..................	3·61	...
War .	Farnborough............	...	...
,, .	Birminghm, Edgbaston	2·89	107
Leics .	Thornton Reservoir....	2·21	82
Leics .	Belvoir Castle...........	2·25	91
Rut .	Ridlington...............	1·96	78
Linc .	Boston, Skirbeck........	1·56	72
,, .	Cranwell Aerodrome...	1·83	83
,, .	Skegness, Marine Gdns	1·16	53
,, .	Louth, Westgate........	2·13	76
,, .	Brigg, Wrawby St.....	1·71	...
Notts .	Worksop, Hodsock.....	1·83	77
Derby.	Derby, L. M. & S. Rly.	1·96	75
,, .	Buxton, Devon Hos....	4·30	76
Ches .	Runcorn, Weston Pt...	4·70	149
,, .	Nantwich, Dorfold Hall	3·30	...
Lancs.	Manchester, Whit. Pk.	3·13	97
,, .	Stonyhurst College.....	3·58	74
,, .	Southport, Hesketh Pk	4·06	126
,, .	Lancaster, Strathspey	5·12	...
Yorks.	Wath-upon-Dearne.....	1·95	82
,, .	Bradford, Lister Pk....	3·08	92
,, .	Oughtershaw Hall......	7·37	...
,, .	Wetherby, Ribston H.	2·52	103
,, .	Hull, Pearson Park.....	1·91	79
,, .	Holme-on-Spalding.....	1·73	...
,, .	West Witton, Ivy Ho.	4·32	118
,, .	Felixkirk, Mt. St. John	2·78	115
,, .	Pickering, Hungate....	2·06	82
,, .	Scarborough.............	2·13	89
,, .	Middlesbrough..........	1·78	92
,, .	Baldersdale, Hury Res.	3·24	...
Durh .	Ushaw College...........	2·88	115
Nor .	Newcastle, Town Moor	...	...
,, .	Bellingham, Highgreen	2·98	82
,, .	Lilburn Tower Gdns....	3·74	139
Cumb .	Geltsdale.................	2·72	...
,, .	Carlisle, Scaleby Hall	2·04	64
,, .	Borrowdale, Seathwaite	11·75	72
,, .	Borrowdale, Rosthwaite	10·87	...
,, .	Keswick, High Hill.....	5·74	...
Glam .	Cardiff, Ely P. Stn.....	4·35	85
,, .	Treherbert. Tynywaun	10·35	...
Carm .	Carmarthen Friary.....	7·33	128
,, .	Llanwrda................	7·46	106
Pemb .	Haverfordwest, School	6·96	122
Card .	Aberystwyth............	6·77	...
,, .	Cardigan, County Sch.	6·52	...
Brec .	Crickhowell, Talymaes	6·10	...
Rad .	BirmW.W.Tyrmynydd	8·39	102
Mont .	Lake Vyrnwy...........	9·12	133
Denb .	Llangynhafal............	4·97	151
Mer .	Dolgelly, Bryntirion...	9·58	140
Carn .	Llandudno...............	4·50	145
,, .	Snowdon, L. Llydaw 9	20·70	...
Ang .	Holyhead, Salt Island	5·13	123
,, .	Lligwy...................	5·93	149
Isle of Man			
	Douglas, Boro' Cem....	7·05	142
Guernsey			
	St. PeterP't. GrangeRd.	4·92	120

Rainfall: December, 1930: Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Pt. William, Monreith	5·18	114	*Suth* .	Loch More, Achfary	8·00	87
,, .	New Luce School	5·22	94	*Caith* .	Wick	2·04	66
Kirk .	Carsphairn, Shiel	8·43	91	*Ork* .	Pomona, Deerness	3·72	89
Dumf.	Dumfries, Crichton, R.I	4·40	...	*Shet* .	Lerwick	5·48	115
,, .	Eskdalemuir Obs.	5·37	77	*Cork* .	Caheragh Rectory	5·95	...
Roxb .	Branxholm	3·68	101	,, .	Dunmanway Rectory	6·09	76
Selk .	Ettrick Manse	5·70	92	,, .	Ballinacurra	...	...
Peeb .	West Linton	2·32	...	,, .	Glanmire, Lota Lo.	4·45	81
Berk .	Marchmont House	2·69	96	*Kerry*.	Valentia Obsy.	6·27	94
Hadd.	North Berwick Res.	1·27	59	,, .	Gearahameen	11·10	...
Midl .	Edinburgh, Roy. Obs.	1·63	76	,, .	Killarney Asylum	6·40	88
Ayr .	Kilmarnock, Agric. C.	4·02	94	,, .	Darrynane Abbey	7·61	129
,, .	Girvan, Pinmore	5·49	92	*Wat* .	Waterford, Brook Lo.	4·54	97
Renf .	Glasgow, Queen's Pk.	3·55	84	*Tip* .	Nenagh, Cas. Lough	4·66	101
,, .	Greenock, Prospect H.	6·97	88	,, .	Roscrea, Timoney Park	4·03	...
Bute .	Rothesay, Ardencraig.	7·67	141	,, .	Cashel, Ballinamona	3·87	89
,, .	Dougarie Lodge	5·38	...	*Lim* .	Foynes, Coolnanes	5·18	110
Arg .	Ardgour House	9·74	...	,, .	Castleconnel Rec.	4·76	...
,, .	Manse of Glenorchy	8·90	...	*Clare* .	Inagh, Mount Callan	7·84	...
,, .	Oban	6·49	96	,, .	Broadford, Hurdlest'n.	5·08	...
,, .	Poltalloch	7·26	114	*Wexf*.	Gorey, Courtown Ho.	4·51	118
,, .	Inveraray Castle	7·60	77	*Kilk* .	Kilkenny Castle	3·63	105
,, .	Islay, Eallabus	8·43	142	*Wic* .	Rathnew, Clonmannon	4·51	...
,, .	Mull, Benmore	...	...	*Carl* .	Hacketstown Rectory	4·07	99
,, .	Tiree	6·34	...	*Leix* .	Blandsfort House	4·90	133
Kinr .	Loch Leven Sluice	2·71	69	,, .	Mountmellick	...	...
Perth .	Loch Dhu	8·90	88	*Off'ly* .	Birr Castle	3·45	105
,, .	Balquhidder, Stronvar	6·63	...	*Kild'r*.	Monasterevin	...	...
,, .	Crieff, Strathearn Hyd.	5·29	118	*Dubl* .	Dublin, FitzWm. Sq.	2·53	102
,, .	Blair Castle Gardens	4·62	121	,, .	Balbriggan, Ardgillan.	4·02	139
,, .	Glen Bruar, Bruar Ldg.	5·04	...	*Me'th* .	Beauparc, St. Cloud	3·56	...
Angus.	Kettins School	4·75	159	,, .	Kells, Headfort	3·75	98
,, .	Dundee, E. Necropolis	2·95	111	*W.M.* .	Moate, Coolatore	3·77	...
,, .	Pearsie House	4·98	...	,, .	Mullingar, Belvedere	4·06	110
,, .	Montrose, Sunnyside	3·65	131	*Long* .	Castle Forbes Gdns	3·85	97
Aber .	Braemar, Bank	4·55	128	*Gal* .	Ballynahinch Castle	9·76	130
,, .	Logie Coldstone Sch.	2·85	101	,, .	Galway, Grammar Sch.	4·78	...
,, .	Aberdeen, King's Coll.	3·96	123	*Mayo* .	Mallaranny	8·42	...
,, .	Fyvie Castle	3·37	99	,, .	Westport House	6·13	107
Moray.	Gordon Castle	1·63	61	,, .	Delphi Lodge	11·36	94
,, .	Grantown-on-Spey	2·08	77	*Sligo* .	Markree Obsy	4·91	104
Nairn.	Nairn, Delnies	1·96	88	*Cav'n* .	Belturbet, Cloverhill	3·16	85
Inv .	Kingussie, The Birches	2·09	...	*Ferm* .	Enniskillen, Portora	...	...
,, .	Loch Quoich, Loan	15·47	...	*Arm* .	Armagh Obsy	2·58	83
,, .	Glenquoich	12·50	85	*Down* .	Fofanny Reservoir	12·37	...
,, .	Inverness, Culduthel R.	...	...	,, .	Seaforde	3·85	94
,, .	Arisaig, Faire-na-Squir	6·39	...	,, .	Donaghadee, C. Stn.	3·37	106
,, .	Fort William	7·68	...	,, .	Banbridge, Milltown	2·85	...
,, .	Skye, Dunvegan	8·49	...	*Antr* .	Belfast, Cavehill Rd.	3·48	...
R & C.	Alness, Ardross Cas	3·27	79	,, .	Glenarm Castle	3·78	...
,, .	Ullapool	5·48	87	,, .	Ballymena, Harryville	4·04	91
,, .	Torridon, Bendamph	7·68	75	*Lon* .	Londonderry, Creggan	4·38	100
,, .	Achnashellach	6·61	...	*Tyr* .	Donaghmore	3·94	...
,, .	Stornoway	4·87	78	,, .	Omagh, Edenfel	4·40	104
Suth .	Lairg	2·34	58	*Don* .	Malin Head	4·10	...
,, .	Tongue	2·76	56	,, .	Dunfanaghy	4·36	...
,, .	Melvich	4·11	...	,, .	Killybegs, Rockmount.	4·59	63

Climatological Table for the British Empire, July, 1930.

STATIONS	PRESSURE: Mean of Day M.S.L. mb.	PRESSURE: Diff. from Normal mb.	TEMPERATURE Absolute: Max. °F.	TEMPERATURE Absolute: Min. °F.	TEMPERATURE Mean Values: Max. °F.	TEMPERATURE Mean Values: Min. °F.	TEMPERATURE Mean Values: ½ max. and min. °F.	TEMPERATURE Mean Values: Diff. from Normal °F.	TEMPERATURE Mean: Wet Bulb °F.	Relative Humidity. %	Mean Cloud Am'nt 0—10	PRECIPITATION: Am'nt in.	PRECIPITATION: Diff. from Normal in.	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
London, Kew Obsy.	1011·3	— 4·5	81	48	69·3	54·5	61·9	— 0·8	55·5	79	6·9	1·84	— 0·33	14	5·6	35
Gibraltar	1015·3	— 1·5	88	55	83·2	64·1	73·7	— 1·1	63·0	81	2·3	0·00	— 0·03	0	..	..
Malta	1013·8	— 1·5	93	68	84·4	72·1	78·3	0·0	71·0	71	1·5	0·04	— 0·01	1	12·7	89
St. Helena	1017·8	+ 1·4	..	53	..	54·8	..	..	56·0	95	9·4	4·86	+ 0·83	28	..	..
Sierra Leone	1015·0	+ 2·3	86	67	81·5	71·3	76·4	— 2·2	75·7	91	7·7	29·43	— 6·15	25	..	..
Lagos, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kaduna, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zomba, Nyasaland	1018·0	— 0·5	78	48	71·2	52·8	62·0	0·0	..	82	4·8	0·25	— 0·10	4	..	..
Salisbury, Rhodesia	1019·6	— 0·2	75	35	68·6	42·7	55·7	— 0·4	47·7	47	1·6	0·00	— 0·03	0	9·2	82
Cape Town	1022·6	+ 1·3	84	44	63·8	50·6	57·2	+ 2·5	50·2	83	5·2	2·64	— 0·98	15	..	..
Johannesburg	1023·8	— 0·2	68	30	60·4	42·1	51·3	+ 0·8	39·5	39	1·1	1·00	+ 0·67	2	9·2	86
Mauritius	1020·0	— 0·4	79	55	74·3	62·8	68·5	+ 0·2	65·3	73	5·1	1·49	— 1·00	14	7·3	66
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	999·3	+ 0·1	95	76	88·6	78·9	83·7	+ 0·2	79·3	90	9·0	20·12	+ 7·61	20*	..	..
Bombay	1005·1	+ 1·2	88	74	85·5	76·7	81·1	— 0·2	77·3	84	8·9	10·26	— 14·01	25*	..	..
Madras	1004·8	+ 0·3	102	75	97·8	80·5	89·1	+ 1·7	74·6	58	6·2	1·13	— 2·81	2*	..	..
Colombo, Ceylon	1010·0	+ 0·8	86	72	84·9	77·9	81·4	+ 0·3	77·0	78	7·5	1·12	— 5·31	11	7·5	60
Hongkong	1001·0	— 3·8	93	74	86·8	78·5	82·7	+ 0·2	78·6	83	7·9	29·03	+ 15·65	22	5·7	42
Sandakan	..	..	94	72	89·9	74·8	82·3	+ 0·5	77·0	79	..	3·95	— 2·60	9	..	..
Sydney, N.S.W.	1017·9	— 0·6	69	43	63·4	48·4	55·9	+ 3·2	49·7	80	4·7	3·93	— 0·91	11	5·7	56
Melbourne	1017·6	— 1·5	63	36	57·7	44·5	51·1	+ 2·5	47·4	74	6·1	1·48	— 0·35	17	3·8	38
Adelaide	1018·6	— 1·8	66	41	61·2	48·8	55·0	+ 3·3	49·7	79	7·5	4·22	+ 1·57	21	4·3	43
Perth, W. Australia	1017·2	— 1·8	70	41	63·9	48·6	56·3	+ 1·1	51·4	77	5·9	10·17	+ 3·72	21	5·1	50
Coolgardie	1018·8	— 1·1	74	33	62·2	40·8	51·5	+ 0·3	46·7	69	2·8	0·25	— 0·66	5	..	..
Brisbane	1019·3	+ 0·8	75	42	69·1	51·9	60·5	+ 2·0	54·5	71	4·3	1·25	— 1·09	9	6·7	63
Hobart, Tasmania	1012·7	— 1·1	60	36	55·4	43·8	49·6	+ 4·2	44·4	77	6·3	2·27	+ 0·13	14	3·9	41
Wellington, N.Z.	1016·4	+ 2·5	57	32	49·4	38·9	44·1	— 3·6	41·7	84	7·0	3·71	— 1·92	23	3·5	37
Suva, Fiji	1013·6	— 0·6	83	62	76·3	67·7	72·0	— 1·6	67·2	76	6·9	3·46	— 1·14	20	3·9	35
Apia, Samoa	1010·8	— 1·2	86	69	83·3	73·4	78·4	+ 1·2	76·3	78	4·4	0·87	— 1·77	6	8·3	73
Kingston, Jamaica	1014·2	— 0·5	93	71	89·5	74·1	81·8	+ 0·1	72·4	77	4·7	0·33	— 1·29	6	7·1	54
Grenada, W.I.	1013·5	+ 0·3	89	71	87·0	73·6	80·3	+ 1·3	73·9	77	4·8	6·65	— 3·14	22	..	..
Toronto	1013·3	— 0·8	92	50	80·9	59·2	70·1	+ 1·9	61·1	65	3·0	3·10	+ 0·06	7	10·5	70
Winnipeg	1012·6	— 0·1	94	51	81·9	59·7	70·8	+ 4·6	60·7	84	4·0	5·22	+ 2·06	9	11·1	70
St. John, N.B.	1011·4	— 2·3	81	51	71·0	55·8	63·4	+ 3·0	59·3	83	7·5	5·34	+ 1·71	18	6·4	42
Victoria, B.C.	1018·6	+ 1·9	87	48	67·0	51·3	59·1	— 1·2	54·6	73	4·0	0·03	— 0·33	1	11·7	75

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