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Conference on Atmospheric Ozone

Oxford: September 9th—11th, 1936

The band of workers on the problems of atmospheric ozone is not large; it was nearly fully represented at last month's Ozone Conference,* attended by about 60 members, and this 60 included a

* The photograph reproduced on the opposite page was taken during the Conference. The names reading from left to right are:—Front row: Prof. V. Conrad, Austria; Mlle. Michel, France; Mme. Gauzit, France; Mme. Vassy, France; Mme. Prettre, France; Mme. Lijot, France; Mme. Chalonge, France; Mme. Cabannes, France; Dr. W. Gorczynski, Poland; Prof. E. van Everdingen, Holland; Mons. Ph. Wehrlé, France; Prof. L. Weickmann, Germany. Second row: Father P. Lejay, China; Mons. D. Chalonge, France; Dr. J. A. Fleming, United States; Prof. R. Ayres, Egypt; Dr. D. F. Martyn, Australia; Prof. S. K. Mitra, India; Prof. B. Gutenberg, United States; Prof. E. V. Appleton, Great Britain; Dr. Hoelper, Germany; Prof. Schmidt, Austria; Prof. J. Cabannes, France; Prof. J. Gauzit, France; Dr. C. L. Godske, Norway. Third row: Dr. Kohn, Great Britain; Dr. W. Morikofer, Switzerland; Dr. A. Ångström, Sweden; Dr. O. R. Wulf, United States; Dr. R. H. Weightman, United States; Dr. F. W. Paul Götz, Switzerland; Mons. Dedebant, France; Dr. C. L. Pekcvis, United States; Mr. C. H. Collie, Great Britain; Dr. A. R. Meetham, Great Britain. Fourth row: Dr. G. M. B. Dobson, Great Britain; Dr. J. Bjerknes, Norway; Mons. E. Vassy, France; Mons. B. Lijot, France; Dr. Ratcliffe, Great Britain; Prof. R. Ladenburg, United States; Father L. Dumas, China; Prof. E. Stenz, Poland; Dr. H. D. Harradon, United States; Prof. J. Bartels, Germany; Prof. S. Chapman, Great Britain; Prof. F. A. Paneth, England. Fifth row: Capt. Heck, United States; Prof. M. Hessaby, Persia; Prof. Cario, Germany; Dr. T. W. Wormell, Great Britain; Dr. White, Great Britain; Mons. D. Barbier, France; Mr. F. J. Scrase, Great Britain; Dr. F. J. W. Whipple, Great Britain; Dr. E. H. Gowan, Canada; Mons. M. Prettre, France; Dr. R. Penndorf, Germany.

number of scientists whose interest in the subject is that of the onlooker. Yet 16 countries were represented and there were members from the United States, Canada, Australia, China, Egypt and Persia. It is remarkable too, that so many branches of science are interested in ozone—meteorologists, physicists, chemists, physical chemists, mathematicians (of course), biochemists and astronomers. The papers at this conference were of wide scientific interest and showed that considerable progress has been made since the last similar conference was held in Paris in 1929.

It is not hard to find the attraction of atmospheric ozone. The whole lot of it would form a layer only 2 or 3 mm. thick at N.T.P., and yet it absorbs 5–6 per cent of the total energy of sunlight. If it were not for this absorption, which is chiefly in the ultraviolet, we could never expose our skin to direct daylight ; while astronomers, who learn many things from stellar spectra, would have much more work to do. Above the limits of sounding balloons our knowledge of temperatures is partly learned from ozone, and we believe the temperatures themselves depend on the presence of ozone. At these heights the geophysicists know more about the distribution of this comparatively rare gas than of oxygen and nitrogen. Meteorologists, in their turn, in their fundamental problem of explaining the weather, are confronted with the ozone, which far into the stratosphere behaves differently with different surface conditions of weather.

Methods of Measurement.—A few years ago the process of measuring upper atmospheric ozone, by using its property of absorbing ultraviolet light from the sun, was extremely tedious and not very accurate. Today it is little more wearisome than reading a barometer. Dobson showed how measurements can be made in a few minutes with a photoelectric spectrophotometer even when the sky is completely overcast, and with a standard error under the worst conditions of less than 3 per cent. Gauzit has developed a simple visual spectroscope which uses the Chappuis absorption bands of ozone in the yellow. Chalonge and others have measured ozone at night with the light of stars and the moon, using the more classical methods of photographic photometry. Chemical methods, which should be very valuable and straightforward for measurements of ozone concentrations near the earth's surface, are still struggling against the handicaps of the very low concentrations which occur in nature. One other technique is being applied to measurement of ultraviolet light intensities—that of the photon counter. At present this method is in its infancy, but it may develop into one of great power.

Demonstrations of Apparatus.—It was hoped to arrange for a demonstration of various pieces of apparatus used by different workers. Unfortunately Customs and other difficulties interfered with this and the only apparatus shown was that of Gauzit for measuring the amount of ozone by visual methods, and the photoelectric instrument shown by Dobson.

Vertical Distribution of Ozone.—In 1929 very little was known of the whereabouts of high concentrations of ozone in the upper atmosphere. There was some evidence which seemed to show that if atmospheric ozone existed in a fairly thin layer, its height above the surface would be about 50Km. With the help of photoelectric instruments measuring intensities of ultraviolet light from the zenith sky near sunset, the vertical distribution of ozone has now been roughly evaluated. The bulk of it lies between the surface and a height of 40Km., with maximum density between 20 and 30Km. The height of the centre of gravity of ozone, which can be evaluated with much greater accuracy, is 22Km. $\pm$ 1Km. under all kinds of conditions in our part of the world. It should be emphasised that these results were deduced rather indirectly from observations at the earth's surface, but they have been strikingly confirmed by the Regeners, using the far more direct method of a spectroscopic camera attached to a sounding balloon. Discordant results are, however, reported from the recent United States stratosphere flight when similar methods to the Regeners were used. Ozone concentrations from sea level to 3Km. have also been determined in France and Switzerland by chemical and photometric methods.

The problem of the vertical distribution of ozone has been approached theoretically by Chapman, and by Wulf and Deming, but theoreticians are severely handicapped by lack of information about absorption coefficients and constants of reaction. With more information from the laboratory they might go very far. At present they can only say that the results of measurements of the vertical distribution are plausible.

Temperatures of the Upper Air.—At heights which are just out of reach of sounding balloons it is believed that temperatures increase very appreciably. If this is so, then some mechanism must be found whereby heat is taken up by the upper air from the radiation which passes it. Now oxygen molecules are known to absorb ultraviolet light, which splits them up into atoms. Where there are atoms and molecules of oxygen, ozone is formed, and ozone itself strongly absorbs some wave lengths of ultraviolet light in the process of disintegrating into oxygen. The radiant energy absorbed by oxygen and ozone degenerates into heat, and hence an atmosphere containing ozone should be warm. The Oxford conference devoted a full day to discussing this important matter of upper air temperatures.

Whipple showed that to account for the reflection of sound waves a negative lapse rate must exist at heights of about 35Km. This has been known for some time, but a possible new method of investigating upper air temperatures is being developed by Vassy, Barbier and Chalonge. It depends on the results of laboratory experiments which show that the absorption curve of ozone in the ultraviolet has an undulatory form if plotted as absorption against wave length, and that the amplitude of undulation is dependent on the temperature of the ozone. Comparison with absorption curves from upper atmospheric ozone will give the mean temperature of the ozone traversed. It should be possible to arrange that ultraviolet light is used which undergoes its greatest absorption by ozone at heights above, say, 40Km. so that this new method may be used to measure temperatures at these heights. Appleton and Martyn discussed temperatures likely to be associated with the regions of the ionosphere, and showed evidence of very high temperatures at 250Km. and above. Eropkin suggested that oxygen at a height of 30Km. or more might be in the form of atomic oxygen, and that the abnormal propagation of sound could be explained in this way.

From the theoretical point of view Gowan has recalculated temperature distributions in the light of modern results about the vertical distribution of ozone. His results depend very much on what percentage of water vapour he assumes to be present, and little information is available about this. However, under all reasonable assumptions he arrives at high temperatures such as Whipple, Dobson and Lindemann require. Ladenburg dealt with the absorption of energy by oxygen.

Horizontal Distribution of Ozone, and Weather Conditions.—Chalonge and Tönsberg brought forward results of measurements of ozone in polar regions both in summer and winter. They confirmed the great correlation of ozone with surface weather conditions. Lejay in Shanghai found that ozone was not high in cyclonic weather, as it is in Europe. Using statistical methods, Meetham showed that in Europe ozone was very highly correlated with potential temperature, entropy, and air density at heights of 15–18Km. above the ground. He further showed that although there is undoubtedly high correlation between surface weather conditions and total ozone content, this is not so high as between surface weather conditions and height of tropopause. He put forward the suggestion that the variations of ozone and potential temperature at 18Km. which are found in association with cyclones might be explained by considering the effect of air of the stratosphere sinking into a depression of the tropopause. In considering this qualitatively, however, he was compelled to assume a vertical circulation of the stratospheric air in association with depressions, and geophysicists are dubious about any assumption of vertical circulation in the stratosphere.

General Papers.—Götz gave a résumé of 10 years' measurements of ozone in Switzerland, in consideration of a possible 11 year cycle of variation of ozone. He showed that there might be an 11 year cycle, but there was also a possibility of a real variation in ultraviolet intensities emitted by the sun. Vassy discussed laboratory technique in handling ozone. V. H. Regener described the technique of automatic spectrographic apparatus used by himself and Professor Regener with sounding balloons, and his efforts to obtain solar spectrophotographs in the far ultraviolet. Much interest was aroused by his ultraviolet light filter, which employed a new principle depending on the variation of the refractive index of paraffin with wave length.

Programme of Future Research.—During the conference Dobson reported on the new survey of ozone in north-west Europe which it is hoped to inaugurate. The following are his own words :—

" The possible aid which ozone observations might give to weather forecasting, makes it very desirable that the subject should be thoroughly explored. Since a suitable instrument for routine observations of ozone is now available, a programme has been drawn up which would require daily observations at some fifteen stations suitably placed in Europe. It is suggested that daily observations should be continued for about two years in the first instance. The programme has received the general approval of the International Meteorological Organization (the Conference of Directors) but it rests with the individual meteorological services to carry out the work. It was suggested that the cost of the instruments should be met by the various countries in which the instruments were used. I have personally been in touch with all the meteorological services concerned, and the countries where observations are most required are willing to co-operate by having observations made if they can be provided with the necessary instruments. The majority are also willing to meet the cost of at least one of the instruments required for use there. Unfortunately the cost of the instruments is high (approximately £400 each), and the money for six instruments is still required in order to make the research a success.

The sort of question which it is hoped will be answered by this research (and can only be answered by such co-operative work) is :—

(1) How does the distribution of ozone round a depression vary with the state of occlusion of the depression ?

(2) How is the distribution related to the speed and direction of movement of the depression ?

If, for instance, it is found that the distribution of ozone is related to the direction of movement of a depression in some definite way, then a knowledge of the ozone distribution must be of great value to the weather forecaster, and while the cost of the investigation is necessarily high, such results would abundantly repay the outlay. At the present time there is some danger that full value of this work may not be obtained owing to lack of money for all the instruments required."

In the subsequent discussion the Conference showed considerable enthusiasm and decided to publish a motion expressing their view that such a survey would give valuable results.

The conference concluded with a vote of thanks to Dr. G. M. B. Dobson, who organised it in such a way that it will have been a great help to all who are engaged in studying the problem of ozone.

Papers and discussions of the conference are to be published by the Royal Meteorological Society as an extra number of the Quarterly Journal.

A. R. MEETHAM.

Melting Hail, Snow, and Soft Hail in the Rain-gauge

By Dugald S. Hancock and Alfred E. V. Pinnock

Considerable difficulty is often experienced by rainfall observers in melting hail, snow, or soft hail when arctic or semi-arctic conditions prevail, e.g. with a strong east wind and screen temperature below freezing-point.

We have frequently found it exceedingly difficult, if not almost impossible, to melt the frozen deposit in the manner suggested on pp. 10 and 11 of " Rules for Rainfall Observers ", viz., by adding a known quantity of boiling water; or by applying a cloth soaked in boiling water round the gauge: either around the cylinder itself or over the cone of the funnel, taking care to prevent any moisture percolating from the cloth into the bottle below.

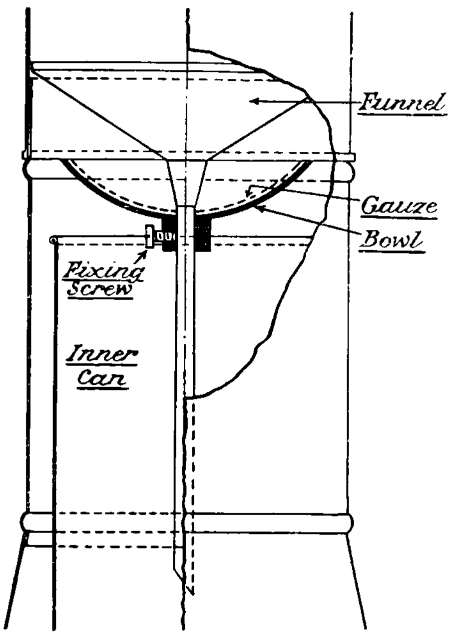
On February 11th last, snow fell, mingled with soft hail, at Greenways School, Bognor Regis. To prevent the gauge from " overflowing ", an attempt was made during a lull in the storm to melt out some of the snow. Although the equivalent of 0·5 in. of boiling water was poured down the funnel, this was not sufficient to get rid of all the soft hail at the apex of the cone. No more satisfactory result was obtained on adding a further 0·5 in. We then resorted to the second " official " method, but even when the contents of two pudding-basins of boiling water had been poured around the outside of the gauge there still remained a few obstinate pellets of soft hail. Fortunately, however, no further snow fell during the following night, otherwise the pellets which persisted would have acted as a cork the next morning and would have frustrated our efforts to melt out the residue by approved methods. On taking out the funnel and removing the bottle at 8h. 30m. (the observation hour) it was found that some of the added water had become ice! The station has been in operation since October, 1928, and, although the severe winter of February, 1929, when a screen temperature of 10·0° F. was recorded, comes within this period, ice has never before been found in the bottle of the gauge. Presumably, the only reason for its appearance on February 12th, 1936, was that boiling water, which had therefore lost some of its air, had been poured into the bottle on the previous day, and this would naturally have a tendency to reach the freezing-point more easily than would cold water. Added to this was the persistence of a biting easterly wind.

It was this sequence of facts that led one of us to the conclusion that if delay and considerable inconvenience could be caused in Sussex, while following the conventional methods, much worse delay and discomfort no doubt often occur in higher latitudes, and, therefore, something ought to be done about it!

The practice employed at some mountain stations of removing the funnel and bottle from the gauge and thawing the contents " in the office " is strongly to be deprecated.

It was evident that if accurate measurements are to be made, without undue waste of time, some form of dry heat must be employed. We first contemplated the use of an electrical method of heating, but rejected this for economical rather than technical reasons, and we have now evolved a simple device which can be fitted to all standard "B.R.O." gauges at a very small cost.

By means of a shallow copper bowl carrying a tray of copper gauze (to facilitate combustion) constructed to slide over the tube of the rain-gauge, and the use of "Meta" solid fuel, we first experimented with a half-scale model under "laboratory" conditions. Later, a full-size attachment was tested on our own 5 in. gauge. We found that one "Meta" tablet (these can be purchased at any chemist, price 6*d*. per box) burnt for 10 minutes, during which time we were continually adding broken ice, some fragments of which were more than 1 in. in length. It will be realised that our object in this test was not to record the amount of "rain" melted out, but to prove that "Meta" fuel will generate sufficient dry heat to melt even the most obstinate hail pellets which may have lodged at the apex of the cone, without at the same time running any risk of melting the joints in the funnel, and thus causing a leak.



No difficulty was experienced in keeping the fuel alight. It was merely necessary to apply a lighted match to the "Meta", stand to windward of the gauge, and then lower the funnel, to which the bowl had previously been fitted, until the locking-nut on the latter rested against the bottle inside the gauge. This enables one (*a*) to watch the flame, and (*b*) permits of sufficient draught through the gauze.

Unfortunately, there is so little space to spare between the copper bowl on the rain-gauge funnel and the bottle, when the former is in position, that it is not possible to allow of our attachment remaining *in situ* the whole time. However, it is an easy matter to slip the bowl over the tube of the gauge, and to adjust its level to allow room to light the fuel from above, before lowering the funnel back into the gauge.

Although the experiment was carried out with "artificial" ice, with one tablet, we are quite convinced that it would be possible to obtain the same results in a shorter time by using several tablets, suitably distributed around the funnel. To the objection that this extra heat might melt the soldering at the joints, it must be pointed out that so long as there is any moisture remaining in the funnel there is no fear of this. Naturally, as soon as all the " solids " have passed through into the bottle below, the fuel must be extinguished. This is best done by tipping the remainder of the " Meta " off the gauze.

Our aim was rather to help the observer who finds the obstinate pellet or two of hail, or a small amount of frozen snow, coagulated at the base of his rain-gauge funnel, than his colleague on the mountain-top, or where heavy falls of snow are recorded. We are none the less confident that our attachment might well be employed under more rigorous conditions, viz., on an arctic or sub-arctic expedition when it is desirable to take hourly readings of all instruments, including the rain-gauge.

[In response to an invitation from the Editor the following comments on the preceding article are offered :—In the first place the British Rainfall Organization has never recommended its observers to melt snow in a rain-gauge by adding a known amount of *boiling* water ; " Rules for Rainfall Observers " definitely says " very warm, but not hot ". I should be interested to know if other observers have experienced difficulty in melting snow by this method. In theory, one gram of water at a temperature of 80° C. (176° F.) should be capable of converting one gram of ice at 0° C. (32° F.) into water at 0° C. It would be very unusual for the funnel of a rain-gauge to contain at any time snow or hail equivalent to more than 0·5 in. of rain. Consequently the addition of a quantity of water at 80° C. equivalent to 0·5 in. of rain should usually suffice to melt out the contents of the funnel, though it might be necessary to pour the water through the funnel more than once before all the ice pellets were melted or washed through. If the deep funnel of the Snowdon or M.O. pattern gauge is quite full of snow, two measuring glasses full (i.e., the equivalent of 1·0 in.) of very warm water should be more than sufficient. Frankly, therefore, I am at a loss to understand why the method failed to satisfy Messrs. Hancock and Pinnock. Also I should be interested to know why the practice of bringing the funnel and receiver indoors and thawing out the contents " is strongly to be deprecated ". I have not heard of it being done at mountain stations, which are usually a long way from " the office ", but I see no reason why ordinary observers should not do it, provided of course that precipitation is not occurring at the time of observation.

The B.R.O. is not favourably disposed towards the fitting of "gadgets" to rain-gauges and would need to be convinced that the methods already recommended for dealing with snow and hail are inadequate before recommending its observers to employ any such device as that described by Messrs. Hancock and Pinnock. Personally, I am by no means convinced, and I hope observers will write to express their views.—Superintendent, British Rainfall Organization.]

OFFICIAL NOTICE

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are:—

November 2nd, 1936, *Teleconnections of climatic changes in present time.* By A. Ångström (Stockholm, Geogr. Ann. 17, 1935, pp. 242–58) and *Biochronology.* By Ebba H. De Geer (Scot. geogr. Mag., 52, 1936, pp. 145–57). *Opener.*—C. E. P. Brooks, D.Sc.

November 16th, 1936. *On the technique of meteorological airplane ascents of the Massachusetts Institute of Technology.* By K. O. Lange (Cambridge, Mass., Pap. Phys. Ocean. Met. 3, 1934, No. 2, Pt. I). *Opener*—R. F. Budden, M.A.

OFFICIAL PUBLICATION

The following publication has recently been issued:—

Annual Report *of the Director of the Meteorological Office,* presented by the Meteorological Committee to the Air Council for the year ended March 31st, 1936.

The demands on the Meteorological Office during the year under review were greatly increased due to the rapid development of civil aviation, the great expansion of the Royal Air Force, and the international situation which developed in the autumn of 1935. Each of these developments demanded the establishment of more meteorological stations, not only in this country but overseas. As no additional trained staff was available it was impossible to meet all these needs adequately and at Headquarters and several stations it was necessary to carry on with depleted staff in spite of the general increase of work. The position was still further complicated by the fact that on April 1st, 1935, a general regrading of the staff was carried out following upon the decision to apply to the Meteorological Office the scheme of grading and pay recommended by the Committee on the Staffs of Government Scientific Establishments presided over by Sir Harold Carpenter. As the needs became clear additional officers were recruited to meet special requirements and for the purpose of training.

The year was also a memorable one on account of the important Empire and International Conferences held, in London in August, and in Warsaw in September, respectively. The Empire Conference met mainly for the purpose of discussion—the subjects for discussion having been prepared in 68 memoranda which were circulated to the delegates before the meeting. At the International Conference of Directors the principal technical matters on which agreement was reached were, Collective issues, Uniformity in weather maps, Distribution by radio telegraphy of monthly values of pressure, temperature and rainfall, Meteorological reports from Iceland, and Observations of ozone.

In 1935 the Air Ministry invited Dr. J. Bjerknes, Professor at the Geophysical Institute, Bergen, to the Meteorological Office to demonstrate to the staff the further progress made in the Norwegian method of forecasting since his visit in 1925. He arrived on December 14th, 1935, for a 5 months' visit and during his stay he gave particular attention to the frontal analysis of the northern hemisphere, more especially to fronts over the Atlantic Ocean.

Early in October the Overseas Division was formed to deal with meteorological questions connected with Empire Air Routes, including the projected trans-Atlantic routes and the Empire Air Mail Scheme. The division is also responsible for the administration of Meteorological Office establishments overseas. Three new stations were opened during the year—at Aden, Khartoum and Gibraltar.

Another change of importance during the year was the introduction into the library on January 1st, 1936, of the revised classification of meteorological literature, based on that employed by the International Institute for Documentation, The Hague. This Classification was adopted by the International Meteorological Conference at Warsaw in September, 1935.

Correspondence

To the Editor, *Meteorological Magazine*

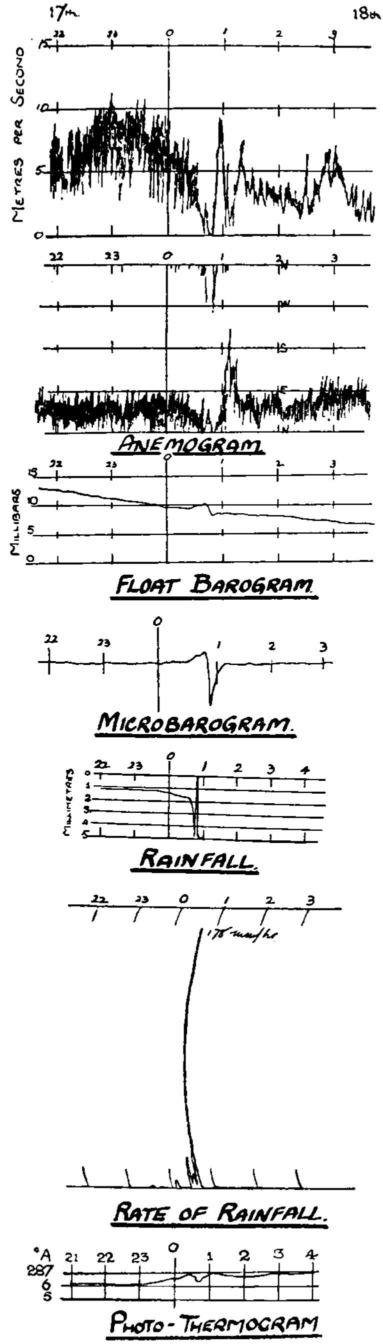
Crepuscular Rays seen from Hastings

Between 18h. 20m. (G.M.T.) and 18h. 30m. on September 12th a fine display of crepuscular rays was observed here. When first noticed there were three wide orange-yellow bands of quite bright intensity extending completely across the sky from the west to a point in the east, where the convergence due to perspective was extremely well and strikingly seen. A fourth band made its appearance shortly after 18h. 20m.; the whole display had faded somewhat by 18h. 25m. There were large cumuli and cumulonimbi round the western horizon forming a bank covering about 2 tenths of the sky in that direction. The remainder of the sky was covered with 9 tenths of cirrostratus and cirrocumulus. It may be worth noting that there was a very red sunrise glow which was particularly noticeable at 5h. 15m. on the same day.

A. E. Moon.

39, Clive Avenue, Clive Vale, Hastings, September 17th, 1936.

Thunderstorm at Eskdalemuir, July 18th, 1936



In the early morning of July 18th, 1936, a thunderstorm, rather severe in intensity, passed over Eskdalemuir. The most important feature of the storm was the heavy rainfall which occurred during part of it.

The storm approached from the south-east at 0h. 20m. and within half an hour had reached its greatest intensity. Rain commenced at 23h. 30m. and fell very heavily for a short time about 0h. 39m., when the Jardi rate of rainfall recorder gave the rate of rainfall as 178 mm./hr. (=7·0 in./hr.), this being the greatest value since the records commenced with this instrument at Eskdalemuir. It is worthy of note, however, that on the same day, July 18th, but in 1934, during a thunderstorm, a rate of 300 mm./hr. was registered at Kew.*

Temperature fell only 1° F. during the storm and recovered its previous value within a few minutes. Pressure changes were also of interest, there apparently being a wave variation superimposed upon a gradual fall, this being evident in the traces from both the float barograph and the microbarograph. The wave came first as a slight surge or increase, this being followed by a very sharp fall, 2·3 millibars in five minutes (0h. 47m. to 0h. 52m.), and this in turn by a slight rise. The microbarograph trace brings out prominently the intensity of the sudden fall in pressure.

The end of the heavy rain was marked by a slight squall in which the wind returned rapidly from NW. to NE. These changes are shown in greater detail on the accompanying diagram, which illustrates the various autographic records.

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* See *Meteorological Magazine*, **69**, 1934, p. 157.

On the night of July 17th–18th, 1936, thunderstorms were reported widely over southern Scotland, parts of England and northern Ireland.

R. F. M. HAY.

Eskdalemuir Observatory, Langholm, Dumfriesshire, August 24th, 1936.

Funnel Cloud at Felixstowe

I am indebted to Mr. T. W. Evans for the following notes on a funnel cloud which nearly developed into a waterspout off the coast at Felixstowe, Suffolk, on Saturday, September 5th, 1936.

Mr. Evans remarks—" the weather during the morning was showery with considerable bright intervals, and at 12.45 p.m., B.S.T., a line squall approached from the south-south-west. At 12.55 p.m. the well-developed line of dark cloud extended to the horizon from north-west to south-east and to the north-east the funnel formed at the base of the cloud. The phenomenon lasted about 15 minutes and the sea beneath the funnel, which appeared to be off the mouth of the river Deben, was much disturbed, but the spout failed to complete its development.

The squall was accompanied by heavy rainfall which lasted for seven minutes."

DONALD L. CHAMPION.

7, Robinson Avenue, Goff's Oak, Herts. September 14th, 1936.

NOTES AND QUERIES

An early Portable Barometer

An interesting addition has been made to the Museum of the Meteorological Office, South Kensington, namely, a specimen of the portable barometer patented by Daniel Quare in 1695. The barometer was acquired by the Office in 1891, but it has not previously been exhibited at South Kensington and a few notes about it may, therefore, be of interest.

The spindle-pattern case of the instrument is of mahogany, beautifully carved. The upper portion of the tube, which is of about $\frac{1}{4}$-inch bore, is visible through a window which also encloses silvered plates engraved with an inch scale, divided to twentieths and with the following legends :—

Above the reading 30 *inches*
on the left " Rising Fair or Frost "
on the right " Dry, Serene "
Between 29 *inches and* 30 *inches*
" Variable "
Below 29 *inches*
on the left " Falling, Rain, Snow or Wind "
on the right " Rainy, stormy ".

A brass plate below the window bears the inscription " Invented and made by Dan Quare, London ".

Two pointers for setting purposes are provided on either side of the tube, these being operated by ornamental brass knobs at the top of the case. The barometer is rendered portable by turning a brass knob at the bottom of the case; this operation causes the mercury to rise to the top of the tube and to be retained in that position by the pressure of a leather pad against the end of the dipping tube.

Before its acquisition by the Meteorological Office in 1891, the barometer to which this note refers was on exhibition at the Royal Naval Exhibition held in that year at Chelsea. While there it is known to have been broken and repaired. Apparently the breakage affected the tube only; externally the barometer is, so far as one can judge, in its original condition.

Daniel Quare was a very distinguished maker of clocks and watches, a contemporary of Thomas Tompion. He was born in 1649 and carried on business, later in partnership with Edward Horseman, for most of his life at the Kings Arms, Exchange Alley, London. Clocks and watches by Quare are greatly esteemed by collectors and one of his outstanding productions, a twelve-months clock, is to be seen at Hampton Court Palace. According to F. J. Britten* six or seven portable barometers by Quare are known to exist; one of them is in the United Service Institution. Another, the property of C. F. Bell, Esq., is figured on p. 298 of Britten's work. The Victoria and Albert Museum also possesses a specimen, bequeathed by Lt. Col. G. B. Croft Lyons. The same Museum possesses another barometer bequeathed by Lt. Col. Croft Lyons, unsigned, but of the same period (c.1700). It strongly resembles the Quare barometers in its external features and was found on examination to be fitted with his portability device; it is very probable, therefore, that this barometer was also made by Quare.

E. G. Bilham.

Luminous Night Cloud, July 26th, 1936

A luminous cloud was observed at Croydon by Mr. R. S. Read from 2.50 a.m. B.S.T. on July 26th, 1936, attaining its maximum brilliance at 3.10 a.m. and fading about 3.35 a.m. In appearance it was of a hard pearly whiteness (similar to lenticular altocumulus) and the top and sides were well defined. The bottom of the cloud was of a reddish colour and was not well defined. Numerous filaments, similar to fine cirrus, spread out from its northern side.

The cloud was also observed from Biggin Hill. The elevation of the upper part was between 4° and 5°, and the azimuth between 344° and 40°; but owing to the short distance between Croydon

* " Old Clocks and Watches and their makers " 1911, p. 299.

and Biggin Hill the observations are not sufficient for a determination of its height and position. If observations of the azimuth and elevation were made at any other stations in this country, an accurate determination may be possible, and Mr. Read, Meteorological Station, Croydon Airport, will be glad to have a note of any such observations.

Relatively Low Temperature during Khamsin Conditions, Ismailia, Egypt.

An interesting case of relatively low temperature during warm southerly or " Khamsin " conditions occurred at Ismailia on April 22nd, 1936. A depression centred near Tobruk at 6h. G.M.T. was moving east about 25 m.p.h., while pressure was high over Syria and northern Iraq. This distribution gave rise to a rather steep gradient for S. or SE. winds over northern Egypt and Palestine, and in consequence very high temperatures were to be expected. At Heliopolis a maximum of 109° F. was recorded, Aboukir 103° F., and Port Said 102° F. At Ismailia only 101° F. was recorded at the Royal Air Force Station, and 95° F. at the Suez Canal Company's station, though at Abu-Sueir, about 8 miles to westward of Ismailia, the temperature reached 110° F. Usually it is found that during such conditions Ismailia experiences temperatures nearly as high as Cairo, so it appears that there must have been some local cause for the relative coolness of the day.

The wind was persistently between 140° and 160° throughout the day and was fresh to strong in force. It appears, therefore, that the relatively low maximum temperature might be accounted for by the fact that the wind was blowing over fairly large expanses of water before reaching Ismailia, coming from the Gulf of Suez and crossing the Bitter Lakes and Lake Timsah. A local inversion at low altitude would thus be set up, and this continued all day over the Canal zone, to which also the relative absence of rising sand might be attributed. Upper wind observations showed that the strongest wind, 35 to 38 m.p.h. was at 1,000 feet with a veer of 10°–15° from the surface. At higher levels up to 7,000 feet the speed decreased gradually, but was persistently southerly.

There was remarkable evidence of an inversion about 6h. G.M.T., as the smell from the oil refineries at Suez, 48 miles south-south-east of Ismailia, was distinctly noticeable ; a most unusual distance for smell to carry. Inversions are, of course, quite common in the early morning when no low cloud is present and the surface wind light.

The front, which appeared to be rather diffuse as the wind veered irregularly to NW, passed Ismailia at 22h. 40m. G.M.T. The temperature which had been falling slowly though still high for the time of night, 79°F, rose suddenly to 85°F, probably due to subsidence of air. It remained about the same for half an hour after which it fell rapidly. It seems, therefore, that should the direction of the wind be such that it blows persistently within the small limit of about 10° either side of 150° and thus crosses fairly large expanses of water before reaching Ismailia, the rise of temperature will be curtailed in " Khamsin " conditions. The maximum of 110°F at Abu-Sueir some eight miles to westward, where the wind came directly over the desert, and also the progressively higher maxima from south to north recorded at the Suez Canal Company's stations (Port Thewfik 91°F, Ismailia 95°F, Port Fouad 102°F) bears this out.

T. F. Twist.

Climatic Maps of North America *

The section on the climate of North America in Köppen and Geiger's great " Handbuch der Klimatologie ", which was begun by the late R. de C. Ward and completed by C. F. Brooks includes a series of climatic maps for that continent. The originals of these maps were drawn by co-operation between the climatologists of Canada, the United States and Mexico, on a scale too large to be reproduced in detail in the " Handbuch," and in order that the enormous amount of material collected might be made generally available, Dr. C. F. Brooks and Mr. A. J. Connor, with the aid of a grant from Harvard University, have published the 26 full scale charts in the form of a loose-leaf atlas.

They form a very fine series, presenting the essential features of the climate of North America in a way never previously attempted. The charts are in black and white, and so as not to obscure the background no shading has been attempted. Orientation is provided by 10° lines of latitude and longitude and by the boundaries of the states or provinces, so that with the aid of an ordinary atlas any point can be located with ease. The absence of shading is only felt seriously in the charts of rainfall and snowfall, and even for these the difficulty of interpretation is minimised by skilful draughtsmanship.

Isotherms for each 2° C, reduced to sea level, are given for each alternate month and unreduced isotherms for January and July. The latter pair are of course extremely complicated over the mountain areas, especially the chart for July ; in January the flow of cold air down the slopes smoothes out the differences to a great extent. A useful pair of maps show the mean annual maxima and minima of temperature (i.e. the highest and lowest temperatures to be expected in a normal year). The maximum exceeds 40° C. (104° F.) over considerable areas in the west and south, but the map of minima is even more striking, and repays detailed study. Maps of mean pressure at M.S.L. in millimetres are given for January and July.

* Climatic maps of North America by Charles F. Brooks, A. J. Connor and others. 26 charts, Cambridge, Mass., Blue Hill Meteorological Observatory, 1936.

Rainfall (inches) is represented by the mean annual fall and by maps for alternate months ; in winter there was some difficulty in joining up the isohyets across the boundary between the United States and Canada, owing to differences in the method of measuring the rainfall equivalent of snow. For the United States, Alaska and the West Indies the compilations are said to have been reduced to months of 30·44 days, which would also introduce a slight break of continuity across the Canadian frontiers.

The chart of mean annual snowfall in inches is a remarkable document, amounts exceeding 400 inches in several places. It would be interesting to know just what this means in terms of depth of snow cover, or if it is to be taken literally as implying that in these localities the snow actually accumulated to a depth of over 30 feet. The remaining charts deal with relative humidity (as always, this element presents difficulties, and for most of Canada the January chart is left blank), mean cloudiness and number of days with thunderstorms. Here again differences of procedure caused difficulties at the boundaries, and no attempt has been made to connect the isobronts of the United States with those for Canada.

C. F. Brooks contributes a brief explanation of the charts, with acknowledgements to the numerous research students in the United States who have taken part in the work, as well as the Canadian climatological staff under A. J. Connor. A valuable feature is the series of brief notes under each chart, pointing out the features of greatest interest and giving short physical explanations. The atlas as a whole is a most valuable contribution to American climatology. Some elements such as sunshine are not represented, but these are to be found in the Atlas of American Agriculture.

C. E. P. Brooks.

BOOKS RECEIVED

Meteorological Results for the Royal Observatory, Hong Kong, 1934 and 1935 and *Report of the Director of the Royal Observatory, Hong Kong, for the year* 1934 and *for the year* 1935. Hong Kong, 1935 and 1936.

Jaarboek, Koninklijk Nederlandsch Meteorologisch Instituut, 1933 *and* 1934. A. Meteorologie, B. Aard-Magnetisme (Nos. 97 and 98), Utrecht, 1934 and 1935.

OBITUARY

Dr. J. B. Charcot.—We regret to learn of the death of Dr. Charcot, the veteran French explorer, who perished in the wreck of the " Pourquoi Pas ? " off the coast of Iceland on September 16th. Dr. Charcot was born at Neuilly in July, 1867, and educated for the medical profession, but he became attracted to polar exploration and in 1903–5 he organised and led an Antarctic expedition in the

" Francais " which explored the region south of Graham Land and added several new lands to the map. He confirmed and extended these discoveries in his famous specially-designed ship the " Pourquoi Pas ? " in 1908–10, one coast being named Charcot Land in his honour. These expeditions brought back important meteorological as well as geographical results. The subsequent years he spent exploring in Arctic and northern Atlantic waters, his knowledge of which proved invaluable for anti-submarine work during the war. In the Second International Polar Year of 1932–3 he organised the French expedition to Scoresby Sound, and he himself took charge of the onerous duties of installing and bringing off the members of the party and their material, in which operations the " Pourquoi Pas ? " again took a large share. Dr. Charcot took the opportunity of continuing his geographical and glaciological investigations in the Greenland Sea. In 1936 he again voyaged to East Greenland in the " Pourquoi Pas ? " to bring back the members of a French trans-Greenland expedition at Angmagssalik, but during a severe gale off the coast of Iceland the ship struck the reefs and sank. Of 40 men on board, only one was saved.

C. Fitzburgh Talman.—Mr. C. F. Talman, Librarian of the United States Weather Bureau since 1908, died on July 24th at the age of 61. He was born at Detroit on August 31st, 1874, and after being educated at Kalamazoo College, Michigan, he joined the United States Weather Bureau in October, 1896. In 1898 and 1899 he was in charge of the meteorological stations which the Bureau was actively establishing in the West Indies ; subsequently he joined the Library as assistant to Prof. Kimball. At that time the Bureau Library was beginning to build up a subject catalogue in addition to the author catalogue, and Talman developed a great interest in library work. He became Librarian in 1908, a post which he retained throughout the remainder of his official service, while he passed through the grades of Junior Professor (1912), Professor (1914) and Meteorologist (1922). Talman was especially interested in weather terminology which he studied both from the etymological and meteorological sides. He wrote a few semi-popular articles on this subject: " The language of Meteorology ", " The meteorological Isograms " and " The vocabulary of Weather " and he acted as meteorological adviser for the " Standard Dictionary " in 1910–11, but he actually published only a small fraction of the material which he collected, and the great " Meteorological Dictionary " which he had in mind remained a project only. The scope of such a work is indicated by his remark that there are at least fifteen hundred weather terms in the British dialects alone. Moreover the number of such terms grows continually, for example by such recent additions as " substratosphere " and " frontology ".

Talman had a pleasant literary style, and besides his etymological researches he published a few articles which mainly reflect the historical aspect of meteorology, and two popular books :—" Meteorology, the Science of the Atmosphere " (republished in 1925 as " Our Weather ") and " The Realm of the Air " (1931).

Miles William Binns.—We regret to learn of the death on September 14th of Mr. M. W. Binns, at Rugby. Before moving to Rugby last year Mr. Binns had kept a climatological record at Lutterworth, Leicestershire, for about 15 years. He was also prominently associated with Mr. Morris Bower of Oakes, Huddersfield in his work on thunderstorms and had also assisted in the fog survey organised by the Meteorological Office last winter. His death at the early age of 37 years followed upon a long period of physical disability, in spite of which he was able to accomplish much useful meteorological work. He was a keen student of long-range forecasting and had made experimental forecasts for several years.

NEWS IN BRIEF

We learn that Mr. R. A. Watson Watt, superintendent of the Radio Department of the National Physical Laboratory since it was formed in 1933, has been appointed superintendent of the Air Ministry Research Station, Bawdsey Manor, Suffolk.

Prof. Dr. Wladimir Köppen, the world-famous climatologist and co-editor with Dr. R. Geiger of the great " Handbuch der Klimatologie " now in course of publication, celebrated his 90th birthday at Graz on September 25th, 1936.

Mr. A. Westley of Blisworth, Northamptonshire, informs us that he has for disposal a complete series of *British Rainfall* for the years 1894 to 1920 in good condition. Anyone wishing to purchase these should communicate direct with Mr. Westley.

The Weather of September, 1936

Pressure was above normal over the eastern United States and Bermuda, most of Canada, Alaska, Greenland, Iceland, Scandinavia and southern and central Europe, the greatest excesses being 2·3 mb. at Kodiak, 6·3 mb. at Jan Mayen and 2·4 mb. at Lisbon. Pressure was below normal over western and central United States, most of the North Atlantic, north Germany, Holland, eastern Europe and north-west Asia, the greatest deficits being 9·4 mb. at Waigatz, 6·2 mb. at 50° N. 30° W. and 3·4 mb. near S. Antonio (Texas). Temperature was generally above normal over Holland, west Germany and Switzerland, below normal in eastern Germany and Hungary and about normal in Sweden. Precipitation was mainly above normal but not in eastern Germany. In Sweden there was a general deficiency of precipitation except in eastern Svealand and sunshine totals were exceptionally large.

The outstanding features of the weather of September over the British Isles were, temperature above normal for most of the month, general deficiency of sunshine except in south Ireland, the prevalence of morning mist or fog and the frequency of thunderstorms. On the 1st, warm dry sunny weather was general in southern England—77° F. was recorded at Southampton and Marlborough that day—but with the approach of a depression from the Altantic the unsettled conditions in the north spread also over the rest of the country, continuing until the 6th with mist or fog locally and thunderstorms in many parts on the 3rd to 5th, 1·85 in. of rain were measured at Inverness on the 4th and 1·62 in. at Wirswall (Cheshire) on the 3rd, of which 1·48 in. fell in 1 hour. Strong squally winds reaching gale force locally at exposed places occurred on the 7th and 8th, when a vigorous disturbance crossed the British Isles giving rain generally, though there were many hours bright sunshine in south-east England on the 7th and in Scotland on the 8th. From the 9th to 13th pressure was low to the west and high to the east so that warm, light to moderate southerly winds prevailed with unsettled weather and morning mist or fog. Temperature exceeded 70° F. at numerous places on the 11th and 13th, even reaching 71° F. at Nairn on the 11th while night minima did not fall below 63° F. at Bath on the 12th and 62° F. at Tottenham on the 13th. Sunshine records were good in the south on the 11th and generally on the 13th but on the 12th rain was experienced at most places, 1·60 in. at Cirencester (Gloucestershire), with thunderstorms in the south and east. On the 14th and 15th shallow depressions lay over the British Isles and thunderstorms, sometimes accompanied by heavy rain—1·97 in. at Middleton-in-Teesdale (Durham)—were widespread. There was also much sunshine, e.g. 10·9 hrs. at Dover on the 14th and 10·8 hrs. at Stornoway on the 15th but a considerable amount of morning mist or fog. From the 16th to 19th pressure was high over the British Isles and the weather fair to cloudy with slight showers or drizzle locally. On the 20th and 21st a depression moved northwards from the Bay of Biscay and caused heavy rain and thunderstorms locally in the south, 3·13 in. at Berkhamsted (Herts) and 2·19 in. at Cottenham (Cambridge) on the 20th, while fair to cloudy weather continued in the north and in Ireland. From the 22nd to 23rd anticyclonic conditions prevailed over the whole country with widespread morning mist or fog—thick fog persisted all day in the western English Channel on the 22nd—but elsewhere there was much sunshine, 10·0 hrs. at Dover and Douglas on the 22nd. On the 24th and 25th a depression passing eastwards across the country brought dull rainy weather with heavy local thunderstorms, 1·87 in. at Dumfries on the 24th and 1·81 in. at Birr Castle on the 25th. High minimum temperatures were again experienced generally on the night of the 24th–25th, 62° F. at Gorleston, Tottenham, Kew and Portsmouth, but on the 26th cold northerly winds brought a fall of temperature. Thunderstorms occurred in the south-east on the 27th. From the 28th to 30th an anticyclone extended over the whole country with low temperatures and ground frosts but much sun on the 28th and 29th, over 10 hrs. being recorded on either day in parts of western Great Britain and Ireland. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	104	−10	Chester ...	80	−44
Aberdeen ...	95	−29	Ross-on-Wye ...	91	−45
Dublin	98	−35	Falmouth ...	153	− 7
Birr Castle ...	133	+14	Gorleston ...	147	−11
Valentia... ...	127	+ 3	Kew	90	−55

Miscellaneous notes on weather abroad culled from various sources

As a result of a violent storm over central Switzerland on the 3rd a torrent from the Dent du Midi cut the Simplon Railway line in the Rhone Valley near St. Maurice and caused a landslip on the Schüpserberg between Berne and Lucerne killing 6 people. Cold unseasonable weather was experienced in northern Italy about the middle of the month when snow fell in Piedmont—on the 18th the snow was 6 ft. deep on the Great St. Bernard Pass. Bad weather occurred generally in Germany during the harvesting. During a severe storm on the 16th the French exploring ship the *Pourquoi Pas?* ran on the rocks off the west coast of Iceland and was completely wrecked ; 39 out of the 40 people on board were drowned. The storm also caused damage to other shipping. Fog was prevalent in the Baltic on the 22nd and off Holland on the 23rd and 25th. (*The Times*, September 5th–24th.)

Snow fell in many of the country districts of South Africa and was general along the reef about the 11th. At Johannesburg it was said to be the first snowstorm in September for 32 years. Heavy weather was experienced by shipping north of Durban about the 20th. (*The Times*, September 12th–22nd.)

Drought was experienced in the Bombay Presidency during the first 7 days but on the 8th heavy rain or showers occurred generally. The monsoon was strong in the central part of India early in the month and floods and landslips occurred in the United Provinces, Bihar and Bengal. By the 22nd drought conditions were again prevailing in the Bombay Presidency and the monsoon was withdrawing from the country. (*The Times*, September 8th–25th.)

The total rainfall for the month in Australia was considerably below normal except in parts of Queensland and New South Wales where it was above normal. (Cable.)

The fringe of an Atlantic hurricane struck Bermuda on the 17th. On the evening of the 17th a hurricane moving northwards from the West Indies struck North Carolina and Virginia. During the 18th it continued to move northwards along the Atlantic coast but on the 19th, it decreased in intensity and swung eastwards out to sea. There was some loss of life in the south and damage to shipping. In the United States temperature was above normal generally, except at the beginning of the month along the eastern coasts, about the middle along the western coasts and towards the end in the Middle States, while rainfall was on the whole below normal except in the Middle States towards the end of the month. (*The Times*, September 18th–21st, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, September, 1936

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see vol. 69, 1934, p. 1).
	mb.		°F	°F	%	in.	hrs.	
1	1021·6	NW 2	56	71	74	—	3·7	w early.
2	1014·3	WSW.3	60	73	63	—	3·5	w evening.
3	1007·7	SSW.4	56	70	71	0·02	0·8	pr_0 8h.–11h. r 15h.
4	1001·8	SW.5	57	67	82	0·19	2·1	r_0–r 7h.–16h.
5	1001·1	W.3	58	65	89	0·75	2·6	r 1h.–6h. TLR 14h–[15h.
6	1010·0	W.4	56	64	57	—	0·9	r_0 21h.
7	998·0	W.5	60	65	42	0·02	8·5	r_0 3h.–7h. & 21h.
8	1004·4	WNW.5	54	65	61	0·04	2·9	r_0–r 6h –9h.
9	1016·4	SSE.2	52	67	75	0·01	2·1	r_0 13h. & 23h.–24h.
10	1016·1	S.2	57	68	85	0·41	1·4	r–r_0 4h.–10h., pr_0 13h.
11	1017·2	SSE.4	57	73	57	—	9·3	w early.
12	1015·5	SSE.2	60	67	82	0·20	0·1	ir_0 11h.–15h. T 15h.
13	1018·2	W.2	59	70	74	—	5·6	r_0 0h.–1h. [PR 17h.
14	1020·2	W.2	50	67	58	—	6·2	w early. Tr_0 15h.–[16h.
15	1022·4	N 1	51	62	68	0·09	2·5	TLr 15h.–16h.
16	1025·3	NE 3	51	65	56	0·01	3·8	pr_0 14h. r_0 21h. & 24h.
17	1022·1	NNE.3	58	69	70	0·03	0·4	r_0 0h.–1h. pr_0 13h.
18	1020·8	SW.2	57	65	70	—	1·4	F from 20h.
19	1024·1	E 3	50	64	77	—	2·7	Fe till 8h.
20	1020·8	E.4	55	69	65	0·62	3·8	r 17h.–18h., 22h.–24h.
21	1020·7	WSW.2	61	66	84	0·20	0·0	r_0–R 0h.–3h. pr 11h.
22	1029·9	W.1	52	66	86	trace	2·9	Fe till 11h. & from [20h.
23	1025·0	ENE.3	52	67	82	trace	3·6	Fe till 10h.
24	1013·1	E.3	58	71	73	—	1·0	d_0 21h.
25	1011·5	W.3	62	66	80	—	0·0	d 5h.–6h.
26	1019·9	N.2	50	57	74	0·06	0·6	r–r_0 1h.–11h.
27	1007·5	W.3	48	55	84	0·13	0·9	r_0–R 10h.–17h. TL [14h.
28	1018·7	ENE.5	45	57	67	0·01	7·8	pr 12h.–13h.
29	1025·3	N.3	42	57	59	—	9·0	w early.
30	1024·3	N.3	42	56	70	—	0·0	w early.
*	1016·5	—	54	65	71	2·81	3·0	* Means or Totals

General Rainfall for September, 1936

England and Wales ...	142	per cent of the average 1881–1915.
Scotland	119	
Ireland	140	
British Isles	136	

Rainfall : September, 1936 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.........	2·99	165	*Leics* .	Belvoir Castle............	2·67	143
Sur .	Reigate, Wray Pk. Rd..	2·06	99	*Rut* .	Ridlington	2·15	112
Kent .	Tenterden, Ashenden...	1·96	92	*Lincs* .	Boston, Skirbeck.........	1·45	82
,, .	Folkestone, Boro. San.	3·29	...	,, .	Cranwell Aerodrome...	2·30	129
,, .	Margate, Cliftonville....	2·16	110	,, .	Skegness, Marine Gdns.	1·69	93
,, .	Eden'bdg., Falconhurst	2·64	117	,, .	Louth, Westgate.........	1·36	67
Sus .	Compton, Compton Ho.	3·24	116	,, .	Brigg, Wrawby St.......	2·03	...
,, .	Patching Farm..........	2·34	98	*Notts* .	Worksop, Hodsock......	1·82	120
,, .	Eastbourne, Wil. Sq....	1·72	69	*Derby*.	Derby, L. M. & S. Rly.	3·15	191
Hants.	Ventnor, Roy.Nat.Hos.	2·72	110	,, .	Buxton, Terr. Slopes...	6·00	186
,, .	Fordingbridge, Oaklnds	4·26	199	*Ches* .	Runcorn, Weston Pt....	4·16	156
,, .	Ovington Rectory.......	3·90	171	*Lancs*.	Manchester, Whit. Pk.	3·88	163
,, .	Sherborne St. John......	4·15	202	,, .	Stonyhurst College......	5·46	143
Herts .	Royston, Therfield Rec.	2·92	155	,, .	Southport, Bedford Pk.	3·34	122
Bucks.	Slough, Upton............	2·45	139	,, .	Lancaster, Greg Obsy.	5·30	157
,, .	H. Wycombe, Flackwell	3·96	202	*Yorks*.	Wath-upon-Dearne......	2·10	133
Oxf .	Oxford, Mag. College...	3·30	196	,, .	Wakefield,Clarence Pk.	2·43	152
N'hant	Wellingboro, Swanspool	2·18	121	,, .	Oughtershaw Hall.......	3·45	...
,, .	Oundle	2·20	...	,, .	Wetherby, Ribston H..	2·72	151
Beds .	Woburn, Exptl. Farm...	3·00	168	,, .	Hull, Pearson Park......	1·57	92
Cam .	Cambridge, Bot. Gdns.	2·61	162	,, .	Holme-on-Spalding......	2·30	132
Essex.	Chelmsford,County Gdns	...	...	,, .	West Witton, Ivy Ho.	3·01	140
,, .	Lexden Hill House......	2·00	...	,, .	Felixkirk, Mt. St. John.	2·76	152
Suff .	Haughley House.........	2·30	...	,, .	York, Museum Gdns....	1·61	99
,, .	Campsea Ashe...........	2·23	117	,, .	Pickering, Hungate......	1·98	104
,, .	Lowestoft Sec. School...	2·40	122	,, .	Scarborough...............	1·73	97
,, .	Bury St. Ed., WestleyH.	2·44	123	,, .	Middlesbrough............	2·93	176
Norf. .	Wells, Holkham Hall...	2·96	156	,, .	Baldersdale, Hury Res.	5·52	220
Wilts .	Calne, Castle Walk......	4·01	...	*Durh* .	Ushaw College............	2·68	133
,, .	Porton, W.D. Exp'l. Stn	3·52	201	*Nor* .	Newcastle, D. & D. Inst.	2·43	131
Dor .	Evershot, Melbury Ho.	3·70	139	,, .	Bellingham, Highgreen	4·72	196
,, .	Weymouth, Westham.	2·08	99	,, .	Lilburn Tower Gdns....	2·86	121
,, .	Shaftesbury,Abbey Ho.	2·97	122	*Cumb*.	Carlisle, Scaleby Hall...	5·13	190
Devon.	Plymouth, The Hoe....	2·96	116	,, .	Borrowdale, Seathwaite	12·00	128
,, .	Holne, Church Pk. Cott.	4·94	137	,, .	Borrowdale, Moraine...	9·26	123
,, .	Teignmouth, Den Gdns.	2·86	146	,, .	Keswick, High Hill......	6·85	162
,, .	Cullompton	3·06	136	*West* .	Appleby, Castle Bank...	4·15	164
,, .	Sidmouth, U.D.C........	2·65	...	*Mon* .	Abergavenny, Larchf'd	3·50	150
,, .	Barnstaple, N. Dev.Ath	3·86	143	*Glam* .	Ystalyfera, Wern Ho....	4·09	94
,, .	Dartm'r,Cranmere Pool	5·80	...	,, .	Cardiff, Ely P. Stn.......	3·11	100
,, .	Okehampton, Uplands.	3·08	95	,, .	Treherbert, Tynywaun.	6·05	...
Corn .	Redruth, Trewirgie......	3·82	122	*Carm* .	Carmarthen, Coll. Rd.	4·10	119
,, .	Penzance, Morrab Gdns.	4·14	141	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	2·39	88
,, .	St. Austell, Trevarna...	2·83	89	*Card* .	Aberystwyth	5·42	...
Soms .	Chewton Mendip.........	4·28	140	*Rad* .	BirmW.W.Tyrmynydd	4·79	124
,, .	Long Ashton............	3·18	133	*Mont* .	Lake Vyrnwy	6·31	179
,, .	Street, Millfield..........	3·26	...	*Flint* .	Sealand Aerodrome......	3·11	...
Glos .	Blockley	5·33	...	*Mer* .	Blaenau Festiniog ...	10·96	153
,, .	Cirencester, Gwynfa....	4·29	194	,, .	Dolgelley, Bontddu......	6·94	163
Here .	Ross, Birchlea............	3·02	157	*Carn* .	Llandudno	3·22	152
Salop.	Church Stretton.........	5·03	248	,, .	Snowdon, L. Llydaw 9..	15·65	...
,, .	Shifnal, Hatton Grange	3·98	206	*Ang* .	Holyhead, Salt Island...	3·49	131
Staffs.	Market Drayt'n, Old Sp.	3·22	159	,, .	Lligwy	2·70	...
Worc .	Ombersley, Holt Lock.	2·25	127	*Isle of Man*			
War .	Alcester, Ragley Hall...	3·02	170		Douglas, Boro' Cem....	5·93	182
,, .	Birminghm, Edgbaston	2·98	166	*Guernsey*			
Leics .	Thornton Reservoir ...	3·07	170		St. PeterP't.Grange Rd.	4·30	165

Rainfall: September, 1936: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig	Pt. William, Monreith.	4·91	168	*Suth*	Lairg	2·78	98
"	New Luce School	5·38	149	"	Tongue	3·65	115
Kirk	Dalry, Glendarroch	6·18	168	"	Melvich	2·08	74
Dumf.	Dumfries, Crichton R.I.	5·28	207	"	Loch More, Achfary	4·73	82
"	Eskdalemuir Obs	5·59	151	*Caith*	Wick	2·74	110
Roxb	Hawick, Wolfelee	3·40	133	*Ork*	Deerness	2·98	103
Selk	Ettrick Manse	4·49	125	*Shet*	Lerwick	1·96	65
Peeb	West Linton	3·14	...	*Cork*	Dunmanway Rectory	4·08	100
Berw	Marchmont House	3·41	141	"	Cork, University Coll.	2·88	107
E.Lot	North Berwick Res	3·90	186	"	Ballinacurra	2·68	107
Midl	Edinburgh, Blackfd. H.	2·92	142	"	Mallow, Longueville	3·26	136
Lan	Auchtyfardle	3·52	...	*Kerry*	Valentia Obsy	4·19	101
Ayr	Kilmarnock, Kay Pk	3·81	...	"	Gearhameen	5·70	93
"	Girvan, Pinmore	4·71	123	"	Bally McElligott Rec	3·80	...
"	Glen Afton, Ayr San.	4·46	114	"	Darrynane Abbey	3·85	108
Renf	Glasgow, Queen's Pk	4·23	153	*Wat*	Waterford, Gortmore	2·94	107
"	Greenock, Prospect H.	4·12	87	*Tip*	Nenagh, Cas. Lough	4·17	148
Bute	Rothesay, Ardencraig	4·78	...	"	Roscrea, Timoney Park	4·09	...
"	Dougarie Lodge	3·78	...	"	Cashel, Ballinamona	4·60	190
Arg	Ardgour House	4·72	...	*Lim*	Foynes, Coolnanes	3·03	109
"	Glen Etive	...	...	"	Castleconnel Rec	4·31	...
"	Oban	3·38	...	*Clare*	Inagh, Mount Callan	5·59	...
"	Poltalloch	4·37	96	"	Broadford, Hurdlest'n.	4·72	...
"	Inveraray Castle	4·75	74	*Wexf*	Gorey, Courtown Ho	3·33	135
"	Islay, Eallabus	3·55	85	*Wick*	Rathnew, Clonmannon.	3·25	...
"	Mull, Benmore	12·20	106	*Carl*	Hacketstown Rectory	4·36	155
"	Tiree	...	...	*Leix*	Blandsfort House	4·11	151
Kinr	Loch Leven Sluice	3·74	146	*Offaly*	Birr Castle	4·67	204
Fife	Leuchars Aerodrome	2·93	152	*Dublin*	Dublin, FitzWm. Sq	2·64	138
Perth	Loch Dhu	7·05	123	*Meath*	Beauparc, St. Cloud	4·33	...
"	Balquhidder, Stronvar.	4·12	...	"	Kells, Headfort	4·40	165
"	Crieff, Strathearn Hyd.	4·26	149	*W.M*	Moate, Coolatore	4·31	...
"	Blair Castle Gardens	2·95	125	"	Mullingar, Belvedere	4·39	164
Angus	Kettins School	2.65	120	*Long*	Castle Forbes Gdns	4·08	142
"	Pearsie House	4·07	...	*Gal*	Galway, Grammar Sch.	3·66	...
"	Montrose, Sunnyside	3·12	157	"	Ballynahinch Castle	5·65	119
Aber	Braemar, Bank	3·03	121	"	Ahascragh, Clonbrock.	4·47	145
"	Logie Coldstone Sch	2·34	100	*Mayo*	Blacksod Point	4·57	118
"	Aberdeen, Observatory.	2·60	117	"	Mallaranny	5·74	...
"	Fyvie Castle	2·60	100	"	Westport House	4·93	139
Moray	Gordon Castle	2·52	101	"	Delphi Lodge	9·13	121
"	Grantown-on-Spey	...	...	*Sligo*	Markree Castle	4·38	129
Nairn	Nairn	2·26	103	*Cavan*	Crossdoney, Kevit Cas.	3·86	...
Inv's	Ben Alder Lodge	3·62	...	*Ferm*	Newtwnbtlr, Crom Cas.	4·41	158
"	Kingussie, The Birches.	3·32	...	"	Enniskillen, Portora	5·37	...
"	Loch Ness, Foyers	...	...	*Arm*	Armagh Obsy	4·35	177
"	Inverness, Culduthel R.	4·13	...	*Down*	Fofanny Reservoir	7·83	...
"	Loch Quoich, Loan	5·47	...	"	Seaforde	5·03	182
"	Glenquoich	4·36	51	"	Donaghadee, C. G. Stn.	4·07	171
"	Glenleven, Corrour	6·20	115	*Antr*	Belfast, Cavehill Rd	4·53	...
"	Fort William, Glasdrum	3·70	...	"	Aldergrove Aerodrome.	3·80	153
"	Skye, Dunvegan	2·98	...	"	Ballymena, Harryville.	4·93	158
"	Barra, Skallary	3·27	...	*Lon*	Garvagh, Moneydig	5·15	...
R&C	Alness, Ardross Castle.	3·38	116	"	Londonderry, Creggan.	5·46	166
"	Ullapool	3·11	83	*Tyr*	Omagh, Edenfel	4·11	135
"	Achnashellach	5·04	69	*Don*	Malin Head	4·11	...
"	Stornoway, Matheson	4·21	107	"	Killybegs, Rockmount.	3·18	...

Climatological Table for the British Empire, April, 1936

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.	1014·8	+ 0·4	63	31	50·9	38·3	44·6	− 2·5	39·8	82	6·9	1·68	+ 0·23	14	4·4	32
Gibraltar	1014·8	− 1·6	68	46	62·5	54·4	58·5	...	54·4	84	6·3	5·67	...	10	...	...
Malta	1013·0	− 0·4	72	51	65·7	56·9	61·3	+ 0·4	56·2	74	5·1	0·93	+ 0·07	5	8·7	67
St. Helena	1012·6	− 0·3	71	58	67·4	60·6	64·0	− 1·3	62·1	95	9·1	2·23	− 0·99	21	...	...
Freetown, Sierra Leone	1008·3	− 0·8	92	68	87·9	74·2	81·1	− 1·3	77·2	84	8·7	6·81	+ 2·75	16	...	...
Lagos, Nigeria	1010·0	+ 0·6	91	73	88·2	78·3	83·3	+ 0·5	78·1	83	7·7	2·57	− 3·51	6	6·7	55
Kaduna, Nigeria	1006·6	− 2·3	99	65	93·3	71·5	82·4	+ 0·9	73·1	76	5·6	2·38	− 0·70	10	8·3	67
Zomba, Nyasaland	1013·7	+ 1·2	81	56	76·7	61·7	69·2	− 0·1	66·2	81	6·8	3·46	− 0·20	11	...	...
Salisbury, Rhodesia	1016·4	+ 0·7	81	47	76·0	52·7	64·3	− 1·4	58·3	67	4·1	1·03	+ 0·04	8	8·0	68
Cape Town	1017·9	+ 1·5	97	45	74·9	55·5	65·2	+ 2·0	55·4	75	3·8	0·52	− 1·35	4	...	...
Johannesburg	1017·8	+ 1·6	78	42	70·9	50·7	60·8	+ 0·8	53·3	68	3·4	0·10	− 1·64	4	8·2	71
Mauritius	1014·1	+ 0·1	86	65	83·3	70·3	76·8	+ 1·0	72·0	71	4·0	1·04	− 3·43	14	8·5	73
Calcutta, Alipore Obsy.	1005·4	− 0·9	107	69	98·8	77·6	88·2	+ 2·6	77·8	79	2·9	0·25	− 1·93	1*	...	...
Bombay	1008·8	0·0	90	73	88·9	76·3	82·6	− 0·5	75·6	77	1·9	0·00	− 0·05	0*	...	...
Madras	1007·0	− 1·4	105	73	94·4	78·2	86·3	+ 1·0	77·9	73	5·8	0·46	− 0·17	1*	...	...
Colombo, Ceylon	1009·3	+ 0·6	91	73	89·0	77·2	83·1	+ 0·4	77·9	71	6·7	2·86	− 6·87	8	7·4	60
Singapore	1008·6	− 0·3	90	74	87·0	76·2	81·6	0·0	77·8	79	6·9	7·00	− 0·63	18	6·2	51
Hongkong	1012·0	− 0·6	86	58	76·5	66·9	71·7	+ 0·9	68·4	85	8·9	4·60	− 1·05	9	3·3	26
Sandakan	1008·9	...	92	74	89·1	76·6	82·9	+ 0·7	78·4	80	8·0	4·76	+ 0·27	16	...	...
Sydney, N.S.W.	1017·6	− 0·8	91	48	70·8	55·3	63·1	− 1·6	57·7	69	4·9	1·85	− 3·67	10	7·6	67
Melbourne	1019·4	− 0·1	80	39	65·5	48·6	57·1	− 2·4	52·7	72	7·2	4·30	+ 2·13	18	4·3	39
Adelaide	1021·7	+ 1·8	85	43	72·1	53·2	62·7	− 1·2	54·9	55	4·8	1·21	− 0·52	10	7·0	63
Perth, W. Australia	1020·2	+ 1·8	93	47	77·1	57·6	67·3	+ 0·5	56·7	55	4·3	0·59	− 1·06	8	7·3	65
Coolgardie	1019·8	+ 1·5	91	43	78·1	52·7	65·4	+ 0·4	56·3	55	3·3	0·18	− 0·78	2	...	...
Brisbane	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hobart, Tasmania	1014·1	− 0·7	72	39	62·4	46·8	54·6	− 0·6	47·3	60	6·6	1·50	− 0·35	14	5·1	47
Wellington, N.Z.	1017·8	− 0·3	73	43	63·5	51·8	57·7	+ 0·6	55·2	81	6·5	3·33	− 0·55	12	4·9	45
Suva, Fiji	1009·7	− 0·9	93	72	87·4	74·6	81·0	+ 2·4	76·2	83	5·5	7·60	− 4·61	19	6·8	58
Apia, Samoa	1009·3	− 0·6	89	73	86·1	75·6	80·9	+ 2·0	77·2	79	6·0	8·70	− 1·45	21	6·6	56
Kingston, Jamaica	1014·0	− 0·1	92	68	87·3	71·8	79·5	+ 1·1	70·6	78	4·2	1·20	− 0·04	3	6·6	53
Grenada, W.I.	1011·9	− 0·6	84	71	83	72	77·5	− 1·4	76	83	5	2·38	+ 0·22	18	...	...
Toronto	1015·7	− 0·4	64	24	45·8	33·4	39·6	− 2·5	...	...	7·5	2·82	+ 0·53	12	3·3	25
Winnipeg	1019·6	+ 2·9	65	−16	40·1	19·6	29·9	− 7·8	...	...	4·0	0·44	− 0·96	9	8·2	60
St. John, N.B.	1013·2	− 0·2	55	26	44·6	32·5	38·5	− 0·5	34·6	76	7·6	3·29	− 0·23	15	4·1	30
Victoria, B.C.	1018·6	+ 1·1	67	32	56·3	43·6	49·9	+ 2·0	46·7	81	6·9	0·88	− 0·64	10	6·9	51

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

(33884) Wt. 19/32 1,125 10/36 Hw. G.377

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RAINBOW WITH VERTICAL SHAFT SEEN FROM SKYE, JULY 7TH, 1936 (*see* p. 230)