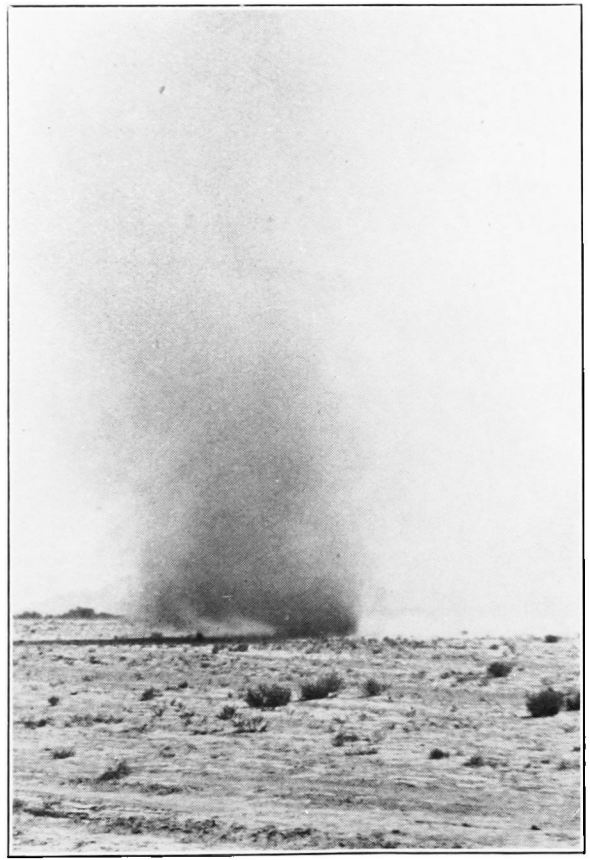
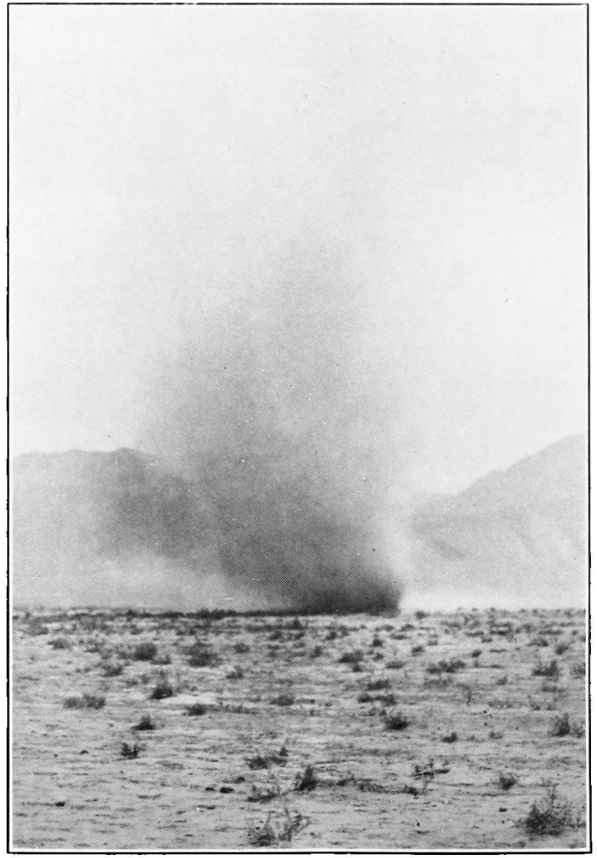


DUST-DEVIL 14H. 40M., AUGUST 10TH, 1934 (*see* p. 268)



DUST-DEVIL 15H. 15M., SEPTEMBER 6TH, 1934 (*see* p. 268)

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The Audibility of the Firing in the English Channel on September 27th, 1934

By F. J. W. WHIPPLE, Sc.D.

It is well known that the way in which the sound from explosions spreads is a phenomenon which is subject to great variations. These variations can be explained in part by changes in meteorological conditions, notably in the direction and strength of the wind, but the extent to which sounds are heard at very great distances is apparently related to characteristics of the upper atmosphere in regions far above those with which we are concerned in the study of the weather.

During recent years there have been two occasions when firing taking place during reviews of the fleet in the English Channel has been heard over a large part of England. On one of these occasions, November 1st, 1930, the sounds attracted general attention at places at considerable distances, 200 Km. and more to the north-east, though they were heard neither at places between 100 Km. and 160 Km. in the same direction nor at places to the westward. On the second occasion, on July 14th, 1932, the sounds were very well heard in the west (near Lands End) and north-west (in Wales). This antithesis is not a mere accident. There is a well marked oscillation according to the time of year. Air waves travel through the high atmosphere to the east in winter and to the west in summer. For this purpose the end of summer is in August or September as we know from experience during the War and from other evidence.

An opportunity for investigating the distribution of audibility in the transitional month September presented itself on September 27th, 1934, when, as was announced by the Admiralty, salvoes were to be fired by H.M.S. *Valiant*. Announcements of the approximate times of firing in the afternoon and in the evening appeared in the newspapers and were broadcast by the B.B.C. There was a generous response to the request that reports by observers who thought they had heard the firing should be sent to Kew Observatory. The reports numbered nearly 700. These have been used in the preparation of the maps (Figs. 1 and 2) showing where the sounds were heard in

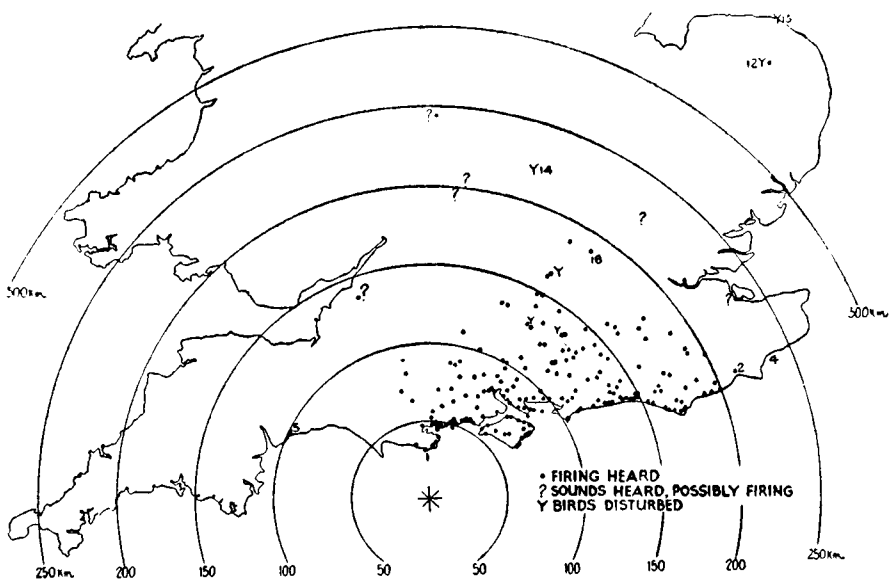


FIG. 1—AUDIBILITY OF FIRING, H.M.S. *Valiant*, SEPTEMBER 27th, 1934, AFTERNOON

the afternoon and in the evening. It will be seen that there is a considerable likeness between the maps. The firing points indicated by stars on the maps were not quite the same. In the afternoon the co-ordinates were 50° 18′ N. 2° 2′ W. and ten salvoes were fired in 5½ minutes between 15h. 22m. 23s. and 15h. 27m. 55s. B.S.T. In the evening the ship was a little further south and west, the co-ordinates being 50° 11′ N. 2° 17′ W. and fours alvoes were fired in the three minutes between 20h. 28m. 31s. and 20h. 31m. 32s. B.S.T.*

Both of the firing points were nearly due south of St. Albans Head[1]†. The firing was heard there and along the south coast to the east as far as Rye[2] in the afternoon and as far as Bexhill[3] in the evening. There were observers listening at Hythe[4] in the afternoon

* The centre in Fig. 2 is placed a little to the east of the correct position.
† These small numbers refer to figures on the maps.

who heard nothing, so the boundary of the zone of audibility must have cut the coast at a distance from the firing point between 220 and 250 Km.

To the west of St. Albans Head there was only one place on the coast, Sidmouth[5], where sounds were heard in the afternoon but in the evening the coastguards heard the firing as far west as Lyme Regis[6] and the airwaves rattled windows at Torquay[7]. Sounds were heard on the other side of the English Channel, in the Channel Islands in the afternoon and at Etretat near Havre in the evening. There might have been more observations in France if the request

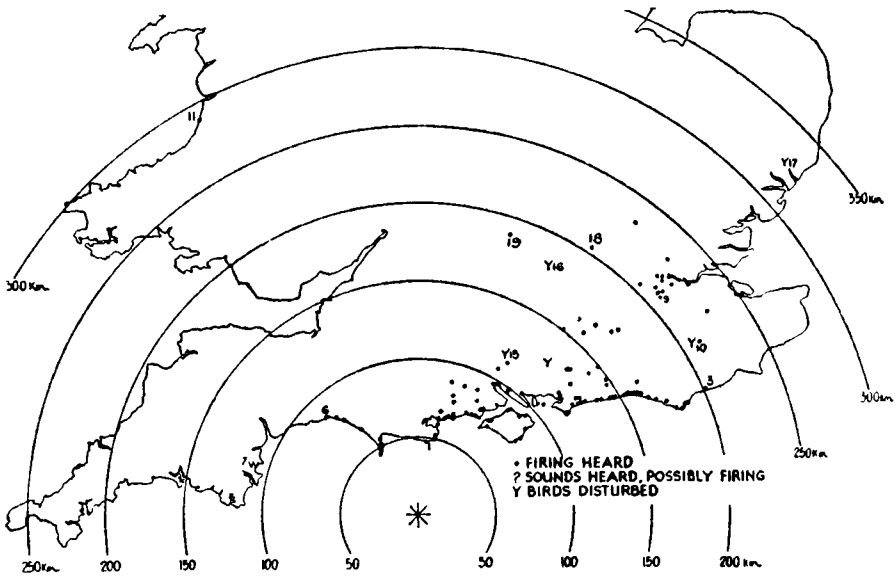


FIG. 2—AUDIBILITY OF FIRING, H.M.S. *Valiant*, SEPTEMBER 27th, 1934, EVENING

for information had reached the French newspapers. It is clear, however, that in Dorset the sounds which were heard on the coast did not penetrate inland. On the other hand, to the north-east of the guns the sounds travelled a long way past the coast line and were heard distinctly as far as the Weald just below the North Downs.

On such occasions there is usually much difficulty in deciding which of the observers at distant points correctly judged faint sounds which come to their ears as gunfire. On September 27th there were a good many observers not far from the south coast who reported ten salvoes in five minutes or four salvoes in three minutes and a few people gave the time to a second, leaving no doubt as to the reliability of their observations, but such detail could not be expected in the majority of the reports. Extraneous noises were troublesome in Essex where there were several detonations soon after 20h. and in Oxfordshire where sounds were reported about 15h. 20m.

It may be, however, that in Kent near Orpington[9] observers heard some of the salvoes twice. Four salvoes were fired. According to one report from Orpington bangs were "clearly heard indoors at 8.36, 8.37, 8.38, 8.39, 8.44," whilst another report runs: "listening in our garden we heard three distinct detonations of undoubted gunfire between 8.40 and 8.45. Two previous ones were heard between 8.35 and 8.40, but these were considerably less distinct. They appeared to come from due west not southwest."

The outer region of audibility in the evening in Kent included Goudhurst and Greenwich. There were observations apparently reliable as far to the north and west as Sarratt[18] in Hertfordshire and Iffley[19] near Oxford. In the absence of well timed observations it is impossible to say whether these regions were in a zone of "abnormal audibility" in the technical sense, i.e. a zone such that the time of passage of the sound waves was much in excess of the time required for sound to travel along the ground.

There are two noteworthy reports of audibility at very distant points. One of these was from Aberystwyth[11] at a range of 290 Km. "At approximately 8.50 p.m. I heard the booming of a distant gun. Several thundery roars could be heard in quick succession." This observer was able to hear sounds at 290 Km. to the north-west of the source. At this time of year it is not found possible to record at Birmingham airwaves from Woolwich on the same bearing. It may be that the waves pass over Birmingham and could be recorded at a greater distance. The other report is for a still greater range, 350 Km. The observer who was at Weston Longville[12], 10 miles north-west of Norwich, says that pheasants "began shouting" and he stopped and listened and could distinctly hear the salvoes. Unfortunately the time of this observation is given merely as "about 3.30." The air waves from H.M.S. *Valiant* could not have reached the observer before 3.40 and the margin of safety in the word "about" is hardly sufficient. There were other cases of the disturbance of pheasants. In the afternoon there was one close to Cromer[13] (the cock pheasants all began crowing at 3h. 40m.) and another at Towcester[14]. In the evening birds were disturbed near Winchester[15], at Goudhourst[10] in Kent, at Nettlebed in Oxfordshire and also at Woodbridge[17] in Suffolk, about 325 Km. from the firing point. Why pheasants are affected by airwaves which cannot be perceived by the human ear and are persumably infrasonic is not known. It is a nice problem for the physiologist.

It is unfortunate that no station with sound-ranging equipment obtained autographic records of the airwaves; in fact, no such records of salvoes fired an "abnormal" distance away have ever been made. Owing to the fact that the firing in the afternoon was later than was anticipated, none of the stations was in operation at appropriate times. Bristol, Birmingham and Nottingham were operating in the evening. It will be seen from the maps that these

stations are in areas where the firing was not generally heard. This negative evidence makes it unlikely that the sounds heard and reported by observers, for example at Clifton and at Gloucester, were due to the firing.

Though it has to be remembered that on this occasion the salvoes were being fired by only one battleship instead of by a squadron it may fairly be concluded from the evidence that sound did not carry so well to the outer zone of audibility on this September day as on the days of the reviews which, as has been mentioned, took place in July and in December.

The large area with normal audibility to the north-east of the firing is associated, of course, with the distribution of wind in the lower atmosphere. In Fig. 3 the velocity of sound in still air is represented as a function of height by the graph AA. This curve depends on the observations of temperature made at Duxford at 12h. 15m. The component of wind velocity towards north-east is represented by the curve BB and the velocity of sound in the same direction by the curve CC. It will be seen that this velocity increased at any rate up to 1·8Km.

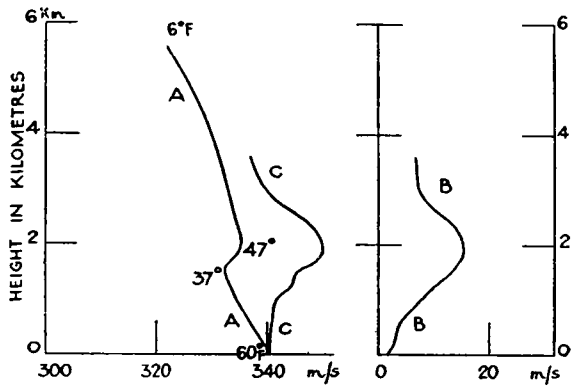


FIG. 3

AA. Velocity of sound according to temperature (Duxford 12 h. 15 m.)
BB. Wind component towards north-east (Lympne 17 h.)
CC. Sum

Such a distribution of velocity favours the travel of sound along the ground, the sound waves being continually refracted downwards. In this way the clearness with which the firing was heard in the Isle of Wight and other parts of the south coast can perhaps be explained.

The observations across the main wind current at Sidmouth and Etretat may be explained by conditions over the sea. The air was at practically the same temperature as the sea so that there would be a tendency for sound waves starting nearly horizontally across the wind to go straight on without being deflected upwards. That the firing was heard in the Channel Islands in the afternoon is more difficult to understand since in this case the sound travelled against the wind and moreover the distance is too short for passage through the high atmosphere to be likely.

In conclusion, I have to express my appreciation and thanks to the Admiralty for so courteously giving notice of the firing, to the

Board of Trade who provided most valuable observations by members of H.M. Coastguard, to the newspapers and the B.B.C. who circulated the request for observations, and to all the correspondents who were so good as to make observations and communicate their reports.

Discussions at the Meteorological Office

The subject for discussion for the next meeting is :—

January 14th, 1935. *Thermodynamics applied to air mass analysis.* By C. G. Rossby (Cambridge, Mass., Met. Pap. I No. 3, 1932). *Opener*—Prof. D. Brunt, M.A., B.Sc.

Royal Meteorological Society

The Buchan Prize of the Royal Meteorological Society for 1935 has been awarded to F. J. W. Whipple, M.A., Sc.D., F.Inst.P., for papers contributed to the *Quarterly Journal* of the Society during the years 1929–33.

The opening meeting of this Society for the present session was held on Wednesday, November 21st, at 49, Cromwell Road, South Kensington. Lieut-Col. E. Gold, D.S.O., F.R.S., President, in the Chair.

J. Edmund Clark, Ivan D. Margary, and C. J. P. Cave.—The Phenological Report, 1933.

1933 was warm, dry and sunny to an exceptional degree. Warmth was +2° F., rain 87 per cent. and sunshine 109 per cent. for the 12-month period, December to November. This was due chiefly to conditions in the summer and therefore phenologically most effective half year. Scotland, north and east, and England, north-east, were strikingly favoured. The difference in flowering period between England, south, and Scotland, north, was reduced from 20 to 10 days. The relative spacing of spring migrant isophenes tallied. Owing to the cold snap in the south at the end of April, they were decidedly close there, but broadened in the north, curiously giving a " normal " year for all districts. The most striking insect phenomenon was the excessive invasion of migrant butterflies. Noteworthy was the record of 30 of the huge American " Milkweed " butterfly, *Danaus plexippus*, treble any previous record.

E. E. Jessop, M.Sc.—A study of climate during abnormal summers in Europe and Asia.

The object was to investigate the climatic conditions prevailing over Europe, Asia and north Africa during periods of summer drought in England. By means of maps the percentage variation of rainfall from the normal over Europe, Asia and north Africa, for four British droughts, was shown, and also the pressure for the same area. From these it was possible to distinguish three types which were described and discussed in detail. In each of these types it

appeared that the high pressure causing the drought in western Europe was accompanied by pressures below normal over northern Russia or northern Siberia, which caused heavy rainfall there. Pressure and rainfall graphs were plotted for a period of 30 years to test this. The influence of the position of the Indian low, and the effect of the pressure gradient to the north-west of India on monsoon rainfall was also briefly discussed.

Dugald S. Hancock.—General Sunshine Values: England and Wales, Scotland, Ireland and the British Isles, for the period 1909–1933.

The values were obtained from the "Bright Sunshine" maps of the *Monthly Weather Report.* They are grouped in four tables, which include quarterly and five-yearly means, together with the highest and lowest values for each month, with the year in which they occurred. The means for 1881–1915 are also given. Outstanding years viz. 1911, 1912 and 1933 are fully analysed. The author suggests a decrease in average insolation from 1916 onwards.

Correspondence

To the Editor, *Meteorological Magazine*

Winds Box the Compass

I experienced a very curious case of winds which veered in a short time through 360°, when I was sailing from Howth to Lambay Island and back on September 1st last.

In the morning the wind was light to moderate SW. At about 13h. 30m. B.S.T. this dropped to nothing as a heavy cloud came over from the west, and for a few minutes very heavy thunderstorm rain fell at about 14h. 15m. in a complete calm. After that a light easterly wind rose, veered in about 10 minutes to SE., S. and SW., increasing considerably until it was quite fresh. Then it got lighter again and was moderate to light veering very slowly to NW. and N., taking three-quarters of an hour to do so. Then it changed to NE., E., and another rain cloud was seen coming again from the west, well to the north of where I now was. The wind then veered to SE., S. and SW., rising to moderate strength, then slowly again to north of west.

I do not know if such small cyclonic winds are at all common anywhere in the British Isles, but I have sailed for a great many years and have never seen anything like such a perfect example.

Here off the east coast of Ireland it is quite common in the summer to get a westerly wind on the land and an easterly on the sea, and the calm between these two often moves about the water so that for a time one is in an easterly wind and a few minutes later in a westerly, but there is always a dead calm between these changes, and not a veering or backing wind.

Of course it is only when sailing on open waters that an ordinary observer can be sure that the wind has varied in direction continuously.

G. S. PHILLPOTTS.

Oakfield, Foxrock, Co. Dublin, September 24th, 1934.

[The synoptic situation on September 1st was as follows. Depressions were centred to the north-west of Ireland, and over Germany and south-west France. Dublin was just within the circulation of the depression to the north-west, but the gradient was very weak.

Conditions were favourable for thunderstorm development, and in fact a thunderstorm was reported at Aldergrove at 10h. G.M.T.

With such a pressure distribution small cyclonic disturbances would be liable to form and move slowly north-eastwards. Two such disturbances following one another at a short interval and passing just to the north-west of the observer would result in wind changes similar to those experienced by Mr. Phillpotts.—Ed. *M.M.*]

Brilliant Moon Pillar

On the evening of October 26th, 1934, at 19h. 15m. G.M.T. a brilliant moon pillar, white in colour, was observed rising from behind a cloud bank which hid the moon. Short segments of the 22° and 46° halos were visible immediately above the moon which made the pillar resemble the beam of a searchlight shining on end through a cloud sheet. Later, when the moon had risen above the cloud bank, the halo segments disappeared but the central portion of the halo increased in brilliance and the four beams of light, two horizontal and two vertical, radiating from the moon were extremely well defined. The two horizontal beams and the upper vertical beam decreased in intensity after 19h. 25m., but the lower vertical beam persisted until at least 19h. 35m.

WILLIAM D. FLOWER.

Royal Air Force, Sealand, November 11th, 1934.

Cloudiness and the State of the Sky

The usual method of expressing the state of the sky with regard to cloudiness is to give an estimate of the amount in tenths of sky covered by cloud, irrespective of type. This being so, the mean cloudiness of a place, although giving the average amount of cloud, does not convey to one the average state of the sky; because a sky totally covered with cirrus is treated numerically as being of the same cloudiness as a sky covered with, say, a dense sheet of stratus.

Having regard to sunshine and what is regarded as "fine" weather, maps shewing isonephs can be very misleading and something more is required than the mean area of the cloud sheet. For instance, in summer months a place having a preponderance of

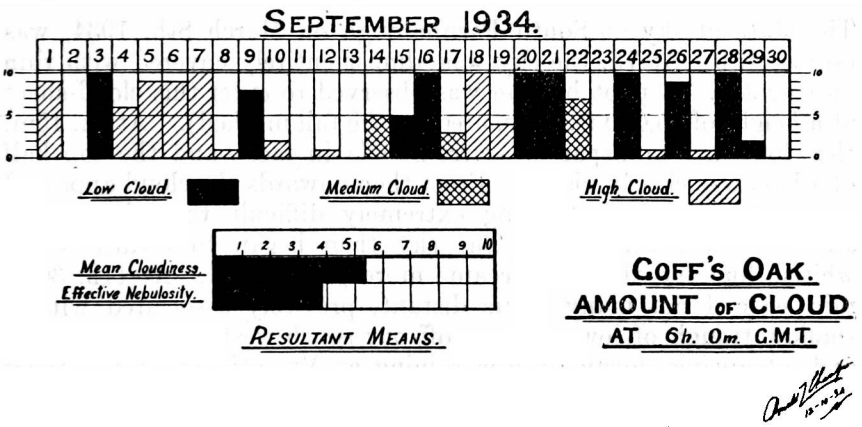
cirriform cloud would be classified with another whose sky is frequently overcast with heavy rain-clouds and certainly not enjoying "fine" weather. In this respect the mean cloudiness is not the same as the mean state of the sky. If, however, the density or opacity of clouds be considered as well as the area of cloud sheet, the resultant figures would give a measure of the "Effective Nebulosity."

At Goff's Oak, Hertfordshire, having found that the lower clouds are usually the more opaque, clouds have been first classified under the headings High, Medium and Low and then the Effective Nebulosity, C, estimated as follows :—

$$C = \frac{3a + 2b + c}{3n}$$

Where a = the sum of low cloud in tenths.
b = ,, ,, medium cloud in tenths.
c = ,, ,, high cloud in tenths.
n = number of observations taken.

During the month of September last, as will be seen in the attached diagram, there were 12 days on which the clouds at 6h. G.M.T.



were high cloud (mostly cirrus). Summarised, there were 84 tenths of low, 15 tenths of medium and 63 tenths of high cloud for the 30 days.

The mean cloudiness would be expressed as

$$\frac{84 + 15 + 63}{30} = 5{\cdot}4$$

Whereas the mean effective nebulosity would be expressed as

$$\frac{(3 \times 84) + (2 \times 15) + 63}{3 \times 30} = 3{\cdot}8.$$

The latter figure seems to be a fairer computation of the mean "State of the Sky" than is expressed by the mean cloudiness.

DONALD L. CHAMPION.

7, Robinson Avenue, Goff's Oak, Herts, October 12th, 1934.

[The point raised by Mr. Champion is frequently noted in the relation between nebulosity and duration of " bright sunshine." It is well known that in summer the percentage of cloud added to the duration of sunshine expressed as a percentage of " possible " amounts to more than 100, the inference being that a certain amount of cloud is so thin that the sun shining through it can still burn the card in the recorder. A calculation made some years ago* showed that in most parts of the world outside the tropics, the total amount of thin cloud (including that hidden by lower cloud) is about 60 per cent. of the total cloudiness. Mr. Champion's figure for total nebulosity is 5·4, and 60 per cent. of this gives 3·24 for total " thin " cloud, of which only 2·1 tenths would be visible. This agrees exactly with his estimated amount of 2·1 tenths of high cloud. It seems, therefore, that a more practical method of estimating " effective " nebulosity would simply be to omit high cloud.—C. E. P. BROOKS.]

Unusual Cloud Sequence and Persistent Solar Halo

The state of sky at South Farnborough on March 8th, 1934, was noteworthy. At 7h. the sky was almost entirely covered with thin alto-stratus. A pilot balloon was observed to enter this cloud-sheet at a height of 15,000 ft. (measured by the tail method). At 8h. 15m. the cloud was transparent—cirro-nebula in fact—and the top half of a halo was clearly visible. From then onwards the cloud appeared slowly to evanesce, it being extremely difficult to estimate the amount, until 10h. 30m. The sky then began to return to its whitish hue and the halo became more pronounced. At 11h. 30m. rain seemed not many hours distant, probably associated with a shallow trough of low pressure off our south-west and west coasts and advancing slowly (it was raining at Valentia at 7h.). Apart from a varying amount of detached cumulus which began to form at 9h. 55m. the sky's appearance remained unchanged until 14h. 30m.–15 h., when the whitish cloud layer became translucent, and at 16h. it appeared definitely to be thin alto-stratus (sun's place visible), but the halo could still be seen, produced perhaps by ice-crystals above the alto-stratus. Later in the afternoon a pilot reported that at 15h. 15m. the " thick haze " was very wet, base at 14,400 ft. and temperature at 14,700 ft. —18°C. (0°F.) (heights from altimeter, uncorrected). Although the sky was still covered at dusk, all stars brighter than those of 3·4 magnitude† and above an elevation of 25–30° were visible at 19h. 30m. It was thought that the cloud layer, which should have been down to about 10,000 ft. or less, was still present but invisible in the same way that the moon

* *London Meteor. Off., Prof. Notes* No. 53, 1929.

† (Faintest star in Ursa Major).

can often be seen through a cloud layer which was impervious until dusk. Similarly, pilots flying after dusk have, I understand, occasionally reported that the ground has been invisible from a height of, say, 2,000 ft. when the sky from the ground appeared to be cloudless. On this occasion a pilot climbed to a height of 10,000 ft. at 20h. and no cloud was encountered. At 23h. 30m. the sky was overcast, but it cleared again in the early hours and hoar frost and fog formed. The wind up to about 10,000 ft. was W. at 7h. 30m. and SW. from midday, 10–15 m.p.h.; from 10,000 ft. to 15,000 ft. it was NW. in the morning and W. from midday, 25–35 m.p.h.

Briefly the interesting facts are: a halo visible almost continuously for approximately eight hours—through clouds composed of water-drops during the afternoon. Alto-stratus, followed at 8h. 15m. by the normal cloud sequence (cirro-nebula to alto-stratus) to be expected in front of an advancing low-pressure system, then a clear sky, frost and fog. The low-pressure system was still advancing the following morning and Farnborough was enjoying summer-like weather with a midday temperature of 51°F.

J. S. SMITH.

R.A.E., South Farnborough, Hants, March 9th, 1934.

Mr. C. K. M. Douglas comments on this observation as follows:—

"My experience was that alto-stratus clouds most frequently consist of ice crystals, and that the characteristic appearance of the sun "as through ground glass" is definitely caused by a layer of ice-crystals of great vertical extent. I noted a number of halo phenomena produced by clouds at 10,000 ft. or less including sun pillars and mock suns below the level at which I was flying. On one occasion when flying at 4,000 ft. the mock sun was estimated to be at 3,000 ft. The same thing has been seen at Ben Nevis Observatory, and its occasional occurrence down to ground level seems probable, even in our latitude. It is well known that this happens in high latitudes. I described my observations fully in *Edinburgh J. Scot. Meteor. Soc.* 18, pp. 83–6.

In the normal sequence of cirrostratus thickening to altostratus, the fading of the halo precedes the disappearance of the sun owing to its luminosity being much less. In the new "International Cloud Atlas," altostratus is defined as a cloud which does not give a halo. Thus a veil of cloud giving a halo is always cirrostratus, according to the new definitions. It may of course sometimes occur quite low. Height does not enter into the new definitions.

The fact that no rain followed the halo on March 8th may be explained in relation to the complex frontal situation as published in the *Daily Weather Report, International Section.* Since the high clouds came over from north-west they were associated with the occlusion off our north-west coasts, which faded out and was eventually caught up by a more active occlusion."

[If the temperature at 14,700 ft. was —18°C., that at 14,400 ft.

was probably well below freezing. If the cloud had been wet and had consisted of supercooled water drops rime should have been formed on the aeroplane. The pilot when asked whether this was the case stated that neither he nor his observer had examined the struts, etc., for rime formation as their time had been fully occupied on a special job. The impression of wetness had been produced by a film which formed on the wind screen and by the mistiness of the cloud. The observer, while agreeing that it was " very wet," preferred to call it " thick haze " rather than " cloud."—ED. *M.M.*]

Rain in Advance of True " Warm-front " Rain

With reference to the note by Col. Gold in the November number of the *Meteorological Magazine* under the above title, I find that I noted the time the rain commenced here on October 6th, 1934. Slight rain began at 11h. 57m. G.M.T. A further observation made at 13h. shows continuous slight rain at that hour.

Is it possible that the cessation of the rain that Col. Gold comments upon may have been due to the diurnal variation of warm-front rainfall ? The existence of this variation is shown by Major Goldie in " Characteristics of rainfall distribution in homogeneous air currents and at surfaces of discontinuity " (*Geophys. Mem.*, No. 53). The curve there given for the diurnal variation of warm-front rainfall in winter (including October) at Kew, shows a secondary minimum between 14h. and 16h. G.M.T. This suggests that there is a tendency for warm-front rainfall to decrease in force at this period. The time of cessation given by Col. Gold, viz., 13h. 30m. until 15h. 30m., seems to be in fair agreement with this.

I have noticed a tendency here (Woodcote Valley) for warm-front cloud to thin or break during the early afternoon. The position here is approximately $1\frac{3}{4}$ miles south by west of the anemometer at Croydon Aerodrome.

C. STUART BAILEY.

Longtridge, 76 Woodcote Valley Road, Purley, Surrey, November 21st, 1934.

Thunderstorms and thick Snow in Cheshire

On November 1st, 1934, West Kirby, Cheshire, was visited by two early-morning thunderstorms which were so severe that they literally shook the foundations of the houses. The first occurred an hour or two after midnight, and the second at 6 a.m., the latter doing serious damage. At 9 a.m. there followed a remarkable hailstorm, the stones coming down in one continuous shower for a whole hour. There was no wind. Shortly before 11 a.m. snow began to fall, and of this there was no abatement until 6 p.m., when the ground away from the immediate sea-front had become covered to a general depth in places of over 4 inches, and on the higher ground the depth was

estimated at 6 inches. The total measurement of the hail and snow, as "rain," during the 12 hours ending at 9 p.m. was 26·2 mm. at St. Andrew's Vicarage. The shade temperature at 9 a.m. was 40°, at 1 p.m. 34°, at 3 p.m. 33°, and it did not rise above 33° until 7 p.m., when a westerly breeze set in. The day altogether was a most unusual experience, and the snowfall almost unprecedented for so early in the year.

E. F. ROBSON.

West Kirby, Cheshire, December 4th, 1934.

Frontal Thunderstorm of October 23rd, 1934

During the evening of Tuesday, October 23rd, 1934, the coastal districts of north Wales and Lancashire were deluged by heavy rain with thunder at many places, the storm being particularly severe at Morecambe, where a house was struck by lightning which tore a large hole in the roof and split in two an iron bedstead. Floods occurred for a time owing to the inability of the drains to cope with the heavy rainfall. Lightning discharges were observed to the south of Liverpool, so that the places affected lay on a line at least 70 miles long. Possibly all the Lancashire coast area was affected by the same storm moving in a north-easterly direction since Manchester was practically immune. I observed a flash about 20h. 30m. G.M.T. which appeared to emanate from a north-westerly direction, and it was so intense that I doubted whether it could be anything but lightning, yet I could not feel certain it was such.

This outbreak of thunder can hardly be ascribed to anything but a front, having due regard to the time of occurrence and the general weather preceding it. An apparently feeble discontinuity was discernable on a line Blacksod–Valentia at 7h. G.M.T., October 23rd, which moved north-east at 20 to 25 m.p.h. and at 18h. had reached a line roughly Dalwhinnie–Eskdalemuir–Llandudno, the limit of its southern extremity being difficult to define. During the night of the 23rd Morecambe had 23mm. of rain, Blackpool 17mm., Southport 14mm., Colwyn Bay 12mm., and Douglas 10mm. Probably the great bulk of the rainfall was associated with the thundery conditions. The occurrence of the thunder is all the more remarkable since at 18h. it was evident that a new disturbance was approaching our south-west coasts which, subsequently moving north-north-east during the night, existed at 7h. on the 24th as a warm occlusion on a line Cork–Holyhead–Catterick. Only a slight shower at 21h. 40m. was recorded at Manchester before midnight, presumably being due to the front which caused the thunder, but 3mm. fell from the warm occlusion. From this, it appears possible that the rainfall at Morecambe due to the thunderstorm was of the order of 20mm.

Upper winds in the vicinity were south-westerly up to 15,000 feet

with no substantial veer but considerable increase in velocity above 8,000 feet. The upper air ascents at Duxford do not assist in this particular case. The 13h. G.M.T. ascent showed that air forced to ascend from about 3,000 feet would meet with a very stable layer at 7,500 feet, and these conditions would prevent the growth of large cumulus clouds.

The fact that no trace of the passage of the front can be found in the records at this station, except for the shower at 21h. 40m. supports the view that the discontinuity passed to the north and that its southern extremity was ill-defined and in process of dispersal. It is likely that thunder occurred also further to the north and east although the reports available do not confirm this.

At any rate, the outbreak of thunder can be directly associated with the cold front referred to, and is all the more remarkable since relatively warmer air was already nearing our south-west coasts. A similar case occurred on July 24th, 1934, when with warm air already up to the west coast of Ireland, cold front thunderstorms were widespread in south-east England.

C. W. G. DAKING.

Barton Airport, Manchester, October 31st, 1934.

Rain in Stationary Depressions

Readers of the *Meteorological Magazine* must be grateful to you and to Colonel Gold for the detailed review of the new Abercromby's "Weather" as revised by Major Goldie, which appeared in your July number. Their thanks are due in part for the critic's spotlight which was turned on to some places which should have received attention at this spring-cleaning of 1934.

The sub-title of the book is "The Nature of Weather Changes from Day to Day" and therefore the statement on p. 24 that "suppose the cyclone stood still for a week, then the observer would see a watery sky for a week, without any rain falling" attains importance. But this statement, which was in the original book and is retained in the new book, is so wrong that its correction seems beyond the scope of a *caveat lector* as suggested by the reviewer, and it might have been deleted without any qualms to the reviser on the score of being called an iconoclast.

Let us suppose a cyclone stands still for a week off Valentia: we shall then find that, practically irrespective of the pressure gradient, rain recurs in the neighbourhood of London at intervals of about 24 hours. In other words, at some 500 miles from the centre of a nearly stationary depression rain occurs with a daily rhythm. In actual experience, the rain bands are generally alternately light and heavy; in seasons of a dry character the lighter rain bands may only be represented by an increase of cloud or by "mackerel sky." The rain bands are separated by fine or fair intervals. Generally the

passage of the rain is indicated by a fall of the barometer followed by a rise : but examples have been noted where the barograph trace has not shown the passage of several of a series of 24-hour " rain stripes," as it is convenient to call them. One example of this type occurred from June 23rd–25th, 1922, and the Director of the Meteorological Office then suggested that the reason for the daily rain and cloudless nights should be a subject for research.

Another interesting example of this type occurred in August, 1927, and lasted from the 6th to 25th ; in this spell of 20 days the average period of the rain cycle at Kew, taken from the *Hourly Values* at Kew Observatory, which show the rhythm at a glance, was 25·3 hours. The average distance of the depression or depressions was 560 miles ; several centres were concerned.

Consider now the case of a depression remaining stationary near Iceland : then rain recurs in London at intervals of 48 hours, giving that rather common type of weather when alternate days are wet and fine.

One cannot establish a dogma on isolated examples but for interest it is convenient to quote the recent case when a 48 hour series of rain bands lasted for a week and the new Cunarder " Queen Mary " was launched on one of the wet days, with the alternate days brilliantly fine. In this example, as in many others, the synoptic charts on the odd days are alike, and those on the even days are also alike. The " fronts " were rather unusual in this September 22nd–29th series, and the interest is increased because they were almost exactly repeated on alternate days.

The two positions I have mentioned, off Valentia and near Iceland, are two places where we know depressions are wont to halt, perhaps for a week. With depressions in these positions, we in London get daily or bi-daily recurrences of rain, 7 in the first case, $3\frac{1}{2}$ in the second, separated by fine or fair intervals. Has anyone seen " a watery sky for a week without any rain falling " ?

R. M. POULTER.

October 1st, 1934.

The remark in question, like two others to which Col. Gold called attention, occurs in the early part of the book in a section reproduced from Abercromby's original version. At this stage the reader has not been introduced to questions of detail which receive attention in later chapters. The point at issue here indeed is the " failure " of the common prognostic if there is not a normal travel of a normal depression. It is fairly evident that the hypothetical remark, with its mild hyperbole, should not be divorced from its context or read without regard to information given elsewhere in the book and also that a digression into the features of quasi-stationary depressions was scarcely appropriate to this section.

It is also fairly certain that Abercromby was by no means ignorant of the weather features of the southern parts of quasi-stationary low

pressures ; as to the northern and north-eastern sectors, he probably kept an open mind. I agree, however, that a footnote or perhaps a reference to later sections might usefully have been inserted at this point to remove cause for misunderstanding.

A. H. R. GOLDIE.

NOTES AND QUERIES

Dust-Devils

Some months ago the writer was asked by the Librarian of the United States Weather Bureau to send him, if available, some prints of dust-devils, and was surprised to discover that this phenomenon had apparently never been successfully photographed in India.

The personnel of the R.A.F. photographic sections at Quetta (in north Baluchistan) and Peshawar (in the North West Frontier Provinces) were therefore asked to take photographs of dust-devils whenever a suitable opportunity occurred. As a result, some excellent prints have been obtained by Sgt. Heaps of No. 5 (A.C.) Squadron, R.A.F., Quetta. Two of these are reproduced as the frontispiece of this number of the magazine.

The first was taken near Quetta (1·66 Km. above sea-level) at 14h. 40m. (Indian Standard time) on August 10th, 1934. On this day the 8h. (local time) chart showed a low pressure area over north Baluchistan with a moderate barometric gradient. The sky at Quetta was covered with high cloud at first but cleared rapidly in the early morning. During the forenoon cumulus cloud appeared over the surrounding hills. This cloud gradually developed into cumulo-nimbus, and by 17h. (I.S.T.) the sky was half covered—clearing subsequently at night. The surface winds were mainly calm during the morning and early afternoon but strengthened to a gentle breeze from W. by 17h. (I.S.T.). The upper winds at 7h. (I.S.T.) were 3 m/s from 150° at 2 Km. and 9 m/s from 320° at 3 Km. ; the upper winds at 15h. (I.S.T.) were 5 m/s from 260° at 2 Km. and 7 m/s from 250° at 3 Km. Upper air temperature observations made by the R.A.F. at 11h. (I.S.T.) were as follows :—

Height above ground (ft.)	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Dry bulb °F. ...	87	84	77	75	71	66	61	55	52	45	42

The dust-devil, which rotated anti-clockwise, was only a few metres in diameter but extended upwards to an estimated height of 100 metres. Its movement was very erratic.

The second photograph was taken at 15h. 15m. (I.S.T.) on September 6th, 1934. On this occasion the 8h. (local time) chart

showed a low pressure area extending over north Baluchistan, the North West Frontier Provinces, and Punjab with a moderate barometric gradient. Except for a little high cloud in the early morning, the sky was clear all day. The surface winds were light and variable at first, but in the afternoon there was a gentle breeze from the west. The upper winds at 7h. (I.S.T.) were 1 m/s from 210° at 2 Km. and 8 m/s from 300° at 3 Km.; the upper winds at 15h. (I.S.T.) were 10 m/s from 260° at 2 Km. and 6 m/s from 260° at 3 Km. Upper air temperature observations made by the R.A.F. at 11h. were as follows:—

Height above ground (ft.)	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Dry bulb °F. ...	76	71	68	65	61	57	52	47	41	37	33

This dust-devil which also rotated anti-clockwise, was a little smaller in diameter than that on August 10th but extended to a greater height—estimated at 150 metres. It moved in the same direction as the surface wind.

Dust-devils occur very frequently on the barren plains and plateaux of the North West Frontier Provinces and north Baluchistan —especially in the afternoons during the hot weather if the sky has previously been mainly clear. They sometimes extend up to several thousands of feet; and aircraft flying over or through them have occasionally experienced severe "bumps." It is hoped in the near future to obtain a large number of observations and photographs of dust-devils in order to study the development of this phenomenon in detail.

R. G. VERYARD.

Agricultural-Meteorological Conference, 1934

The annual Conference of workers in Agricultural Meteorology for 1934 was held at the Meteorological Office, South Kensington, on Friday, October 5th, 1934. Sir W. Napier Shaw, F.R.S., was in the Chair.

The following papers were read and discussed:—

1. "Further Development of the Growers' Year," by Sir Napier Shaw, F.R.S.
2. "Why Things Grow," by Sir A. D. Hall, K.C.B., F.R.S., Director, John Innes Horticultural Institute and Chief Scientific Adviser to the Ministry of Agriculture and Fisheries.
3. "Evaporation—A Review of Methods and Results," by Mr. E. G. Bilham, B.Sc..(Meteorological Office).

Mr. Bilham's paper was followed by a demonstration of evapori-

meters recently designed by Dr. J. S. Owens and by E. Ashby and T. A. Oxley of the Imperial College of Science.

About 40 persons attended the Conference and a few observers under the Crop-weather scheme of the Ministry of Agriculture attended a short instructional course given by Mr. E. V. Newnham of the Meteorological Office, before the Conference began.

OBITUARY

The Hon. Lady Peek.—We regret to record the death on November 3rd, 1934, of The Hon. Lady Peek who maintained a climatological station at Rousdon, Devonshire from 1886 to 1921. The data, which form a substantial contribution to the climatology of Devonshire were published successively in the *Meteorological Record* of the Royal Meteorological Society, *Daily Readings from Stations of the Second Order* and the *Monthly Weather Report.*

We regret to learn of the death, at Vilno, on October 21st, 1934, of Professor Colonel Stefan Hlasek-Hlasko, late Director of the Polish National Meteorological Institute and formerly, Director of the Observatory of Pavlovsk, Director of the Observatory of Terrestrial Magnetism at Tiflis and Commanding Officer of the Meteorological section of the Army.

We regret to learn of the death, on December 4th, 1934, at the age of 85, of Sir Horace Lamb, F.R.S., Professor of Mathematics at the University of Manchester from 1885–1920.

NEWS IN BRIEF

A Royal Medal has been awarded by the Royal Society to Prof. S. Chapman for his researches in kinetic theory of gases, in terrestrial magnetism and in the phenomena of the upper atmosphere.

Professor W. Meinardus of Göttingen will retire on April 1st, 1935 in order to carry on scientific research.

Erratum

November, 1934, title under the diagram facing p. 239 *should* read " Luminous night clouds, July 2nd, 1934."

The Weather of November, 1934

Pressure was above normal over Mexico, eastern Canada, eastern United States and across Bermuda and the North Atlantic to Iceland, southern Scandinavia, France, central and southern Europe, central and southern Russia and western Siberia, the greatest excesses being 10.4 mb. at Ekaterinburg, and 8.4 mb. at 50° N, 70° W. Pressure was

below normal in western Canada, western and central United States, the Azores, Spain, north coast of Africa, Spitsbergen, northern Scandinavia and northern Russia, the greatest deficits being 4.3 mb. at Spitsbergen and 4.1 mb. at Pt. Barrow (Alaska). Temperature and rainfall were generally above normal in Spitsbergen and Scandinavia but below normal in central and south-west Europe. In Götaland (Sweden) rainfall was however deficient.

The chief features of the weather of November over the British Isles were the wintry conditions prevailing early in the month, the general deficiency of sun except in north Scotland, the deficiency of rain and the widespread fog. From the 1st to 8th the British Isles was under the influence of a complex low pressure system and unsettled conditions prevailed generally. Showers of snow, sleet or hail occurred in many places on the 1st, 2nd and 3rd with severe frost at night, —13° F. was the grass minimum at S. Farnborough on the 1st, at Dumfries on the 2nd and 11° F. at Dalwhinnie on the 3rd—but there were many long bright intervals. From the 4th to 8th however the weather became mainly dull with cold northerly winds and some rain in the south and local wintry showers in the north. The mist or fog prevailing in the northern Midlands early in the month became general in the south as well after about the 4th. On the 8th a depression advanced from the North Atlantic and remained centred over south England for the next 2 or 3 days. Heavy rain occurred generally in the south; 2·25 in. fell at Appledore (Kent) and Heathfield (Sussex) on the 8th and 1·22 in. at Banstead (Surrey) on the 9th, but in the north and west the falls were slight. Strong winds reaching gale force locally were experienced at times at exposed places. On the 12th–14th another depression moved across Ireland and south-west England giving slight to moderate rain locally in Ireland and England while mist or fog was experienced generally in England and south Scotland. At Renfrew fog persisted for 4 days from the 12th–15th being densest on the 12th and 15th, when the temperature did not rise above 31° F. all day. From the 14th to 17th pressure was low over France and a ridge of high pressure extended across Scotland connecting the anticyclones over the North Atlantic and Russia. Weather was mainly cloudy or dull with some rain locally and much mist or fog except in north Scotland and parts of Ireland where it was mainly fair. There was little diurnal variation of temperature in the south at this time, only 1° F. at Croydon on the 16th, though frost occurred in the north and west. After the 17th the high pressure area gradually moved south and from the 19th to 27th pressure was high to the south and low to the north of the British Isles. Much mist or fog prevailed in England especially the London area from the 19th to 22nd with temperature well below normal in the foggy districts, but elsewhere the weather was mild and cloudy with some rain and bright intervals. Weymouth had 7·9 hours bright sunshine on the 19th and Ross-on-Wye 7·4 hours

on the 22nd. From then until the 27th the weather was mainly mild and dull with local mist and fog though there were a few bright intervals especially in northern England. Gales occurred frequently in the extreme north of Scotland from the 24th to 28th but ceased as the high pressure area extended northwards to Iceland on the 28th to 30th. On the 30th a depression was approaching from the Atlantic giving S to SW winds strong to a gale in the western districts in the evening. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	52	+ 7	Liverpool ...	43	−20
Aberdeen ...	66	+ 6	Ross-on-Wye ...	26	−40
Dublin	44	−26	Falmouth ...	56	−23
Birr Castle ...	41	−20	Gorleston ...	51	−19
Valentia... ...	53	−11	Kew	38	−15

Miscellaneous notes on weather abroad culled from various sources.

Snow fell in abundance on the Alps about the 8th and the majority of the passes were closed to vehicles. Following the recent gales and heavy rain unusually high tides flooded the square of St. Mark at Venice and the lower quarters of the city where temporary bridges have been erected (*The Times*, November 9th–10th).

During a storm in the Kwango region of the Belgian Congo a herd of buffaloes was struck by lightning 30 of them being killed. Sixty-six Africans who were crowded in a hut were killed by lightning on the 17th at Clarkesbury, Cape Province (*The Times*, November 8th–19th).

Seven hundred fishermen of Korea were reported to be missing following a storm which struck them while fishing off Kanyo about the 11th. A typhoon which passed across the Philippines about the 14th or 15th resulted in many deaths and much destruction of property. Mauban was buried under 9 ft. of water. Another typhoon struck the Philippines on the 29th cutting off communications between 7 of the central islands and Manila. In Leyte the wind is said to have reached 125 m.p.h. Eighteen people were killed and much material damage was done. The storm was far to the south of Manila (*The Times*, November 12th–December 3rd).

The heavy rain and floods in South Australia on the 5th helped diminish the grasshopper plague there. A tornado swept across the western half of Victoria on the 7th, damaging houses, crops and orchards in some parts and causing disastrous floods, but elsewhere the rain ensured plenty of summer feed. Thirty-six lives were lost by lightning and drowning and £100,000 worth of damage done to railways, bridges and crops etc. by the gales and floods near Melbourne and in Gippsland (Victoria) at the end of the month. Rains measuring $\frac{1}{4}$ to $1\frac{3}{4}$ in. fell in many districts of New South Wales near the end of the month (*The Times*, November 6th–December 4th).

A severe gale occurred in the Gulf of St. Lawrence at the beginning of the month. Fourteen people were killed owing to the flooding of the streets of San Francisco and Los Angeles by a storm passing along the Pacific coast about the 19th. Temperature was above normal in the western and central United States but variable in the eastern States early in the month becoming above normal later while the rainfall was irregular (*The Times*, November 3rd–20th and *Washington D.C., U.S. Dept. Agric. Weekly Weather and Crop Bulletin*).

Daily Readings at Kew Observatory, November, 1934

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	Remarks. (see p. 1).
	mb.		°F.	°F.	%	in.	hrs.	
1	1016·8	W.3	29	45	60	0·01	6·3	x early, r_0 18h.–19h.
2	1016·8	W.3	35	45	56	trace	4·8	r_0 9h., m 18h.
3	1017·0	SSW.4	38	54	56	—	7·2	
4	1005·1	E.2	43	44	87	0·06	0·0	fr_0r 11h.–19h.
5	1003·3	N.2	39	46	79	trace	0·0	r_0 20h.–22h.
6	1001·8	NNE.4	43	47	73	0·02	0·0	r_0 5h.–9h. & 15h.
7	1008·8	N.2	36	45	71	—	1·8	x 21h.
8	1008·0	SW.3	31	47	86	0·12	0·0	r_0r 11h.–24h.
9	989·3	SSE.3	45	51	93	0·56	0·0	r_0r 0h.–8h. & 19h.–24h.
10	987·5	SE.3	45	48	87	0·57	0·1	r_0r 0h.–9h. & 14h.–19h.
11	1002·7	NNE.3	44	50	79	trace	0·4	m 9h.–12h., pr_0 15h.
12	1001·6	NW.2	41	49	70	—	2·3	f early, F night.
13	993·7	ESE.2	32	48	77	0·01	2·9	F till 9h., r_0 3h. & 8h.
14	1001·6	NNE.3	40	47	89	0·22	0·0	rr_0 17h.–21h., f or m.
15	1009·1	E.3	45	50	76	0·07	0·3	rr_0 3h.–6h. & 23h.–24h.
16	1013·5	E.2	45	47	85	0·04	0·0	rr_0 0h.–9h., f or m.
17	1016·2	N.3	45	47	83	trace	0·0	d_0 15h.
18	1025·9	NNE.3	44	49	80	0·01	0·0	r_0 3h.–5h., f 21h.
19	1028·2	SW.1	36	40	98	trace	0·0	F all day.
20	1028·7	WSW.1	34	43	93	trace	0·0	F or f all day.
21	1032·6	WSW.1	33	41	95	trace	0·0	F all day.
22	1033·4	SW.2	41	51	71	—	3·7	f till 10h. 30m.
23	1030·5	WSW.2	36	49	87	trace	0·9	r_0 3h.–8h., f 7h.
24	1034·5	SW.1	47	51	99	0·01	0·0	r_0 9h.–12h., f 7h.–18h.
25	1038·0	S.2	48	50	89	—	0·0	f till 12h.
26	1032·5	W.3	48	52	66	—	3·1	
27	1034·0	W.2	48	56	70	—	4·2	f about 9h.
28	1033·7	N.1	50	52	82	0·02	0·0	fd_0, 15h.–24h.
29	1033·3	S.1	48	49	92	0·03	0·0	fm all day, r_0 0h.–9h.
30	1032·3	SE.3	47	49	68	—	0·0	f till 8h.
*	1017·0		41	48	80	1·76	1·3	* Means or totals.

General Rainfall for November, 1934

England and Wales ...	75	per cent of the average 1881–1915.
Scotland	49	
Ireland	46	
British Isles	62	

Rainfall : November, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.....	1·85	78	*Leics* .	Thornton Reservoir ...	2·44	108
Sur .	Reigate, Wray Pk. Rd..	3·17	102	,, .	Belvoir Castle.....	2·09	94
Kent .	Tenterden, Ashenden...	2·73	90	*Rut* .	Ridlington	2·19	95
,, .	Folkestone, Boro. San.	2·30	...	*Lincs* .	Boston, Skirbeck.....	1·97	99
,, .	Eden'bdg., Falconhurst	4·07	115	,, .	Cranwell Aerodrome...	1·73	93
,, .	Sevenoaks, Speldhurst.	2·72	...	,, .	Skegness, Marine Gdns.	1·48	69
Sus .	Compton, Compton Ho.	3·66	96	,, .	Louth, Westgate.....	2·33	90
,, .	Patching Farm.....	5·10	143	,, .	Brigg, Wrawby St.....	2·03	...
,, .	Eastbourne, Wil. Sq....	4·47	128	*Notts* .	Worksop, Hodsock.....	2·18	111
,, .	Heathfield, Barklye....	4·67	126	*Derby*.	Derby, L. M. & S. Rly.	2·03	94
Hants.	Ventnor, Roy.Nat.Hos.	4·44	138	,, .	Buxton, Terr. Slopes...	2·00	43
,, .	Fordingbridge, Oaklnds	2·42	71	*Ches* .	Runcorn, Weston Pt....	1·98	71
,, .	Ovington Rectory.....	...	...	*Lancs*.	Manchester, Whit. Pk.	1·39	53
,, .	Sherborne St. John.....	1·88	66	,, .	Stonyhurst College.....	2·25	50
Herts .	Welwyn Garden City ...	2·03	85	,, .	Southport, Bedford Pk.	2·60	83
Bucks.	Slough, Upton.....	2·08	94	,, .	Lancaster, Greg Obsy.	1·46	37
,, .	H. Wycombe, Flackwell	1·85	72	*Yorks*.	Wath-upon-Dearne.....	1·91	94
Oxf .	Oxford, Mag. College...	1·57	71	,, .	Wakefield,Clarence Pk.	2·12	100
Nor .	Pitsford, Sedgebrook...	1·74	79	,, .	Oughtershaw Hall.....	2·99	...
,, .	Oundle	1·47	...	,, .	Wetherby, Ribston H..	2·25	96
Beds .	Woburn, Exptl. Farm...	1·94	87	,, .	Hull, Pearson Park.....	2·04	93
Cam .	Cambridge, Bot. Gdns.	2·06	107	,, .	Holme-on-Spalding.....	1·80	83
Essex.	Chelmsford, County Lab	1·52	68	,, .	West Witton, Ivy Ho.	2·17	63
,, .	Lexden Hill House.....	1·52	...	,, .	Felixkirk, Mt. St. John.	2·18	89
Suff .	Haughley House.....	1·56	...	,, .	York, Museum Gdns....	1·68	80
,, .	Campsea Ashe.....	1·75	79	,, .	Pickering, Hungate.....	1·96	79
,, .	Lowestoft Sec. School...	1·45	62	,, .	Scarborough.....	2·91	118
,, .	Bury St. Ed., WestleyH.	1·20	52	,, .	Middlesbrough.....	2·05	97
Norf. .	Wells, Holkham Hall...	1·73	80	,, .	Baldersdale, Hury Res.	1·80	49
Wilts .	Calne, Castleway.....	1·58	58	*Durh* .	Ushaw College.....	2·98	117
,, .	Porton, W.D. Exp'l. Stn	1·67	64	*Nor* .	Newcastle, Town Moor.	2·97	123
Dor .	Evershot, Melbury Ho.	2·22	52	,, .	Bellingham, Highgreen	2·08	61
,, .	Weymouth, Westham.	2·14	69	,, .	Lilburn Tower Gdns....	4·09	122
,, .	Shaftesbury,Abbey Ho.	2·05	63	*Cumb*.	Carlisle, Scaleby Hall...	·50	17
Devon.	Plymouth, The Hoe....	1·46	40	,, .	Borrowdale, Seathwaite	5·00	39
,, .	Holne, Church Pk. Cott.	3·23	50	,, .	Borrowdale, Moraine...	2·40	23
,, .	Teignmouth, Den Gdns.	2·24	72	,, .	Keswick, High Hill.....	1·38	24
,, .	Cullompton	1·47	43	*West* .	Appleby, Castle Bank...	·74	22
,, .	Sidmouth, U.D.C.....	1·43	...	*Mon* .	Abergavenny, Larchf'd	2·04	53
,, .	Barnstaple, N. Dev.Ath	2·80	71	*Glam* .	Ystalyfera, Wern Ho....	2·13	32
,, .	Dartm'r,Cranmere Pool	3·30	...	,, .	Cardiff, Ely P. Stn.....	1·72	41
,, .	Okehampton, Uplands.	2·54	48	,, .	Treherbert, Tynywaun.	3·77	...
Corn .	Redruth, Trewirgie.....	2·67	55	*Carm* .	Carmarthen, Priory St..	...	...
,, .	Penzance, Morrab Gdn.	2·91	64	*Pemb* .	Haverfordwest, School.	...	...
,, .	St. Austell, Trevarna...	2·08	42	*Card* .	Aberystwyth	1·87	...
Soms .	Chewton Mendip.....	1·92	45	*Rad* .	BirmW.W.Tyrmynydd	2·39	36
,, .	Long Ashton.....	1·32	42	*Mont* .	Lake Vyrnwy	2·74	49
,, .	Street, Millfield.....	1·16	42	*Flint* .	Sealand Aerodrome.....	2·55	107
Glos .	Blockley	1·93	...	*Mer* .	Dolgelley, Bontddu.....	2·11	34
,, .	Cirencester, Gwynfa....	1·51	51	*Carn* .	Llandudno	1·65	57
Here .	Ross, Birchlea.....	2·13	84	,, .	Snowdon, L. Llydaw 9..	5·57	...
Salop.	Church Stretton.....	2·75	93	*Ang* .	Holyhead, Salt Island...	2·75	66
,, .	Shifnal, Hatton Grange	2·33	97	,, .	Lligwy	2·72	...
Staffs .	Market Drayt'n, Old Sp.	2·31	88	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	1·42	62		Douglas, Boro' Cem....	2·83	59
War .	Alcester, Ragley Hall...	1·82	79	*Guernsey*			
,, .	Birminghm, Edgbaston	2·07	87		St. PeterP't.Grange Rd.	5·34	127

Rainfall: November, 1934: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	2·00	46	*Suth* .	Melvich.....	2·59	65
„ .	New Luce School.....	2·19	43	„ .	Loch More, Achfary....	5·79	68
Kirk .	Dalry, Glendarroch.....	1·19	20	*Caith* .	Wick.....	2·01	64
„ .	Carsphairn, Shiel.....	2·02	26	*Ork* .	Deerness	2·66	68
Dumf.	Dumfries, Crichton, R.I.	·59	17	*Shet* .	Lerwick	3·03	71
„ .	Eskdalemuir Obs.....	2·26	39	*Cork* .	Caheragh Rectory.....	3·62	...
Roxb .	Branxholm.....	1·76	48	„ .	Dunmanway Rectory...	3·00	48
Selk .	Ettrick Manse.....	2·38	44	„ .	Cork, University Coll...	1·33	33
Peeb .	West Linton.....	2·66	...	„ .	Ballinacurra.....	1·26	31
Berw .	Marchmont House.....	2·91	97	„ .	Mallow, Longueville....	1·87	50
E.Lot .	North Berwick Res.....	2·07	92	*Kerry.*	Valentia Obsy.....	3·76	69
Midl .	Edinburgh, Roy. Obs..	·93	42	„ .	Gearhameen.....	4·90	51
Lan .	Auchtyfardle	1·21	...	„ .	Darrynane Abbey.....	3·76	74
Ayr .	Kilmarnock, Kay Pk....	1·13	...	*Wat* .	Waterford, Gortmore...	1·24	34
„ .	Girvan, Pinmore.....	1·36	26	*Tip* .	Nenagh, Cas. Lough....	1·79	45
Renf .	Glasgow, Queen's Pk....	1·05	28	„ .	Roscrea, Timoney Park	1·36	...
„ .	Greenock, Prospect H..	2·70	42	„ .	Cashel, Ballinamona....	1·04	30
Bute .	Rothesay, Ardencraig...	2·09	...	*Lim* .	Foynes, Coolnanes.....	2·17	54
„ .	Dougarie Lodge.....	1·79	...	„ .	Castleconnel Rec.....	2·70	...
Arg .	Ardgour House.....	4·65	...	*Clare* .	Inagh, Mount Callan....	4·01	...
„ .	Glen Etive.....	...	...	„ .	Broadford, Hurdlest'n.	1·93	...
„ .	Oban.....	1·98	...	*Wexf* .	Gorey, Courtown Ho...	2·17	62
„ .	Poltalloch.....	2·13	38	*Wick* .	Rathnew, Clonmannon.	4·90	...
„ .	Inveraray Castle.....	3·20	38	*Carl* .	Hacketstown Rectory...	1·96	50
„ .	Islay, Eallabus.....	2·57	48	*Leix* .	Blandsfort House.....	1·41	42
„ .	Mull, Benmore.....	...	...	„ .	Mountmellick	1·30	...
„ .	Tiree.....	1·67	35	*Offaly.*	Birr Castle.....	1·34	43
Kinr .	Loch Leven Sluice.....	...	...	*Dublin*	Dublin, FitzWm. Sq....	1·90	71
Perth .	Loch Dhu.....	1·75	20	„ .	Balbriggan, Ardgillan...	1·76	61
„ .	Balquhidder, Stronvar.	2·10	...	*Meath.*	Beauparc, St. Cloud....	1·23	...
„ .	Crieff, Strathearn Hyd.	·74	17	„ .	Kells, Headfort.....	1·21	36
„ .	Blair Castle Gardens....	·29	8	*W.M* .	Moate, Coolatore.....	1·60	...
Angus.	Kettins School.....	·71	23	„ .	Mullingar, Belvedere...	1·45	43
„ .	Pearsie House.....	·82	...	*Long* .	Castle Forbes Gdns.....	1·55	43
„ .	Montrose, Sunnyside...	1·23	46	*Gal* .	Galway, Grammar Sch.	·88	...
Aber .	Braemar, Bank.....	1·52	40	„ .	Ballynahinch Castle....	4·01	67
„ .	Logie Coldstone Sch....	2·33	76	„ .	Ahascragh, Clonbrock.	1·61	40
„ .	Aberdeen, King's Coll..	2·42	82	*Mayo.*	Blacksod Point.....	3·54	68
„ .	Fyvie Castle.....	3·29	95	„ .	Mallaranny	4·02	...
Moray	Gordon Castle.....	1·73	60	„ .	Westport House.....	2·32	47
„ .	Grantown-on-Spey	...	...	„ .	Delphi Lodge.....	6·39	61
Nairn.	Nairn	·76	32	*Sligo* .	Markree Obsy.....	1·82	43
Inv's .	Ben Alder Lodge.....	·62	...	*Cavan.*	Crossdoney, Kevit Cas..	1·34	...
„ .	Kingussie, The Birches.	1·13	...	*Ferm* .	Enniskillen, Portora....	·91	...
„ .	Inverness, Culduthel R.	1·13	...	*Arm* .	Armagh Obsy.....	·69	24
„ .	Loch Quoich, Loan.....	...	...	*Down.*	Fofanny Reservoir.....	2·66	...
„ .	Glenquoich.....	6·42	53	„ .	Seaforde	1·82	48
„ .	Arisaig, Faire-na-Sguir.	2·65	...	„ .	Donaghadee, C. Stn.	·98	32
„ .	Fort William, Glasdrum	2·88	...	„ .	Banbridge, Milltown....	·85	31
„ .	Skye, Dunvegan.....	5·86	...	*Antr* .	Belfast, Cavehill Rd.....	1·30	...
„ .	Barra, Skallary.....	2·76	...	„ .	Aldergrove Aerodrome.	·70	22
R&C .	Alness, Ardross Castle.	1·79	45	„ .	Ballymena, Harryville.	1·64	40
„ .	Ullapool	3·21	60	*Lon* .	Garvagh, Moneydig....	1·39	...
„ .	Achnashellach	4·67	51	„ .	Londonderry, Creggan.	1·51	37
„ .	Stornoway	2·35	40	*Tyr* .	Omagh, Edenfel.....	1·45	38
Suth .	Lairg.....	1·72	43	*Don* .	Malin Head.....	1·51	...
„ .	Tongue	2·89	63	„ .	Killybegs, Rockmount.	2·64	...

Climatological Table for the British Empire, June, 1934

STATIONS.	PRESSURE.		TEMPERATURE.							Relative Humidity.	PRECIPITATION.				BRIGHT SUNSHINE.	
			Absolute.		Mean Values.				Mean.		Mean Cloud Am'nt	Am'nt.	Diff. from Normal.	Days.	Hours per day.	Percentage of possible.
	Mean of Day M.S.L.	Diff. from Normal.	Max.	Min.	Max.	Min.	½ Max. and Min.	Diff. from Normal.	Wet Bulb.							
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1017·7	+ 1·0	84	46	70·5	52·3	61·4	+ 2·2	53·2	76	7·2	1·00	− 1·15	8	6·83	41
Gibraltar	1015·8	− 1·5	91	57	81·1	63·1	72·1	+ 1·6	62·0	80	3·8	0·00	− 0·54	0	...	...
Malta	1015·0	− 0·2	94	65	79·5	68·4	73·9	+ 1·2	67·1	71	4·0	0·02	− 0·07	1	10·92	75
St. Helena	1014·5	− 0·4	69	55	64·6	58·3	61·5	+ 1·0	59·2	94	7·5	2·39	...	13	...	...
Freetown, Sierra Leone	1012·7	+ 0·7	89	64	86·7	72·3	79·5	− 0·8	77·1	90	8·2	17·95	− 2·09	26	...	...
Lagos, Nigeria	1012·1	− 0·3	89	72	85·7	75·4	80·5	+ 1·0	76·0	87	8·4	15·68	− 2·80	19	5·1	41
Kaduna, Nigeria	1008·6	...	91	66	87·3	68·8	78·1	+ 1·6	72·5	83	6·8	8·70	+ 1·61	14	7·5	59
Zomba, Nyasaland	1014·6	− 2·9	79	50	72·2	57·0	64·6	+ 1·7	60·5	81	7·2	1·14	+ 0·66	10	...	...
Salisbury, Rhodesia	1021·3	0·0	76	40	69·0	47·2	58·1	+ 1·2	51·5	67	4·1	0·28	+ 0·23	8	6·5	59
Cape Town	1020·8	+ 0·7	85	41	70·3	50·5	60·4	+ 4·7	50·8	87	3·8	1·79	− 2·71	5	...	...
Johannesburg	1024·7	+ 2·4	65	36	60·7	42·0	51·3	+ 0·6	43·2	63	1·5	0·14	0·00	1	8·2	78
Mauritius	1019·4	+ 0·4	77	58	74·7	63·3	69·0	− 0·4	65·5	73	4·7	3·09	+ 0·29	23	7·6	70
Calcutta, Alipore Obsy.	1000·9	+ 1·2	101	73	92·1	79·5	85·8	+ 0·7	80·7	87	7·8	7·69	− 4·22	9*	...	...
Bombay	1003·8	− 0·2	93	75	88·9	78·1	83·5	− 0·5	78·5	84	7·7	28·45	+ 8·58	20*	...	...
Madras	1003·9	+ 0·1	108	73	97·4	80·3	88·9	− 1·1	76·1	65	8·0	1·76	− 0·21	5*	...	...
Colombo, Ceylon	1009·4	+ 0·8	87	73	84·5	76·4	80·5	− 1·1	77·2	83	8·5	18·22	+ 10·90	21	3·4	27
Singapore†	1009·0	+ 0·1	89	71	86·3	75·6	80·9	− 0·6	78·0	82	8·1	8·39	+ 1·52	13	6·2	51
Hongkong	1008·2	+ 2·4	91	74	86·0	77·1	81·5	+ 0·1	78·1	82	8·6	25·11	+ 9·41	26	4·7	35
Sandakan	1009·8	...	92	71	88·6	74·4	81·5	− 0·2	77·0	86	7·0	8·59	+ 1·09	22	...	...
Sydney, N.S.W.	1020·3	+ 2·4	67	43	61·6	47·4	54·5	− 0·2	48·8	81	6·2	4·12	− 0·62	14	5·2	53
Melbourne	1022·0	+ 3·5	65	33	56·2	39·8	48·0	− 2·4	43·5	86	6·1	1·73	− 0·33	13	4·2	44
Adelaide	1021·0	+ 1·9	69	39	63·3	47·2	55·3	+ 1·8	48·7	68	6·6	1·03	− 2·07	11	4·1	42
Perth, W. Australia	1019·1	+ 1·1	73	41	63·9	48·9	56·4	− 0·4	50·6	73	5·3	11·41	+ 4·47	15	5·2	52
Coolgardie	1019·3	+ 0·4	71	37	60·8	44·2	52·5	− 0·3	48·4	76	5·8	1·19	− 0·07	9	...	...
Brisbane	1019·7	+ 1·4	76	40	68·6	47·6	58·1	− 2·1	51·8	70	2·8	0·76	− 2·03	4	7·6	73
Hobart, Tasmania	1022·0	+ 7·7	55	31	51·1	39·0	45·1	− 1·9	40·1	79	6·8	1·04	− 1·19	12	4·0	44
Wellington, N.Z.	1015·7	+ 0·8	57	35	51·7	42·6	47·1	− 2·4	45·1	85	6·9	4·81	+ 0·04	20	3·3	36
Suva, Fiji	1014·2	+ 0·6	88	64	79·9	70·7	75·3	+ 0·6	71·8	85	7·7	3·20	− 3·51	19	3·3	30
Apia, Samoa	1011·3	− 0·3	88	69	85·4	73·0	79·2	+ 1·4	75·6	79	4·1	1·64	− 3·71	8	...	...
Kingston, Jamaica	1013·6	− 0·2	92	69	88·1	74·1	81·1	− 0·2	72·6	73	5·1	0·61	− 3·49	6	6·5	49
Grenada, W.I.	1010·1	− 3·2	88	70	85	72	78·5	− 0·5	73·0	74	7	11·98	+ 3·73	23	...	...
Toronto	1011·3	− 3·4	94	49	78·9	56·8	67·9	+ 4·1	59·2	67	4·1	2·75	+ 0·09	7	9·8	64
Winnipeg	1011·6	− 0·2	90	38	71·5	50·7	61·1	− 1·2	51·9	80	6·2	4·15	+ 1·04	14	7·6	47
St. John, N.B.	1011·3	− 2·2	78	39	64·3	47·8	56·1	− 0·4	51·4	78	7·3	4·57	+ 1·30	15	6·5	42
Victoria, B.C.	1016·2	− 0·6	72	47	65·6	50·1	57·9	− 0·9	53·8	75	3·7	0·21	− 0·63	4	12·0	75

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

(23666) Wt. 25/32 1,000 12/34 Hw. G 377/6