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Measuring the Flow of Rivers

Ere rivers league against the land

In piracy of flood,

Ye know what waters slip and stand

Where seldom water stood,

Yet who will note,

Till fields afloat,

And washen carcass and the returning well,

Trumpet what these poor heralds strove to tell! (*Kipling.*)

These lines, which Dr. H. R. Mill prefaced to the 1907 volume of 'British Rainfall', might have served as an inspiration to the British Association's Inland Water Survey Committee, whose efforts have now resulted in the setting up of an Inland Water Survey, under the auspices of the Ministry of Health. The driving force which caused the British Association to move in the matter came from Capt. W. N. McClean, who subsequently became Secretary of the British Association's Committee, of which Vice-Admiral Sir H. P. Douglas is Chairman and Lt.-Col. E. Gold, Vice-Chairman. For some years Capt. McClean has devoted himself with great enthusiasm and success to the measurement of river-flow. His work on the rivers draining into Loch Ness is well known to hydrologists. More recently he has worked on the River Dee (Aberdeenshire) and we now have his records for that river in the form of a portfolio containing data and charts of levels, flow and rainfall, published at the price of 10s. 6d.*

* River Dee (Aberdeenshire). The records of water level, rainfall and run-off for the year 1934 by Capt. W. N. McClean (late R.E.), M.A.

It is not inappropriate that we should take notice of this work in the *Meteorological Magazine*. The amount of water flowing across a particular section of a river is an expression of the integrated result of a number of factors, partly geographical, partly geological and partly meteorological. Everyone knows that the water in the river represents the running-off of the rainfall which has occurred at some previous period over the area drained by the river, an area commonly referred to as the catchment area. It is also well known that the run-off in a period of say 12 months is very much below the figure obtained by integrating the rainfall over the catchment area. The loss is mainly due to evaporation, but is also partly due to seepage or percolation of water down to low-lying strata which do not drain into the river. For example, part of the loss in the Thames catchment area goes to replenish the deep-seated supplies which can be tapped below London by driving wells through the clay into the chalk.

The various factors cannot be readily disentangled. It is impossible, for example, to give a reliable estimate of the loss due purely to evaporation. We have measurements of evaporation from tanks, such as that at Camden Square, but if we compare such a record of evaporation for a series of years with a record of losses we find that the two do not run parallel. Evaporation from a tank is greatest in dry years, but the losses in a catchment area are greatest in wet years. The explanation of this fact is not far to seek, but we need not turn aside to consider it now. The important point is that if one really wants to know how much water runs off a given catchment area there is only one satisfactory method of obtaining the information, and that is to measure the flow of the streams draining the area.

Various methods of recording stream-flow are in use and descriptions of them are to be found in text-books. Only one method is regarded, however, as entirely satisfactory. In this method, which is that employed by Capt. McClean, two sets of data are involved. The first is a continuous record of the water level at one or more suitable gauge points. The second is a series of flow-meter readings for the purpose of determining the rate of flow corresponding to any given value of the water level. The recording of river levels is a comparatively simple operation; the real difficulty lies in the accurate determination of the flow and it is to this part of the problem that Capt. McClean has made important contributions. The method of procedure is fully described in a paper entitled "Practical River-Flow Measurement and its place in Inland Water Survey, as exemplified on the Ness (Scotland) Basin", read before the Institution of Water Engineers, December 1st, 1933. Briefly, the gauging of a stream for a particular value of the level involves the determination of the velocity of flow at a sufficient number of points on the selected cross section of the stream to permit of the total flow across the section being calculated by integration. The readings must be taken at various points across the stream from

bank to bank, and at various depths. When the calculation has been made we have the value of the flow corresponding to one particular value of the water level; that is to say, we have one point on the "stage-discharge curve". The whole operation must be repeated for different levels from very low water up to high flood levels. The complete stage-discharge curve can then be drawn. Fortunately, it is found that in ordinary circumstances the river bed does not change its characteristics appreciably over long periods. Consequently the stage-discharge curve may be assumed to hold good for some years at least after its determination. Readings of level can thus be converted to flow by simple reference to the stage-discharge curve. The flow, which is usually expressed in "cusecs" (cubic feet per second), may, of course, readily be converted into millions of gallons per day, or depth in inches over the whole catchment area. The latter form of expression is the most useful for comparison with the rainfall.

From the meteorological point of view the relation of the run-off to the rainfall is naturally the most interesting part of Capt. McClean's work. For the determination of this relationship it is necessary to evaluate the general rainfall over the whole catchment area. The evaluations have been made from the formula

$$R_G = \sum (n/100 \times p/100 \times R)$$

where R is the rainfall measured by a particular gauge, regarded as representing n per cent. of the area, and p is the annual average general rainfall expressed as a percentage of the annual average for the particular gauge. Ten rain-gauges are available in the area, which has an average annual general rainfall of 42 in. The formula can obviously only give an approximation to the true general rainfall when a short period such as a day or a week is in question, but it is probably accurate enough for practical purposes.

The results for the year 1934 show that the rainfall exceeded the net run-off by 9.0 in. In the Thames basin the annual average loss is about 18 in. Although the rainfall of the Dee basin exceeds that of the Thames basin by no more than 50 per cent., it appears that a square mile of the Dee basin yields nearly four times as much surface run-off as a square mile of the Thames basin under normal conditions. This result serves to impress on our minds the vital importance of accurate determinations of run-off if we are ever to possess reliable data in regard to the surface-water supplies of this country.

E. G. BILHAM.

The Influence of the North Sea on Cold Easterly Winds

The effect of the North Sea as a tempering influence on the cold east winds from the continent in winter and the warm east winds in summer is well known. An example of the former case which

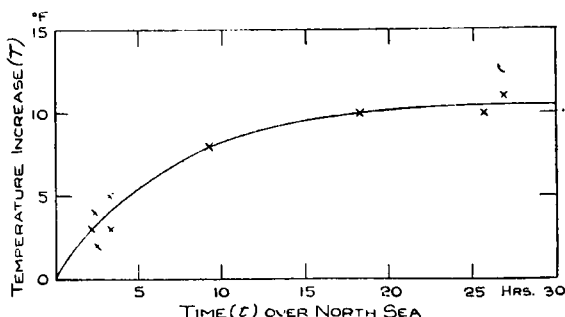
occurred on March 9th, 1935, is sufficiently well marked to be put on record.

The cold easterly current set in on March 8th and was firmly established by 7h. G.M.T. on March 9th, when the temperatures at coastal stations on the east coast, given in column (2), were recorded.

Station.	Temperature at 7h. on March 9th.	Increase of temperature in crossing North Sea.	Length of air-track across North Sea.	Geo- strophic wind.	Time over North Sea.
	° F.	° F.	miles.	m.p.h.	hours.
Aberdeen ...	40	10	410	16	25.6
Leuchars ...	38	11	430	16	26.8
Tynemouth ...	37	10	400	22	18.2
Spurn Head ...	35	8	240	26	9.2
Yarmouth ...	33	3	120	36	3.3
Felixstowe ...	33	4	120	50	2.4
Shoeburyness...	32	5	130	40	3.25
Manston ...	30	3	90	40	2.25
Lympne ...	29	2	100	40	2.5

The length of the air track across the North Sea from coast to coast was measured and also the geostrophic wind at the different stations. The temperatures at stations on the coasts of Holland, Germany and Denmark which bordered on the North Sea were next examined. They varied irregularly between 27° and 30° F., but by taking the approximate temperature corresponding to the point where the easterly current left the shores of the continent, the increase in temperature of the current in passing over the North Sea to the stations given in column (1) was deduced. The values are set out in column (3).

The increase in temperature of the easterly current between the latitudes of Manston or Lympne in south-east England and the Scottish stations, is well marked, and on a first examination would appear to be proportional to the length of track over the North Sea. A glance at the geostrophic winds, however, indicates that a similar, but inverse, relation holds for the wind strength. In other words, the increase in temperature of the air current in crossing the North Sea is a function of both the length of track and of the speed of the current; i.e., a function of the time taken (column 6) to cross the North Sea. A



curve showing the relation between the increase of temperature (T) and the time (t) over the North Sea is given in the diagram. The curve indicates that at $t = 0$, i.e., assuming the east coasts of England and Scotland were joined to the neighbouring coastline of the continent, there would have been no increase of temperature. For values of t greater than about 25 hours the curve appears as if it might become asymptotic to the line $T = 11$; i.e., the maximum increase of temperature in crossing the sea is of the order of 11° F. This means that, taking an average figure of 29° F. for the temperature of the air current entering the North Sea from the east, the temperature will not rise appreciably above 40° F. in its further passage westwards. Now it would be expected that an air current would eventually take up the temperature of the sea over which it was travelling, provided the track was of sufficient duration. The figure of 40° F. is in good agreement with the average temperature of the surface water of the North Sea in March. The curve also indicates that it took approximately 24 hours of sea track for the air temperature to rise to this figure. Owing to lack of surface wind observations on the North Sea, however, the geostrophic wind, i.e., the wind at 1-2,000 ft. as deduced from the surface pressure gradient, was used in constructing column (6) of the table. Assuming the surface wind to be one-half of the geostrophic wind, a duration of approximately 48 hours sea track is required for the temperature of the air current to rise to its maximum, viz., the sea temperature.

A similar distribution of temperature to that noted in the table, though not always so pronounced each day, occurred along the east coasts of England and Scotland throughout the cold spell from March 8th to 11th, 1935.

W. H. BIGG.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, April 17th, at 49, Cromwell Road, South Kensington, Lt.-Col. E. Gold, D.S.O., F.R.S., President, in the Chair.

The following papers were read and discussed:—

W. F. Tyler.—Bracing and relaxing climates.

Mr. Tyler considered the question of whether the cause of bracing and relaxing conditions can be ascertained. The conclusion arrived at was that while relative humidity was the only ordinary meteorological factor that might control those conditions and though doubtless it was frequently an important factor, yet on the average its effect was entirely swamped by one or more climatic stimuli of which we had no knowledge. In effect, the conclusion came to was that the problem of what bracing and relaxing conditions depend on was at present insoluble.

In connexion with the subject a curious climatic phenomenon at Shanghai—for which no reason could be found—was described. On days occurring perhaps once in six weeks, Chinese pedestrians

in the fast motor traffic of the Nanking Road are so lethargic that they saunter across it looking neither to the right nor left, quite oblivious to the risk of doing so. At similar intervals—not necessarily alternate ones—the opposite occurs. Men dash across dodging cars; boys often double back like rabbits; women put their heads down and blindly flutter over; and rickshawmen race along at extra speed swerving to the right and left in an ecstasy of vigour. These two conditions do not merge into the normal; they are sharply marked. The only known approach to this behaviour in the West is the occasional collective wild orgy of skilful recklessness shown by the Paris taxi-drivers.

Lt.-Col. E. Gold, D.S.O., F.R.S.—The effect of wind, temperature, humidity and sunshine on the loss of heat from a body at a temperature, 98° F.

(a) Diagrams are given showing isopleths of cooling power of the air in millicalories per cm.² per second for winds up to 30 m.p.h., and for temperatures from 0° to 90° F. for (i) a “dry” body at 98° F.; (ii) a “wet” body at 98° F.—(1) for dry air, (2) for saturated air; (iii) a “wet” body at 98° F. for wet-bulb temperatures from 0° to 90° F. They are based on the formulæ given by Sir Leonard Hill.

(b) The cooling power of the air at Croydon has been computed for each day of the year 1934 both for a dry body and for a wet body and a frequency table is given showing the number of days in each month with different degrees of cooling power. In an exposed situation there is little difference on the average between the cooling power by day and by night.

(c) The effect of reducing the wind to values similar to those ordinarily experienced in unexposed places has been examined for typical months. It is found that this smoothes the differences and reduces the mean values of cooling power by about one-third.

(d) The effect on cooling power in the daytime of solar and sky radiation is computed: in a warm summer month the gain of heat in the middle of the day exceeds the loss of heat by a body at 98° F. in a situation when the wind is only 1/4 of that recorded at Croydon at 100 ft. above the ground. The effect of loss of heat by outward radiation to sky and earth at night is shown to be generally insignificant compared with the losses due to convection and radiation to the surroundings at the temperature of the air.

(e) The relation between cooling power and the terms hot, warm, cold, is examined and a scale suggested which agrees with a scale independently proposed by Conrad. From this scale a scheme of terms appropriate to different conditions of temperature, wind, and cloud is obtained.

A. E. M. Geddes, D.Sc.—Temperature trend at Aberdeen from 1870–1932.

Temperature records at Aberdeen during the period 1870–1932

have been examined to test whether they show evidence of a change of climate in the north-east area of Scotland during the period mentioned. The first method adopted in the investigation is that of moving 20-year summations of temperature. This method was first applied to the whole year. The results seem to indicate a tendency, however, less marked at the end of the period.

To test the effect in the seasons, the year was divided into four, the winter season commencing with December. From the charts exhibited one might conclude that from near the end of last century the climate has become milder in winter and spring, has remained unchanged in summer, while in the autumn it has become colder. One finds from the examination of the months, that spells of warm seasons and warm months have occurred, but that these spells have not occurred simultaneously in all seasons nor in all months of the same season. Milder winters have been experienced during the last half of the 63-year period. There appears to be no evidence however, that the change is progressive, nor any guarantee that it will continue. The cause of the milder winters cannot be attributed to the increase in the number of houses, nor to the increase of fuel consumption in the neighbourhood. It may be found in a more persistent south-westerly air current during the winter months.

Correspondence

To the Editor, *Meteorological Magazine*

Rain in advance of true "Warm-front" Rain

A note by Col. Gold on this subject appeared in the November, 1934, number of this magazine. A similar occurrence was observed at Aldergrove on Friday, December 14th.

A very deep depression, centred about 600 miles west of Ireland at 7h., was moving eastwards. A few spots of rain fell at Aldergrove between 11h. 40m. and 11h. 45m., G.M.T. but were not recorded by the rain-gauge. There was then a short interval without any precipitation until about 12h. 10m. when, after a few minutes of heavy rain, there was continuous rain until about 12h. 50m., after which slight rain continued until about 13h. 30m. A further interval with no rain then followed and the appearance of the sky definitely improved. At about 14h. 25m. rain commenced again and continued up to 18h.

The sequence of events noted above is very similar to the case described by Col. Gold. In the present case, however, the wind veered from ESE. at 12h. 10m. to SSE. by 12h. 20m. and then backed again to ESE. by 13h. The speed also increased sharply from about 12 m.p.h. to 18 m.p.h. at the commencement of the veer, subsequently decreasing gradually to about 10 m.p.h. by 12h. 45m., after which there was an increase to an average of about 20 m.p.h. during the afternoon. These changes suggest that the rain may in

this case have been due to some form of discontinuity.

A special pilot balloon ascent was made at 10h. 40m. The results are given below.

<i>Height</i> <i>ft.</i>	<i>Upward.</i> <i>ft. min.</i>	<i>Direction</i> <i>from N.</i>	<i>Speed</i> <i>m.p.h.</i>	
(525)	—	137	18	
1050	+50	153	29	
1560	+10	160	30	
2060	0	167	31	
2580	+20	171	36	
{ 3140	+60	171	41	} Swinging Tail ?
{ 3470	—170	172	31	
3940	—30	171	42	
4440	0	166	46	
4980	+40	167	50	
5450	—30	164	41	

Balloon lost in cloud.

Though there are no outstanding features the changes in direction are of the same nature as those occurring at the surface later.

D. DEWAR.

R.A.F., Aldergrove, Co. Antrim, December 17th, 1934.

(At 13h. on December 14th, there was a slight but distinct warm front, roughly on a line from Aldergrove to Calshot. The main front was 150 miles to the rear and was occluded as far south as Scilly. The slight rain ahead of the first warm front had reached Croydon and Sealand by 13h., while the rain from the main front had not yet reached Pembroke or Portland Bill. The first front only gave very slight rain at most places.—C. K. M. DOUGLAS.)

Frequency of Calms in Winter

In the *Meteorological Magazine* for February, 1935, Mr. Donald L. Champion invited information as to the above subject.

The observer at Grayshott, on the Surrey border, has kindly placed the records at my disposal and I have found the monthly percentage frequency of calms at the observation hour (9h.) for the ten years 1925–34. The investigation was limited to this period to make the results comparable with Mr. Champion's. No mention was made of smoothing in his note, so I have plotted results directly as obtained. Both Waltham Cross and Grayshott curves are shown in the diagram. No smoothness was evident from the latter—in fact, I doubt whether I am justified in presenting the data as a continuous curve. Both, however, have their maxima in December; and the Waltham Cross minimum in June has its analogy at Grayshott, but here the curve is very irregular and a lower minimum occurs in April.

It has been the custom of the observer at Grayshott to make every month an arithmetical mean of the Beaufort numbers recorded each day. Though valueless quantitatively, the mean gives a rough idea

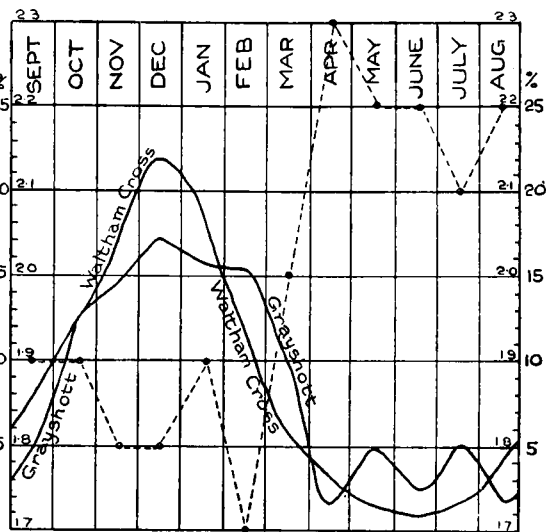
of whether a month was quiet or windy generally. These mean Beaufort numbers have been plotted as a dotted line on the same graph. There is a rough inverse relationship with the percentage frequency of calms. From this we can assume with some safety that, for instance, the December minimum shows that it is generally a quiet month, rather than one in which conditions rapidly alternated from stormy to dead calm and back to stormy.

Grayshott is 661 ft. above M.S.L. I should think its climate is quite different from

Waltham Cross, and this fact may cause the difference between the two curves of frequency of calms. I consider also that ten years is far too short a period of time to employ. The smoothness of Mr. Champion's curve may be largely fortuitous. Furthermore, at Grayshott, eight years out of the ten gave zero days of calm in April. I cannot believe that this is a regular occurrence.

S. E. ASHMORE.

14, Villa Road, Handsworth, Birmingham, 19, March 12th, 1935.



MEAN FREQUENCY.

Winter. Summer. Year.

	%	%	%
Grayshott ...	14.1	1.7	8.8
Waltham Cross	14.4	3.4	8.9

Small figures inside the ordinates indicate means of Beaufort numbers of wind speed.

Brilliant Refraction Phenomenon in Unusual Circumstances

A particularly brilliant refraction phenomenon was observed at this station at 15h. 30m. on January 29th, 1935. Bright orange colouring was first noticed on the side nearest the sun of an isolated fragment of comparatively low cloud moving with the general northerly drift and at the same altitude as the sun. In a short time the whole of the cloud fragment became a brilliant glowing patch of light, like a "luminous ball of cotton wool". The diameter of the roughly circular cloud fragment was approximately three times that of the sun, and the brightness became so intense that it caused temporary blindness similar to that experienced after looking directly at the sun itself. The brilliant phase was quite transient and soon began to fade gradually as the cloud moved toward the sun; at one or more phases of the phenomenon a greenish blue tint was also seen

but unfortunately we are not in entire agreement as to the exact stages when this tint was observed. It was, however, less pronounced than the orange colouring. Within a short while the luminosity had faded and the cloud structure was again visible for a time before the cloud finally dispersed. It should be mentioned that the azimuth bearing of the luminous cloud was 23° north of the sun. At the time of the display the cloud fragment was in an almost blue sky although the front edge of a sheet of stratocumulus was approaching from the north at a height of 6,000 ft.

A further point of interest was a report from Flight Lieut. G. H. Stainforth, A.F.C., that he had produced "aeroplane" cloud at 5,500 ft. (temperature at this height about -8°C.) during the afternoon, and that he had seen the "mock sun" effect on this fragment of cloud soon after he had produced it. The appearance of the halo phenomenon establishes the fact that the artificially produced cloud was composed of ice crystals.

Whether the unusual brilliance was due purely to the halo effect or whether some of the luminosity was due also to an added "mock sun" effect is not obvious; the fact that the whole of the cloud fragment was equally brilliant and the band of orange colouring also prominent are rather against the "mock sun" effect and one is tempted to suggest that the restricted vertical thickness of the artificial cloud was a contributory factor.

F. H. DIGHT.

R.A.E., South Farnborough, Hants, February 12th, 1935.

Nocturnal Cooling and the Prediction of Night Minimum Temperatures

In view of Col. Gold's note in the *Meteorological Magazine* for May, 1934, suggesting further investigation into the subject of nocturnal cooling, begun at Larkhill* similar data have been extracted for the station at Abbotsinch, Renfrewshire.

Table I is based on observations for 8 months from September 1st, 1933, to April 30th, 1934, and varies in the same way as those for Larkhill, Ismailia and Catterick.† The short period for which data have been extracted is due to the fact that the station at Abbotsinch has only been open since February, 1933, and an anemometer record was only available from June, 1933; there is however, sufficient material to show that the formula found by plotting $(T-M)$ against $(T-D)$, as suggested by Col. Gold, is similar to those already published. The formula found to apply to Abbotsinch is:—

$$(T-M) = 0.4 (T-D) + 0.35 T - 4.5$$

It is not surprising to see a variation in the constants when the geographical position of the various stations is considered; whereas Larkhill is situated on comparatively high ground, the land round Abbotsinch is very flat for about 2 to 3 miles in all directions with

* See *Meteorological Magazine* 69, 1934, p. 61.

† *Ibid.*, 69, 1934, p. 230.

hills rising rather abruptly to 800 to 1,200 ft. about 4 miles distant both to north and south.

TABLE I.—MEAN DIFFERENCE BETWEEN 16H. TEMPERATURE AND MINIMUM SCREEN TEMPERATURE, ON CLEAR OR PARTLY CLEAR NIGHTS WHEN THE MEAN WIND SPEED WAS LESS THAN 10 M.P.H. AT ABBOTSINCH, SEPTEMBER 1ST, 1933 TO APRIL 30TH, 1934.

Temperature at 16h.	35-44° F.	45-54° F.	55-64° F.	65-74° F.
Relative Humidity 16h.	Temperature Difference (T-M) ° F.			
90-100 per cent	10	—	—	—
80-89 per cent	11	12	18	—
70-79 per cent	13	16	20	—
60-69 per cent	15	17	21	22
50-59 per cent	16	21	23	—
40-49 per cent	—	—	—	—
30-39 per cent	—	—	25	—

R. T. ANDREWS.

R.A.F., Abbotsinch, Paisley, November 29th, 1934.

Sun Pillar seen from Salisbury Plain

A very distinct and noteworthy sun pillar was observed on Salisbury Plain at sunset between 18h. 30m. and 19h. on Saturday, March 30th, 1935. The sun was just below the horizon and the clouds in the immediate vicinity of the setting sun appeared to be a small amount of cirrostratus down on the horizon and some altocumulus at a rather higher altitude. The vertical pillar reached to a height which subtended an angle of about 8° to 10°. It was red in colour but brighter and lighter than the colour of the actual sunset.

A similar but much less marked pillar was also observed on the following evening, Sunday, March 31st, 1935.

C. W. LAMB.

R. A. F., Boscombe Down, Amesbury, Wilts. April 2nd, 1935.

[A sun pillar was also observed by Mr. H. W. L. Absalom from Wallington, Surrey, on the evening of March 31st, 1935—Ed. M.M.]

Temperature at Falmouth

For some years there had been an impression on my mind that the maximum temperature at Falmouth during the summer months was higher than is given in the *Book of Normals*. It is stated there, on p. 84, that at Falmouth the readings refer to a louvred screen on a north wall.

A set of *Reports of the Royal Cornwall Polytechnic Society* was given to me and from them were extracted the monthly mean maxima and minima for the 20 years 1893 to 1912 as taken by

thermometers in the north wall screen and in a Stevenson screen. Averages from the two screens were computed with the following results.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Maximum Temperatures												
North wall ..	47.0	47.1	49.2	53.1	57.9	62.7	66.4	65.6	62.2	56.5	51.4	49.3
Stevenson Screen ..	47.5	47.7	50.0	53.9	58.8	63.4	67.3	66.6	63.6	57.6	52.1	49.8
Deviation of North wall from Stevenson Screen ..	-0.5	-0.6	-0.8	-0.8	-0.9	-0.7	-0.9	-1.0	-1.4	-1.1	-0.7	-0.5
Minimum Temperatures												
North wall ..	40.3	39.8	40.4	43.3	47.1	52.1	55.5	55.3	52.8	48.3	44.0	42.7
Stevenson Screen ..	39.6	39.1	39.9	42.8	46.7	51.9	55.3	55.1	52.7	48.3	43.5	41.9
Deviation of North wall from Stevenson Screen ..	+0.7	+0.7	+0.5	+0.5	+0.4	+0.2	+0.2	+0.2	+0.1	0	+0.5	+0.8

The greatest deviation in the maximum is seen to be in September with 1.4° and in the minimum in December with 0.8°.

The north wall screen was dismantled in 1913.

C. C. VIGURS.

Marcus Hill, Newquay, Cornwall.

Abnormal Behaviour of a Pressure Tube Anemometer

The pressure tube anemometer, fully described in the *Meteorological Office Observer's Handbook*, records the wind velocity as measured by the movement of a float due to the difference in pressure between a "pressure pipe" open to the direct force of the wind and a "suction pipe" in which the pressure is reduced by the wind blowing past a number of small holes. The pressure and suction sides each contribute to the total effect and when either side is cut out and the bottom of the appropriate pipe opened directly to the surrounding air by means of the tap provided the recorded velocity is reduced. The following behaviour, recently observed, was therefore rather mystifying.

During a period of light winds, about 4 m.p.h., the suction pipe was opened to the room and instead of the recorded velocity decreasing there was a marked increase of some 3 m.p.h. When, on the other hand, the pressure side was cut out and the suction side alone in action the reading fell rapidly to zero. Broadly speaking the pressure pipe alone gave a reading of 7 m.p.h., both pipes together 4 m.p.h., and the suction pipe alone registered a flat calm. The immediate and obvious inference, that for some reason the suction pipe was behaving as a pressure pipe, was however not

substantiated by any apparent defect and it was some time before the true explanation presented itself. It has been mentioned that either side is cut out by opening the float to the air in the room while the tube leading to the anemometer head is closed. If, therefore, the air in the room is at a lower pressure than that outside, the suction effect will appear weak and the pressure effect strong; if the pressure in the room is even less than that in the suction pipe this side will appear to have a negative effect, opening it to the room will cause an increase in the reading. That this was the correct interpretation was easily demonstrated by the opening of the door or window of the room when, the pressure within and without being equalized, the instrument was found to work normally.

The only cause which can be suggested to account for the smaller pressure within the room is the forced outflow of air caused by an open fire; there has so far been no opportunity of making a test in the room without fires and it will be interesting to see whether the cause has been rightly inferred. The necessary pressure is only a small fraction of a millibar, for the total pressure difference in a wind of 5 m.p.h. is only about $\cdot 04$ mb.; at higher velocities the effect of the same pressure differences rapidly becomes negligible. It is, of course, important to note that the effect is only to give an apparent failure of the suction side as, when both pressure and suction sides are in action, the working of the instrument is independent of the pressure within the room.

R. C. SUTCLIFFE.

R.A.F., Felixstowe, February 13th, 1935.

Cloud Formation at Sealand

During the late afternoon of Monday, March 11th, 1935, a very interesting example of cloud formation was witnessed at Sealand, near Chester.

An isolated band of cirrus appeared to the east at 17h. 30m. and proceeded to extend towards the west. This westerly development continued until 17h. 40m. when the band extended from an elevation of 22° to 84° . During the time the first band of cirrus was extending to the west two further bands appeared, one on each side of the original and at an angular distance of 20° from it.

A most interesting phase now occurred as, although the front parts of these three bands remained almost stationary, the eastern ends dissolved with the result that the western ends seemed to absorb the remainder of the bands until at 17h. 50m. three isolated patches in an almost clear sky were all that remained. The cirrus was particularly dense and white in appearance, and while the northerly edge of all three bands was quite smooth, the southerly edge was rough and tufted. The cirrus movement was 9 rad./h. from 90° .

G. R. READ.

Roker, Station Road, Gt. Saughall, nr. Chester, March 12th, 1935.

Fog at Anacapri

Fog is very unusual here. In fact the long distance lighthouse on the south-west corner of this island of Capri is not, as far as I know, provided with any fog signalling apparatus.

But on Thursday last, April 11th, towards sunset, a thick tide of fog lying close on the water was seen to be advancing from the south-west. During the whole of the night the fog covered the sea and lay there until it was dispersed by the sun about midday on the 12th. Throughout the whole time it was close down on the water.

I suppose that the fog cannot have been more than 100 ft. deep. Above was warm air and a perfectly clear sky which followed on a clear and warm day (exceptionally warm for this year, which has been distinguished here by the length of the winter and unusual cold). It struck me that, as the fog lay so very close on the water it might be due to some cold water which had been thrown up from depths by some submarine earthquake.

The usual thing which happens to us here at the early part of the spring is cold winds coming down from a northerly and north-easterly direction off the snows on the mountains of the mainland.

M. RAWNSLEY.

Dil-Aram, Anacapri, Italy, April 15th, 1935.

Unusually Bright Tangential Arc.

Attention was drawn by Mr. Goodyear this morning to an unusually large and bright tangential arc (46°). The colours were equal in brilliance to the brightest rainbow. Elevation of arc was approximately 65° , and the extremities subtended an angle of over 80° at the ground.

The arc persisted from 9h. 0m., when first seen, to about 9h. 10m., when it faded rapidly. No other halo phenomenon was seen. The appearance of the sky at the time was chaotic with clouds mostly high and medium at various heights. Thin altostratus could be seen passing in front of the arc, as evidenced by watery streaks against the bright colours.

J. C. CUMMING.

Meteorological Station, R.A.F., Upper Heyford, Oxford, March 5th, 1935.

NOTES AND QUERIES

Rainfall at Cranmere Pool, Dartmoor

Everyone who has had occasion to study rainfall statistics closely is aware of the fact that our data are apt to be least complete for the areas of greatest interest, namely, the moors and uplands where rainfall is heavy and where many streams and rivers have their birth-place. Such areas are very sparsely inhabited and it is a matter of considerable difficulty to obtain even monthly readings of a rain-

gauge. One such area about which we possessed, until recently, little information is the northern part of Dartmoor. In 1930, information was received from Mr. H. P. Cornish, of Keswick, that two residents of Okehampton—Mr. E. P. Burd and Mr. R. Harry—would be prepared to read monthly rain-gauges set up in this area. Shortly afterwards two gauges of the new "Octapent" pattern were installed at Newbridge (1,500 ft.) and Cranmere Pool (1,845 ft.) about 3 miles and 6 miles respectively, south of Okehampton.

Initially, the Newbridge gauge was read by Mr. Burd, but he was obliged to relinquish the task in September, 1933, and since that date both gauges have been read by Mr. Harry. We were aware from the outset that a monthly visit to Cranmere Pool, in particular, was an undertaking that called for real enthusiasm. In the belief that the observer's experience would be of interest to readers of this magazine, I invited Mr. Harry to contribute the note printed below and I am glad to take this opportunity of acknowledging our indebtedness to him, and to Mr. Burd also, for their services in extending our knowledge of the rainfall of this interesting region.

It may be added that the readings show that the rainfall at Cranmere Pool is a little less than at Princetown Prison, some 8 miles further south. The highest monthly total so far recorded is 22.9 in. at Cranmere Pool in December, 1934.

E. G. BILHAM.

"Is this all that there is to see?" is perhaps the most usual remark made by those who visit Cranmere Pool for the first time. Pool, there is none; though probably there was one there once before the peat washings from the surrounding bogs half filled it and the erosion of the winter storms cut a channel through the banks on the north side. And yet this weird and lonely hollow, 1,850 ft. above sea level, concealed in the great central morass of Dartmoor is a rendezvous for thousands every year from all parts of Devon. Tucked in a hole on the west side is a zinc box containing a visitors' book. The last book was filled in sixteen months and contained over 4,000 names. Postcards and letters are also left to be taken away and posted the next day, the writer once posted 140 letters and cards at one time. Besides being an objective point, it is almost equidistant from Princetown, Lydford, Okehampton and Chagford; its charm lies, I believe, in its remoteness from civilization—four miles from a house and seven from a town, or village, and also the difficulty for a stranger even when equipped with a map and compass in finding it. There is an entire absence of adjacent landmarks to guide one and the ground around is a bewildering maze of hummocks, ridges, gullies and fissures, covering the great beds of peat in places as much as 8 ft. deep. A few years ago a gauge was placed at the Pool and has been visited once every month. A second journey had to be made once as the water in the gauge had frozen solid. Whilst the seven-mile journey—five of which from Okehampton can be done by car—is in

summer a pleasant journey, winter time is a different story. Contrary to general belief, fog is very rare and has never caused any trouble, but snow blocking the road with drifts and filling all the gullies and pits is a much worse enemy. Two years ago the car had to be dug out of a drift in which it stuck, and this year being unable for the drifts to take it more than half-way the rest of the journey was made on foot. The snow was thawing rapidly and the ground underneath waterlogged; more than one gully was slipped into waist deep, not nice when filled with ice cold water, but eventually the Pool was reached, the gauge read and the homeward journey made in safety. When the gauge was first placed at the Pool it was often interfered with by thoughtless persons, but the provision of a lock and its removal to a short distance away did much to reduce this. The Pool is popularly supposed to be haunted by the ghost of a former Mayor of Okehampton—Benjamin Gayer (“Bengie” for short)—who was banished to this lonely place by the local clergy with “candle bell and book” for returning to this mortal world to trouble his widow who had consoled herself with a second husband.

S. R. HARRY.

REVIEWS

India Meteorological Department, Scientific Notes, Vol. V, No. 56.

A Preliminary Study of a Tornado at Peshawar. By Flt.-Lieut.

R. G. Veryard, B.Sc., R.A.F.

This interesting paper describes a tornado which passed close to the meteorological station at Peshawar on April 5th, 1933. A very full description is given of the meteorological conditions during April 4th and 5th, and the account is accompanied by very fine photographs of the tornado taken at five-minute intervals. This tornado ploughed up a furrow 90 feet wide and 1 foot deep for $1\frac{1}{2}$ miles but did little damage beyond tearing up some crops.

The aerological situation is described in great detail based on upper air temperature observations made by the R.A.F. at Risalpur 30 miles east of Peshawar and on pilot balloon observations at Peshawar, Quetta, Lahore and Karachi. The tornado occurred close to the tip of the warm sector of a depression passing eastwards across North-West India and three different air masses were in the vicinity of Peshawar at the time it occurred. These air masses were (1) warm moist air in the warm sector moving from south-west, (2) cold dry air moving from north-west, and (3) cool dry air moving from between south-east and north-east. The warm moist air was in an unstable state with a lapse rate of temperature exceeding the saturated adiabatic and approaching the dry adiabatic lapse. The cold air surface is assumed to have taken the form described by Giblett of an overhanging wedge extending in front of the surface cold front. As described by Wegener there is a tendency for the formation of a vortex about a horizontal axis along the overhanging wedge while the violent convection produced in the unstable warm

air by the underrunning cold air leads to the formation of vortices about vertical axes. Both these effects are considered to have played a part in the production of the tornado. The cool dry air in front of the depression appears to have been moving towards Peshawar from the north-east or north and the author considers this to have played an essential part. His reason for this does not seem quite clear. Tornadoes do not occur exclusively at the tip of warm sectors with three different air masses in close proximity but also occur along straightforward cold fronts and even under cumulonimbus unassociated with any front.

The paper is accompanied by numerous diagrams in addition to the tornado photographs. These diagrams give maps of the tornado track, isobaric charts, charts of upper winds, pilot balloon trajectories and height curves, reproductions of the autographic records at Peshawar of pressure, temperature, wind and rainfall, and height-temperature and tephigrams of the Risalpur upper air temperature observations.

G. A. BULL.

General Astronomy by H. Spencer Jones, M.A., Sc.D., F.R.S., Astronomer Royal, 2nd edition, Size $8\frac{1}{2}$ in. \times $5\frac{1}{2}$ in., pp. viii + 437. *Illus.*, London, E. Arnold & Co., 1934, 12s. 6d. net.

Dr. Spencer Jones published the first edition of his well-known text-book in 1922. Since that date the science has made notable strides, especially in the realm of astrophysics. The second edition has been thoroughly revised and contains much additional matter.

The work is essentially a text-book and provides a well-balanced summary of modern astronomy and astrophysics. It is not intended as a popular account of the more spectacular aspects of the science but Dr. Spencer Jones has the gift of lucid exposition and the book is suitable for the general reader as well as for those desirous of beginning a serious study of the subject. With the exception of occasional formulæ the book is non-mathematical in character. It is well-produced and is illustrated with many clear diagrams and reproductions of astronomical photographs.

E. W. BARLOW.

Radio round the World. By A. W. Haslett. Size $7\frac{1}{2}$ in. by 5 in., pp. vii + 196. *Illus.* Cambridge University Press, 1934, 5s.

This is a really excellent little book for the general reader. Mr. Haslett has a wide knowledge of his subject, both in its theoretical basis and in the problems of practical application, and he has also the ability to set out his knowledge in a lucid and non-technical way. After a brief prelude on waves in general, he proceeds with an historical account of the work of Maxwell, Hertz and Marconi. The latter introduces the problem of long-distance transmission and an account is given of the "mirrors" in the upper atmosphere—the Kennelly-Heaviside and Appleton layers.

Although "popular" in the sense that no mathematical symbols appear and technical jargon is successfully avoided, this section is very thorough and should be read by meteorologists with interest. The present reviewer certainly both profited by it and enjoyed it.

Chapter IV, entitled "Up in the Sky", and Chapter V, "The sun calls the tune", carry the story further, describing the diurnal and seasonal changes in the height of the reflecting layers and the influence of the eleven year sunspot cycle and other solar changes on the propagation of wireless waves. The book is sufficiently up-to-date to include an account of the work carried out by the British party at Tromsø during the Polar Year of 1932-3, but the discussion of the nature of corpuscular radiation from the sun might have been fuller and clearer.

The remaining chapters deal with applied radio, including probable future uses of ultra-short and micro waves (shorter than 1 metre). To illustrate the relation between X-rays, light rays, etc. and wireless waves the old analogy of octaves on the electro-magnetic piano is adopted but the diagram is not very helpful and could have been made clearer. The description of the properties and uses of ultra-short and micro waves is good. There are interesting chapters on Television, Radio and Medicine, Radio and Safety at Sea, and Radio in War, and the book concludes with a short account of "Radio and the Weather Forecaster". The description of the international exchange of weather information is far too sketchy even for a popular book (it occupies only $1\frac{1}{2}$ pages), but the account of the location of thunderstorms and cold fronts by direction finding on atmosphericics is fuller.

References to authorities are few—the name of Watson Watt for example is not once quoted in spite of frequent mention of the cathode-ray oscillograph—but that is not a serious fault in a book of this kind. The author does what he sets out to do, and it is likely that his readers, next time they tune-in to a broadcast programme, will spare a thought for the romance and invention behind the knobs.

BOOKS RECEIVED

- Jaarboek, Koninklijk Nederlandsch Meteorologisch Instituut*, 1932.
A. Meteorologie, B. Aard-Magnetisme (Nos. 97 and 98), Utrecht, 1933.
- Ergebnisse Aerologischer Beobachtungen*, 1932. K. Ned. Meteor. Inst. (No. 106A), Utrecht, 1933.

The Weather of April, 1935

Pressure was above normal over Alaska, most of Canada, Greenland, Iceland, Spitsbergen, the extreme north of Europe, and over southern Europe and the Mediterranean, the greatest excesses being 8.8 mb.

at Spitsbergen, and 4.9 mb. in central Canada, while pressure was below normal over the United States, south-east Canada, the North Atlantic, western, central and eastern Europe, and western Asia, the greatest deficits being 8.0 mb. at Bornholm, and 4.7 mb. at 50° N., 30° W., and near Reno (Nevada, U.S.A.). Temperature was above normal at Spitsbergen, most of Scandinavia and at Kew; but was below normal in Portugal and in central Europe. Rainfall was generally in excess especially in Norrland and western Svealand where in some parts it was more than three times the normal.

The dominant feature of the weather of April over the British Isles was the excess of rainfall except in the Hebrides and parts of Ireland. Sunshine was generally deficient in Scotland and south-east England, but variable elsewhere. From the 1st to the 5th with high pressure on the Atlantic and low pressure on the continent, the British Isles came under the influence of north-west to north winds, which reached gale force at times in the extreme north; bright periods with snow, sleet, hail or rain occurred generally over the whole country. The 1st was a warm day, but the weather got colder after that and a maximum of 37° F. was reported from Aberdeen and 39° F. from Cambridge on the 4th. From the 6th to the 23rd complex low pressure systems with alternate ridges of comparatively high pressures passed across the country coming gradually further south and unsettled weather with rain generally ensued. Gales occurred at times at exposed places, especially on the 10th and thunderstorms were experienced locally, especially between the 20th and 23rd. Between the passage of depressions, however, bright intervals with good sunshine amounts were enjoyed, particularly so on the 6th, 11th and 12th, in Scotland on the 19th, east England on the 23rd, and at isolated places on other days, 13.0 hrs. were measured at Tiree on the 19th, 12.8 hrs. at Clacton on the 23rd, and 12.5 hrs. at Oban on the 12th. During this period rainfall was frequently moderate to heavy, 2.03 in. were registered at Trecastle (Brecon) on the 8th, 1.95 in. at Treherbert (Glamorgan) on the 9th, 1.94 in. at Denshaw (Yorkshire) on the 23rd, and 1.56 in. at Fofanny (Co. Down) on the 19th. Temperature was mainly about or above the normal, maxima of 60° F. being reported occasionally, while 63° F. occurred at Greenwich on the 20th and 65° F. at Cranwell and Camden Square (London) on the 23rd, but frosts were experienced on many nights, especially on the nights of the 6th-7th, 11th-12th, and 12th-13th; 17° F. was recorded at Rhayader on the 12th and Durham on the 13th. Mist or fog occurred in the south-east and east on the 13th-15th and inland on the 20th. On the 23rd the low pressure system gave way to an anticyclone over the Atlantic which moved north and east and remained covering the British Isles for the rest of the month. Quiet variable conditions prevailed generally with cool northerly winds and much cloud and some drizzle, especially in the east—in the west conditions were finer and sunnier, though some sunny days were also experienced in the east. Tiree had 14.5 hrs.

bright sunshine on the 25th and Mallarany 13·6 hrs. on the 27th. Thunderstorms occurred locally on the 23rd and 24th and slight mist or fog was frequent. Temperature was variable during this time but reached 60° F. at some places on most days; 66° F. was recorded at Waterford on the 27th and 65° F. at Markree Castle on the 26th and Valentia on the 27th. The distribution of bright sunshine for the month was as follows:—

		Diff. from				Diff. from	
		Total	normal			Total	normal
		(hrs.)	(hrs.)			(hrs.)	(hrs.)
Stornoway	...	137	—20	Liverpool	...	172	+13
Aberdeen	...	107	—44	Ross-on-Wye	...	142	— 5
Dublin	...	145	—17	Falmouth	...	149	—39
Birr Castle	...	157	+ 3	Gorleston	...	136	—34
Valentia...	...	164	+ 5	Kew	...	113	—36

Miscellaneous notes on weather abroad culled from various sources.

Severe frosts occurred in the Bordeaux area on the 3rd and 4th and severe frosts also damaged the vines over a large area round Santarem, Portugal, about the 7th. Heavy rains caused a landslide near Ober-Audorf, Upper Bavaria, on the night of the 22nd–23rd, and a big landslide caused by the thaw and heavy rain also occurred in the valley of Abondance, Haute Savoie, on the 24th, the main road to Abondance being blocked by mud in spite of protective works. Snow fell in many parts of France on the 24th. Navigation reopened at Vasa (Finland) on the 10th, at Riga on the 25th, and Levisa (Finland) on the 26th. (*The Times*, April 8th–27th.)

A dense duststorm occurred in the Baghdad area on March 30th. A typhoon swept across the Philippine Islands on the 7th, killing 70 people on Luzon Island and 33 on Samar Island, and doing extensive damage. (*The Times*, April 1st–12th.)

At the beginning of the month rain fell in the northern pastoral districts of South Australia, in parts of which it is reported that no rain has fallen for 12 years. (*The Times*, April 3rd.)

The Newfoundland train service was paralysed for about a week at the beginning of the month by snowstorms; in some places the snow was 14 ft. deep on the line. Tornadoes were experienced in Louisiana, Mississippi and Alabama on the night of the 6th and on the 7th, causing the death of 26 people and injuring about 200 others. Snow fell on the 7th in Missouri and parts of Iowa, Illinois and Kansas and was followed by low temperatures. Gales occurred on the North Atlantic seaboard and over the North Atlantic on the 7th, 8th and 9th. Duststorms were continuing in Oklahoma, Kansas and parts of Colorado, Texas and Nebraska during the middle of the month, while rain had broken the drought in the Dakotas and parts of Nebraska, Colorado and Wyoming. Snow fell over a wide area stretching from New York to Cleveland (Ohio) and Charleston (Virginia) on the 16th, while 11° of frost were recorded at the Niagara Falls. Heavy rain and snow broke the drought over a large part

of the north and middle-west about the 26th, but duststorms were again experienced at the end of the month. During the first three weeks of the month temperatures were mainly below normal except in the Gulf States early in the month and in the Mountain Region and Pacific coast about the middle of the month, while rainfall was generally irregular in distribution and slight, though some heavier falls occurred in the east early in the month. (*The Times*, April 8th-May 3rd, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*.)

Daily Readings at Kew Observatory, April, 1935

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp.		Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
			Min.	Max.				
	mb.		°F	°F	%	in.	hrs.	
1	1012.8	NW.4	47	52	46	0.03	3.8	r ₀ -r 21h.-24h.
2	1015.1	NNW.5	38	48	46	0.04	5.7	pr 15h. ; pr ₀ 18h.
3	1017.2	N.4	35	44	69	0.02	6.8	ph ₀ rs ₀ s ₀ 12h.-16h.
4	1005.6	NNW.3	35	45	71	0.11	0.0	prs ₀ 7h. ; r 14h.-17h.
5	1006.2	WNW.3	32	46	62	0.03	6.8	prs 12h. & 15h.
6	1009.5	W.4	33	51	42	0.01	9.5	r 23h.-24h.
7	1003.5	WNW.3	42	55	54	0.54	2.6	r 0h.-6h. & 15h.-24h.
8	1005.8	NW.3	42	52	90	0.45	4.6	Rrs 12h.-13h.
9	1002.7	SW.5	45	57	81	0.10	0.0	rr ₀ 0h.-2h. & 8h.-11h.
10	999.3	SW.6	52	57	65	0.20	1.7	rr ₀ 0h.-9h. & 21h.-
11	1007.5	WSW.5	49	57	46	0.09	7.8	pr 10h. [23h.
12	1004.3	NE.3	38	53	56	—	2.0	x early.
13	1015.1	SSE.3	34	52	53	0.14	5.3	f 7h. ; r 19h.-22h.
14	1006.2	W.2	41	53	65	0.04	3.7	r 14h.-15h.
15	1012.0	SW.2	37	57	65	0.06	3.1	F 7h. ; r 21h.-24h.
16	996.7	WSW.4	46	52	65	0.26	5.1	r 0h.-5b. ; pr 13h.
17	994.3	W.3	40	54	51	0.06	8.4	rr ₀ 1h.-3h. & 9h.
18	1004.6	W.3	44	56	51	0.07	4.6	rr ₀ 15h.-19h. & 24h.
19	1008.0	SW.4	49	58	73	0.09	2.7	rr ₀ 0h.-3h.
20	1002.6	S.2	48	58	80	0.04	1.3	pr 14h.
21	1000.6	S.4	47	58	61	—	5.2	
22	1006.5	SSW.4	45	57	63	0.01	3.8	pr 11h.
23	1014.5	N.2	39	61	57	—	4.8	f 0h.-10h.
24	1021.0	NE.4	44	54	77	—	3.6	w early.
25	1018.3	N.3	40	49	69	0.29	0.0	r-r ₀ 13h.-19h.
26	1019.4	NNE.4	46	53	72	—	5.0	
27	1024.0	NNE.4	44	49	78	—	0.0	
28	1027.9	NE.3	44	51	70	—	0.1	
29	1026.3	WSW.2	44	61	70	—	4.0	w early.
30	1021.0	SSW.1	43	61	70	—	0.8	f w early.
<hr/>								
*	1010.3		42	54	64	2.69	3.8	* Means or totals.

General Rainfall for April, 1935.

England and Wales	...	186	} per cent. of the average 1881-1915.
Scotland	...	144	
Ireland	...	116	
British Isles	...	162	

Rainfall : April, 1935 : England and Wales

Co.	STATION.	In.	Per cent of Av.	Co.	STATION.	In.	Per cent of Av.
<i>Lond.</i>	Camden Square.....	3·09	200	<i>Leics.</i>	Thornton Reservoir ...	3·57	210
<i>Sur.</i>	Reigate, Wray Pk. Rd..	3·62	217	"	Belvoir Castle.....	2·38	156
<i>Kent.</i>	Tenterden, Ashenden...	3·69	228	<i>Rut.</i>	Ridlington	3·55	226
"	Folkestone, Boro. San.	3·32	...	<i>Lincs.</i>	Boston, Skirbeck.....	2·09	155
"	Eden'bdg., Falconhurst	3·60	193	"	Cranwell Aerodrome...	2·67	202
"	Sevenoaks, Speldhurst.	3·17	...	"	Skegness, Marine Gdns.	2·28	170
<i>Sus.</i>	Compton, Compton Ho.	4·41	221	"	Louth, Westgate.....	2·77	166
"	Patching Farm.....	4·03	230	"	Brigg, Wrawby St.....	2·16	...
"	Eastbourne, Wil. Sq....	3·80	209	<i>Notts.</i>	Worksop, Hodsock.....	1·61	110
"	Heathfield, Barklye....	4·05	219	<i>Derby.</i>	Derby, L. M. & S. Rly.	3·24	199
<i>Hants.</i>	Ventnor, Roy. Nat. Hos.	3·59	214	"	Buxton, Terr. Slopes...	4·16	141
"	Fordingbridge, Oaklands	3·62	198	<i>Ches.</i>	Runcorn, Weston Pt....	2·34	135
"	Ovington Rectory.....	5·09	269	<i>Lancs.</i>	Manchester, Whit. Pk.	2·74	143
"	Sherborne St. John.....	3·67	207	"	Stonyhurst College....	3·49	129
<i>Herts.</i>	Royston, Therfield Rec.	2·96	188	"	Southport, Bedford Pk.	2·23	121
<i>Bucks.</i>	Slough, Upton.....	2·94	205	"	Lancaster, Greg Obsy.	2·81	125
"	H. Wycombe, Flackwell	3·77	231	<i>Yorks.</i>	Wath-upon-Deane.....	1·93	122
<i>Oxf.</i>	Oxford, Mag. College...	3·30	214	"	Wakefield, Clarence Pk.	2·46	146
<i>Nor.</i>	Wellingboro, Swanspool	3·18	213	"	Oughtershaw Hall.....	4·43	...
"	Oundle	2·66	...	"	Wetherby, Ribston H..	...	...
<i>Beds.</i>	Woburn, Exptl. Farm...	2·98	199	"	Hull, Pearson Park.....	2·06	132
<i>Cam.</i>	Cambridge, Bot. Gdns.	2·85	209	"	Holme-on-Spalding.....	2·19	132
<i>Essex.</i>	Chelmsford, County Lab	2·66	208	"	West Witton, Ivy Ho.	3·18	148
"	Lexden Hill House.....	2·36	...	"	Felixkirk, Mt. St. John.	2·77	166
<i>Suff.</i>	Haughley House.....	2·66	...	"	York, Museum Gdns....	1·93	121
"	Campsea Ashe.....	2·16	153	"	Pickering, Hungate.....	2·32	139
"	Lowestoft Sec. School...	2·10	142	"	Scarborough.....	2·29	147
"	Bury St. Ed., Westley H.	2·48	162	"	Middlesbrough.....	2·48	181
<i>Norf.</i>	Wells, Holkham Hall...	2·71	211	"	Baldersdale, Hury Res.	...	...
<i>Wilts.</i>	Calne, Castleway.....	4·20	226	<i>Durh.</i>	Ushaw College.....	3·20	169
"	Porton, W.D. Exp'l. Stn	3·81	228	<i>Nor.</i>	Newcastle, Town Moor.	3·28	200
<i>Dor.</i>	Evershot, Melbury Ho.	5·06	214	"	Bellingham, Highgreen	3·26	151
"	Weymouth, Westham.	3·10	187	"	Lilburn Tower Gdns....	3·54	179
"	Shaftesbury, Abbey Ho.	3·09	145	<i>Cumb.</i>	Carlisle, Scaleby Hall...	3·44	176
<i>Devon.</i>	Plymouth, The Hoe.....	4·94	217	"	Borrowdale, Seathwaite	8·25	120
"	Holne, Church Pk. Cott.	9·15	253	"	Borrowdale, Moraine...	6·66	119
"	Teignmouth, Den Gdns.	3·66	183	"	Keswick, High Hill.....	4·10	134
"	Cullompton	4·73	208	<i>West.</i>	Appleby, Castle Bank...	3·09	158
"	Sidmouth, U.D.C.....	3·87	...	<i>Mon.</i>	Abergavenny, Larchf'd	5·63	223
"	Barnstaple, N. Dev. Ath	4·35	205	<i>Glam.</i>	Ystalyfera, Wern Ho....	7·40	195
"	Dartm'r, Cranmere Pool	10·50	...	"	Cardiff, Ely P. Stn.....	5·06	200
"	Okehampton, Uplands.	7·91	248	"	Treherbert, Tynywaun.	9·43	...
<i>Corn.</i>	Redruth, Trewirgie.....	5·21	181	<i>Carm.</i>	Carmarthen, Priory St..	...	...
"	Penzance, Morrab Gdn.	4·45	183	<i>Pemb.</i>	Haverfordwest, Portfld.	...	...
"	St. Austell, Trevarna...	6·39	226	<i>Card.</i>	Aberystwyth	3·71	...
<i>Soms.</i>	Chewton Mendip.....	6·16	207	<i>Rad.</i>	Birm W.W. Tyrmynydd	8·22	222
"	Long Ashton.....	4·85	222	<i>Mont.</i>	Lake Vyrnwy	6·16	220
"	Street, Millfield.....	4·09	204	<i>Flint.</i>	Sealand Aerodrome.....	2·08	141
<i>Glos.</i>	Blockley	4·46	...	<i>Mer.</i>	Dolgelley, Bontddu.....	6·54	179
"	Cirencester, Gwynfa....	4·58	245	<i>Carn.</i>	Llandudno	1·88	111
<i>Here.</i>	Ross, Birchlea.....	4·27	225	"	Snowdon, L. Llydaw 9..	10·35	...
<i>Salop.</i>	Church Stretton.....	3·82	177	<i>Ang.</i>	Holyhead, Salt Island...	2·26	109
"	Shifnal, Hatton Grange	3·17	189	"	Llwgwy	2·44	...
<i>Staffs.</i>	Market Drayt'n, Old Sp.	3·16	183	<i>Isle of Man</i>	Douglas, Boro' Cem....	3·75	152
<i>Worc.</i>	Ombersley, Holt Lock.	3·53	232	<i>Guernsey</i>	St. Peter P't. Grange Rd.	3·37	168
<i>War.</i>	Alcester, Ragley Hall...	4·20	248				
"	Birmingham, Edgbaston	3·50	201				

Rainfall : April, 1935 : Scotland and Ireland

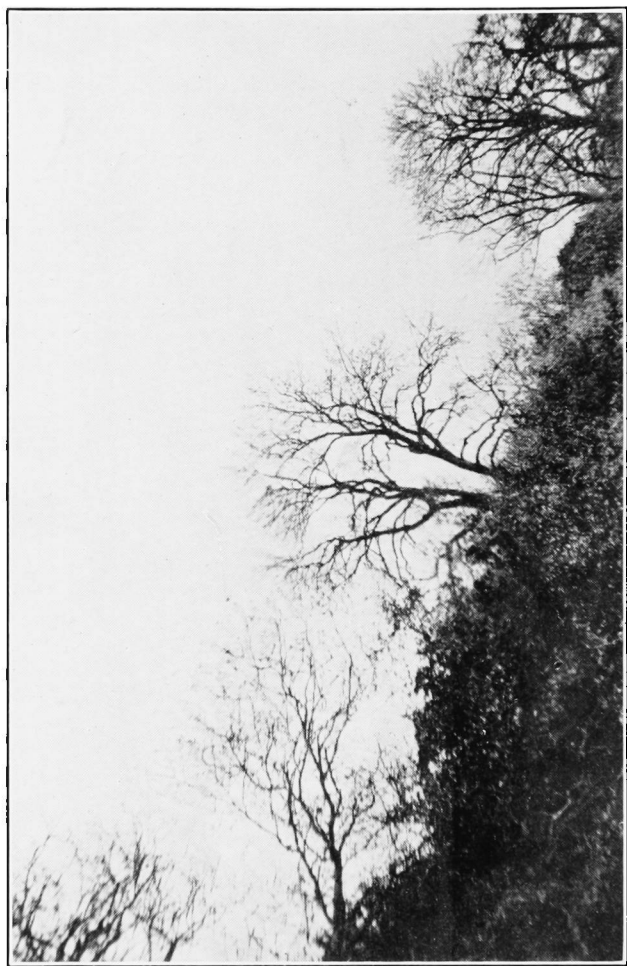
Co.	STATION.	In.	Per cent of Av.	Co.	STATION.	In.	Per cent of Av.
<i>Wig</i>	Pt. William, Monreith.	3.06	139	<i>Suth</i>	Melvich.....	1.88	81
	New Luce School.....	4.15	156		Loch More, Achfary....	3.46	71
<i>Kirk</i>	Dalry, Glendarroch.....	4.45	145	<i>Caith</i>	Wick.....	2.86	144
	Carsphairn, Shiel.....	6.94	167	<i>Ork</i>	Deerness.....	2.99	144
<i>Dumf.</i>	Dumfries, Crichton, R.I.	3.62	163	<i>Shet</i>	Lerwick.....	2.00	88
	Eskdalemuir Obs.....	5.79	170	<i>Cork</i>	Caheragh Rectory.....	4.43	...
<i>Roxb</i>	Branxholm.....	4.12	218		Dunmanway Rectory...	5.18	125
<i>Selk</i>	Ettrick Manse.....	3.87	110		Cork, University Coll...	3.31	126
<i>Peeb</i>	West Linton.....	3.44	...		Ballinacurra.....	3.49	135
<i>Berw</i>	Marchmont House.....	3.22	159		Mallow, Longueville....	2.90	119
<i>E.Lot</i>	North Berwick Res.....	3.28	234	<i>Kerry</i>	Valentia Obsy.....	3.72	101
<i>Midl</i>	Edinburgh, Roy. Obs.	2.97	202		Gearhameen.....	7.90	137
<i>Lan</i>	Auchtyfardle.....	3.17	...		Darrynane Abbey.....	3.52	102
<i>Ayr</i>	Kilmarnock, Kay Pk....	2.93	...	<i>Wat</i>	Waterford, Gortmore...	3.51	140
	Girvan, Pinnmore.....	2.92	98	<i>Tip</i>	Nenagh, Cas. Lough....	2.80	112
<i>Renf</i>	Glasgow, Queen's Pk....	3.03	154		Roscrea, Timoney Park	3.45	...
	Greenock, Prospect H..	3.84	105		Cashel, Ballinamona....	2.77	111
<i>Bute</i>	Rothsay, Ardenraig...	3.43	...	<i>Lim</i>	Foynes, Coolnanes.....	3.76	154
	Dougarie Lodge.....	3.19	...		Castleconnel Rec.....	2.82	...
<i>Arg</i>	Ardgour House.....	4.11	...	<i>Clare</i>	Inagh, Mount Callan...	...	...
	Glen Etive.....	...	...		Broadford, Hurdlest'n.	2.97	...
	Oban.....	2.59	...	<i>Wexf</i>	Gorey, Courtown Ho....	3.10	141
	Poltalloch.....	3.21	110	<i>Wick</i>	Rathnew, Clonmannon...	3.04	...
	Inveraray Castle.....	3.77	82	<i>Carl</i>	Hacketstown Rectory...	3.19	120
	Islay, Eallabus.....	3.70	129	<i>Leix</i>	Blandsfort House.....	2.84	109
	Mull, Benmore.....	8.60	112		Mountmellick.....	3.05	...
	Tiree.....	...	...	<i>Offaly</i>	Birr Castle.....	1.77	82
<i>Kinr</i>	Loch Leven Sluice.....	3.53	184	<i>Dublin</i>	Dublin, FitzWm. Sq....	1.52	80
<i>Perth</i>	Loch Dhu.....	5.80	122		Balbriggan, Ardgillan...	2.82	142
	Balquhiddel, Stronvar.	...	...	<i>Meath</i>	Beauparc, St. Cloud....	2.19	...
	Crieff, Strathearn Hyd.	3.38	154		Kells, Headfort.....	2.77	111
	Blair Castle Gardens...	2.88	136	<i>W.M</i>	Moate, Coolatore.....	2.90	...
<i>Angus</i>	Kettins School.....	3.16	174		Mullingar, Belvedere...	2.93	123
	Pearsie House.....	4.12	...	<i>Long</i>	Castle Forbes Gdns.....	2.96	124
	Montrose, Sunnyside...	3.94	216	<i>Gal</i>	Galway, Grammar Sch.	2.26	...
<i>Aber</i>	Braemar, Bank.....	4.44	187		Ballynahinch Castle...	4.64	131
	Logie Coldstone Sch....	4.15	206		Ahascragh, Clonbrock.	2.89	114
	Aberdeen, King's Coll.	4.15	222	<i>Mayo</i>	Blacksod Point.....	3.89	134
	Fyvie Castle.....	3.88	181		Mallaranny.....	4.20	...
<i>Moray</i>	Gordon Castle.....	3.03	173		Westport House.....	2.88	107
	Grantown-on-Spey.....	...	...		Delphi Lodge.....	5.18	90
<i>Nairn</i>	Nairn.....	2.33	155	<i>Sligo</i>	Markree Obsy.....	4.21	159
<i>Inv's</i>	Ben Alder Lodge.....	...	...	<i>Cavan</i>	Crossdoney, Kevit Cas.	3.03	...
	Kingussie, The Birches.	2.37	...	<i>Ferm</i>	Enniskillen, Portora...	2.77	...
	Inverness, Culduthel R.	...	...	<i>Arm</i>	Armagh Obsy.....	2.11	100
	Loch Quoich, Loan.....	3.45	...	<i>Down</i>	Fofanny Reservoir.....	6.20	...
	Glenquoich.....	...	...		Seaforde.....	3.28	125
	Arisaig, Faire-na-Sguir.	1.98	...		Donaghadee, C. Stn....	1.70	85
	Fort William, Glasdrum	2.98	...		Banbridge, Milltown...	1.66	81
	Skye, Dunvegan.....	3.14	...	<i>Antr</i>	Belfast, Cavehill Rd....	3.02	...
	Barra, Skallary.....	3.33	...		Aldergrove Aerodrome.	2.40	114
<i>R&C</i>	Alness, Ardrross Castle.	4.17	172		Ballymena, Harryville.	3.48	132
	Ullapool.....	2.35	76	<i>Lon</i>	Garvagh, Moneydig....	2.69	...
	Achnashellach.....	3.83	68		Londonderry, Creggan.	3.41	133
	Stornoway.....	2.31	76	<i>Tyr</i>	Omagh, Edenfel.....	2.66	101
<i>Suth</i>	Lairg.....	2.19	95	<i>Don</i>	Malin Head.....	3.03	...
	Tongue.....	2.55	97		Killybegs, Rockmount.	2.97	...

Climatological Table for the British Empire, November, 1934

STATIONS.	PRESSURE.		TEMPERATURE.							Relative Humidity.	Mean Cloud Am't.	PRECIPITATION.			BRIGHT SUNSHINE.	
	Mean of Day M.S.L.	Diff. from Normal.	Absolute.		Mean Values.			Mean.	Wet Bulb.			Am't.	Diff. from Normal.	Days.	Hours per day.	Per-cent. age of possible.
			Max.	Min.	Max.	Min.	1/2 Min.										Diff. from Normal.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	%	0-10	In.	In.				
London, Kew Obsy.....	1017.3	+ 2.7	56	30	48.2	40.1	54.1	58.0	92	9.4	1.76	0.46	14	1.3	14	
Gibraltar.....	1016.0	+ 2.0	78	47	63.2	52.8	68.0	72.0	83	6.7	9.30	2.87	21	...	...
Malta.....	1016.8	+ 0.9	75	54	69.6	60.9	65.3	69.0	85	7.6	4.76	1.19	13	4.4	43	
St. Helena.....	1013.0	- 0.3	67	54	64.2	56.2	60.2	64.0	89	9.3	1.11	...	14	...	...
Freetown, Sierra Leone.....	1013.5	+ 2.6	89	71	86.4	74.3	80.3	84.0	87	4.5	4.35	0.77	15	...	...
Lagos, Nigeria.....	1010.4	+ 0.3	91	72	88.0	76.6	82.3	86.0	87	5.7	1.17	1.50	8	7.5	64	
Kaduna, Nigeria.....	1009.3	...	95	52	92.4	56.5	74.5	78.0	71	2.0	0.00	0.21	0	10.5	91	
Zomba, Nyasaland.....	1009.6	+ 0.7	93	60	82.9	65.2	74.1	78.0	63	6.8	2.86	2.22	15	...	...
Salisbury, Rhodesia.....	1010.6	- 0.8	89	56	79.5	60.0	69.7	73.0	72	4.9	4.80	1.20	13	5.6	43	
Cape Town.....	1014.1	- 1.7	97	47	77.8	58.6	68.2	72.0	71	6.2	6.51	1.55	17	7.2	54	
Johannesburg.....	1012.6	+ 0.4	82	46	72.6	53.4	63.0	67.0	71	6.2	6.69	5.11	13	7.4	57	
Mauritius.....	1015.3	- 0.8	85	61	81.9	67.6	74.7	78.0	68	6.1	0.86	0.21	2*	...	...
Calcutta, Alipore Obsy.....	1012.6	- 0.7	87	53	82.0	64.3	73.1	77.0	85	3.4	3.23	2.78	3*	...	...
Bombay.....	1012.2	+ 0.2	92	68	87.2	71.4	79.3	83.0	81	6.0	1.86	1.75	4*	...	...
Madras.....	1011.8	+ 0.5	88	62	84.8	71.0	77.9	81.0	77	5.8	20.61	8.85	19	6.9	58	
Colombo, Ceylon.....	1011.2	+ 1.2	86	68	83.7	72.7	78.2	82.0	80	8.8	12.47	2.56	24	4.3	36	
Singapore.....	1009.6	+ 0.2	89	72	85.6	74.2	79.9	83.0	73	7.1	0.41	1.33	5	4.8	43	
Hongkong.....	1017.1	- 0.5	83	58	75.0	65.8	70.4	75.0	85	8.2	17.44	2.72	25	...	...
Sandakan.....	1009.3	...	89	73	87.1	75.2	81.1	85.0	68	7.2	4.23	1.38	16	7.0	50	
Sydney, N.S.W.....	1013.7	- 0.1	91	48	72.0	59.8	65.9	70.0	66	7.8	5.24	3.01	18	4.4	31	
Melbourne.....	1013.3	- 1.1	90	45	70.2	52.7	61.5	65.0	48	6.3	4.10	2.95	12	8.3	60	
Adelaide.....	1014.2	- 1.0	97	48	76.4	55.6	66.0	70.0	51	5.0	0.72	0.08	8	9.7	71	
Perth, W. Australia.....	1015.1	- 0.3	90	48	74.1	55.1	64.6	68.0	56	2.7	1.10	0.51	3	...	...
Coolgardie.....	1012.7	- 0.4	99	43	79.2	52.1	65.7	69.0	65	7.6	5.68	1.95	12	6.9	51	
Brisbane.....	1014.4	- 0.2	88	58	78.8	63.8	71.3	75.0	71	5.5	2.16	1.36	16	5.7	39	
Hobart, Tasmania.....	1011.8	+ 2.2	88	39	66.1	50.2	58.1	62.0	61	7.6	1.85	0.62	16	9.2	64	
Wellington, N.Z.....	1018.8	+ 6.7	81	40	66.3	52.1	59.2	63.0	71	5.5	2.16	1.36	8	9.2	64	
Suva, Fiji.....	1011.9	+ 0.8	90	67	84.2	72.8	78.5	82.0	82	6.7	5.33	4.46	17	6.2	48	
Apia, Samoa.....	1009.3	- 0.2	89	72	85.7	74.7	80.2	84.0	78	6.2	14.05	4.22	21	6.3	50	
Kingston, Jamaica.....	1011.5	- 0.9	90	66	86.1	70.4	78.3	82.0	86	4.3	4.06	1.03	9	4.9	43	
Grenada, W.I.....	...	...	85	70	84	73	78.5	82.0	78	5	11.62	3.16	19	...	...
Toronto.....	1018.0	+ 0.7	63	25	47.6	36.6	42.1	46.0	82	7.9	3.10	0.47	14	2.2	23	
Winnipeg.....	1016.8	- 0.6	55	7	35.9	23.7	29.8	35.0	83	7.6	0.26	0.81	3	2.8	31	
St. John, N.B.....	1019.0	+ 4.4	59	19	45.2	32.8	39.0	45.0	86	8.0	6.46	2.05	16	2.6	27	
Victoria, B.C.....	1011.0	+ 4.9	56	41	51.0	44.7	47.9	51.0	91	8.4	4.58	0.83	23	1.7	18	

* For Indian stations a rain day is a day on which 0.1 in. or more rain has fallen.

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VALLEY BETWEEN RICKMANSWORTH AND CHORLEYWOOD, HERTS., MAY 27TH, 1935, showing oak trees stripped of their leaves and ashes with blackened and shrivelled foliage—the result of the severe frost of May 16th–17th, 1935 (*see* p. 108).