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A THUNDERY SPELL IN JULY, 1939, AND SOME PREVIOUS THUNDERY PERIODS

By C. K. M. Douglas, B.A.

Thunderstorms are numerous in July whenever the month is of an unsettled type, with numerous depressions, and July 1939 was no exception. The most notable thundery spell began in Ireland on the 13th and spread next day to north-west England and south-west Scotland. From then till the 21st thunderstorms occurred every day in England and Wales, and were widespread except on the 18th, when only a few districts were affected. Another widespread outbreak occurred on the 24th. The storms were mostly in the day-time but there were a few at night, though nothing approaching the number of night storms experienced on August 1st to 12th, 1938. The storms were severe locally but there is no reason to believe that there was anything comparable in intensity with the storm of August 4th, 1938. There were quite a number of cases of damage by lightning, but this was due to the lowness of the clouds. Hail was frequent, and also heavy rain, the largest daily rainfalls reported by telegram being 3·72 in. at Troon on the 5th, and 2·83 in. at Teignmouth and 2·32 in. at Shrewsbury on the 21st. During the thundery period there was much cloud and showers or periods of rain in various districts in addition to thunderstorms.

The thunderstorms were associated with depressions which originally moved south-eastward from near south Greenland and subsequently turned east or north-east and filled up over England. The first one was over Ireland on the 14th and dissipated over the Midlands on the 17th; the second was off Brittany on the 18th and filled up on the 21st, and the third moved more quickly south-eastward over England on the 24th and then away eastward.

The thunderstorms developed in maritime polar air, either behind a cold front or occlusion, or else in the central area of a depression after the occlusion had been twisted up and had ceased to be recognisable in the region in question. The air currents had their origin in the Greenland area and had gained warmth and moisture from the surface of the Atlantic, including the seas off our south-west coasts in the case of the storms up to the 21st. Upper air temperature was low, and only a little trigger action was required to start off thunderstorms. This was provided by even small amounts of sunshine, or in the case of the few night storms by convergence or orographic ascent. The table below gives the mean temperatures observed at Mildenhall and Aldergrove for the period July 15th to 21st, 1939 at pressures of 900, 700 and 500 mb., corresponding to

	Mean temperature (°F.) July 15th–21st 1939		Mean temperature (°F.) August 4th–12th 1938	
Pressure (mb.)	Mildenhall	Alder-grove	Mildenhall	Alder-grove
900	49·9 (−2·4)	50·7	60·0 (+8·2)	58·3
700	27·1 (−6·1)	30·8	36·6 (+3·7)	37·7
500	−1·3 (−7·1)	4·1	9·1 (+2·9)	9·3

height of about 3,000, 10,000 and 18,000 feet, with the differences between the Mildenhall figures and the Duxford monthly normals for the period 1927–36. For these seven days the mean temperature was lower over Mildenhall than over Aldergrove, and the storms were much more widespread in England than in Ireland or Scotland.

The corresponding figures for August 4th to 12th 1938 are included for comparison (August 1st to 3rd are omitted, because the thunderstorms were only experienced in south-west districts on those days). It can be seen that in the 1938 period the mean lapse-rate over Mildenhall from 3,000 to 18,000 feet was the same as in the recent thundery spell, but that the whole column of air was ten degrees warmer. In neither period was there much variation of upper air temperature.

Before leaving the July thunderstorms, one other point deserves mention, namely the influence of surface friction on the supply of moisture in a depression. It is almost impossible to evaluate the inflow of air accurately, but from the available pilot balloon data and the observed absolute humidity and general theoretical considerations, it must have been sufficient to produce nearly 2 mm. of rain per day over the whole of a circular area of 200 miles radius, so long as the depressions had a definite circulation. Actually, of course, the rainfall is irregularly distributed. If when a depression fills up a flat area of uniform pressure supervenes, precipitation becomes less general, but there is still a chance of severe local thunderstorms, even on successive days. The evaporation from land, especially if wet, is an appreciable factor.

The Editor has asked for a more general discussion of the normal development of the weather situation leading to widespread thunderstorms. These developments are diverse and only some of the most frequent can be discussed in a short space, with special reference to unusually prolonged thundery spells. The period August 1st to 12th 1938 (fully discussed in the *Meteorological Magazine* for September 1938) and the recent period, are good examples of two of the main thundery types. It has long been recognised that the spread of a shallow depression from France generally leads to thunderstorms in summer, and it is now known that there is a transference of air (not always including the surface layers), which brings over thundery weather, often with active storms crossing the Channel at the very onset of the thundery upper air situation. Alto cumulus castellatus clouds often give a valuable preliminary warning, corresponding with the altostratus clouds ahead of a typical warm front, but normally the thunderstorms cannot break out until the new air mass extends lower down. If this were not so, the warning given by the turret clouds would be much shorter than it actually is. Low turret clouds (stratocumulus cumuliformis) usually indicate thunder within a short period.

The storms which give spectacular displays of lightning are associated with really high temperatures, at least within some 200 miles. The supply of very warm air in Western Europe is limited, and if there are widespread frontal thunderstorms it is quickly exhausted, and stable conditions often follow with cold air below the warm air, so that the worst storms are often not associated with prolonged thundery spells. In the case of August 4th, 1938, the air behind the occlusion was itself warm and no important surface of discontinuity developed aloft, so that thunderstorms continued, but the prolongation of the thundery weather till August 12th was only made possible by the general conditions of air circulation (or in other words the general pressure distribution) over Europe and the Atlantic, and this is true of all thundery periods. On June 18th to 21st, 1936, there were spectacular storms on four successive nights in some districts, an event unequalled during the present century. The abnormal prolongation of the warm thundery south-easterly upper current was due to a combination of factors over an area which certainly included the whole North Atlantic and most of Europe. Another notable spell of south-easterly storms occurred on June 12th to 18th, 1920, but temperature was lower than in the 1936 series and the storms were mainly in the daytime.[1]

[1] Some facts relating to the diurnal variation of thunderstorms in hot weather are given in the *Meteorological Magazine*, 68, 1933, p. 54.

There is often a gradual fall of temperature at high levels ahead of a cold front, especially if the barometer is falling, and this should be interpreted in terms of temperature gradients aloft, and not as a frontal surface sloping the wrong way. There is usually a strong upper current from between south and south-west, or occasionally from a point east of south. The fall of temperature high up is of a type depending little on season or locality, but it helps the development of thunderstorms if conditions lower down are also suitable. The increased lapse-rate high up may be associated with the appearance of altocumulus castellatus clouds, but these clouds do not necessarily indicate falling temperature. Summer thunderstorms at or ahead of cold fronts generally involve previous heating of the warm air over land, but they occasionally occur when the warm air is pure maritime tropical, as in south-west England on the nights of July 4th–5th and 29th–30th, 1939. Thunderstorms at the warm front in maritime tropical air are distinctly rare, but there was a case near the centre of a depression on September 24th, 1935.[1]

Complications are frequent in the case of cold front thunderstorms in summer, in addition to those produced by precipitation from pre-frontal thunderstorms and consequent cooling. Temperature contrasts often develop along the west coast of France and to a lesser extent on our own western coasts, and if there is convergence of air motion frontogenesis takes place. The convergence is usually an isallobaric effect either ahead of an Atlantic cold front or ahead of a small depression moving up from Spain or North-west Africa. Frequently the two features are combined, since the strong upper current which often exists ahead of an Atlantic cold front favours the motion of any previously existing small depression in a direction more or less along the upper current. Probably actually the motion depends on the sheer between the upper and lower air.[2] A front which is

[1] See R. P. Batty's note in *Meteorological Magazine*, 70, 1935, p. 233.

[2] This statement is based on an important paper by R. C. Sutcliffe, not yet published.

originally formed chiefly just ahead of such a moving depression trails behind it as a cold front and then sweeps eastward, often with an Atlantic front following some distance behind it. This sequence has occurred over France several times this summer but the storms have all missed the British Isles. Storms travelling in a strong upper south-west current are more frequent on the Continent than over the British Isles, since the west of France is the chief breeding ground. They are more likely to reach the British Isles if the upper current is south-south-west or still better south. The severe storm in south-east England early on August 12th, 1932, was associated with a cold front which formed on the west coast of France, and the Atlantic front followed some hours later without thunder, and other examples could be given. When a steady fall of upper air temperature commences ahead of a cold front and continues afterwards, the cold front thunderstorms may start a series which is continued in the maritime polar air. On July 8th to 21st, 1918, there were thunderstorms on every day in Great Britain, recorded in the *Daily Weather Report,* most of which developed in maritime polar air, but a few at major fronts associated with brief incursions of warm continental air. There has not been such a long series of consecutive days of thunderstorms in the *Daily Weather Report* since then. (There is, of course, an element of chance in the occurrence of thunder at *Daily Weather Report* stations, but widespread storms have normally been recorded, even when there were fewer stations than there are now.)

Any one depression rarely gives thunder for more than three or four days, but on June 17th to 23rd, 1933, there were seven days of thunder in the same depression, which drifted slowly from the Faeroes to England, while pressure at the centre rose from about 980 to 1,006 mb. The thundery spell of August 1938 was associated with an indefinite belt of relatively low pressure rather than with a depression proper. The chief condition for a long thundery period is the absence of subsidence or of advection of stable air aloft. Different air masses may be involved, provided that none of them is stable.

The following account of the thunderstorm of July 16th, 1939, has been received from Mr. H. Forster of Tern Hill, Salop:—

> Thunder was first heard at 16h. G.M.T. approaching from the SSW and gradually increased in intensity, the storm arriving at Tern Hill at 16h. 45m., eventually passing over and ceasing at 18h. 20m., thunder was, however, heard until 19h. The intensity of the rain, thunder and lightning was according to local residents, of a character, that has not before been experienced, at least during the past 40 years. During the storm a row of houses (12 in number) in Garden City, Tern Hill, were shaken on five different occasions, at 17h. 10m., 17h. 17m., 17h. 25m., 17h. 40m., 17h. 45m. in a manner similar to what one would expect in slight earth tremors. No actual damage occurred.
>
> At Market Drayton, two adjoining cottages in Corn Mill Yard, Cheshire Street, were struck by lightning, on one the bricks of the chimney stack were bulged outwards and the chimney, together with some of the tiles from the roof, was deposited on the ground about 10 yards from the building. On the other, the lightning apparently travelled down the rain water pipe to approximately halfway, thence through the wall to the electricity circuit and finally to the meter in the basement, the meter being entirely burnt out. About halfway down the wall there is a burnt patch on the brick-work, as though a small explosion had occurred and the plaster on the wall inside the room opposite the burnt patch had fallen away. Villages and small towns about 4 to 5 miles east and west of the area were not affected, they experienced only slight rain or showers.

Mr. J. M. Brierley of South Petherton, Somerset, sends the following account of the storm of July 21st, 1939.

> During a violent thunderstorm on Friday, July 21st, 1939, considerable damage was done in this neighbourhood. I examined two houses in South Petherton and a Wellingtonia tree (in a row of similar trees) at Yeabridge, near South Petherton, which were struck by lightning. The fact that both houses were apparently struck on their west or north-west sides and that the highest point on the tree, where damage was visible, was also on the west side interested me very much. The storm approached from the north-west, running up the river Parrett valley from Langport. Hailstones up to half an inch in diameter fell during the height of the storm.

THE DRAMA OF WEATHER

The dictionary defines " *drama* " as " a representation of *actions* in human life; a series of deeply interesting events ". On both these counts the title of Sir Napier Shaw's book* is justified, for he represents the weather in action, as an ever present feature of human life, and he certainly makes of the process a series of deeply interesting events. The conceit is carried on through the book, but the play is the dignified drama of classical Athens, not the more lurid productions of Drury Lane.

The stage is set, but first, we must study the programme. This, as befits the occasion, is lavishly illustrated, mostly with stills from the kaleidoscopic backdrop of the sky, but not forgetting some of the chief biographical particulars of performers, Ice, Wind and Sun. Then the plot, not one of those modern trumpery affairs, but a story old as time, written and re-written a hundred times as the playwrights learned their job. In the first performance the centre of the stage was held by the persons of the actors themselves, thundering Zeus, or the demigods of the winds. Next the play took a mystical turn, with the planets cast for the leading parts, to change again in the Victorian era to the homely domestic drama, with the barometer in the rôle of heavy father. Finally, since 1920, the number of actors has become legion, and their destinies unfold in interplay of gigantic forces, no longer limited to the bare boards but enacting their whirling dances or subtle transformations high above the stage.

We glance at the press gallery or " watchers ", the world-wide corps of meteorological observers, who note and report the varying tempo, the more or less spectacular incidents, and draw their parallels from the voluminous records of past performances, but by a " marvellous contrivance " of weather maps we can

* *The Drama of Weather.* By Sir Napier Shaw (2nd edition). 8 × 5½, pp. XIV + 308 illus. Cambridge University Press, 1939, 10*s.* 6*d.* net.

look with a thousand pairs of eyes at once. These instruments are truly magical, for, through them, we can at will direct our glance backwards into the past, to see a distillation of all that the watchers have noted for a generation, or forwards, dimly and uncertainly, into the future.

The orchestra strikes up, the music of the spheres. rhythms, intrusions, synchronism, syncopation, the beating drums of the years, the piccolos of the days. The curtain rises, the barometer plays a flowing melody as cyclones and anticyclones cross the stage in stately procession, winds circling smoothly around them, lows to the left, highs to the right. The music becomes more staccato as the spotlight fades from the attendant isobars, new actors, fronts, appear and dominate the play, while the muted strings of the isobars are almost drowned in the triumphant duet of polar and tropical air. The curtain falls, to rise again for a moment on a brief glimpse of the weather map of the future, filling the stage from wing to wing to the very roof. The play is over.

The play is over, but for the latest revival the producer, not content with revising the script hands us a momento on the way out, in the shape of two new chapters "Where the rain comes from" (with a digression on the energy of winds) and "Chapter and verse for weather in relation to agriculture". The drama has gone, but Sir Napier cannot write a dull word, even as an afterthought. Nor can he write a sentence which is not packed with insight and experience, and the reviewer, attempting, however lamely, to pass on something of the spirit of the book must not forget to add that it is also a vast storehouse of information, a "Manual" in miniature. As for the illustrations, Sir Napier might equally well have chosen as his title "The diorama of weather", for through the covers we view a series of pictures vividly illuminated by the light of his personality and humour.

C.E.P.B.

LETTERS TO THE EDITOR

Determination of Cloud Heights

The method commonly in use for determining the height of the base of cloud at night is to use a searchlight with a vertical beam and to observe the patch of light where the beam meets the base of the cloud from a point at some distance from the base of the searchlight. If the angle of elevation of the patch of light is E and the distance of the point of observation from the searchlight is D, then the height of the base of the cloud is D tan E, i.e.

$$H = D \tan E \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

It is assumed that the point of observation is at the same level as the searchlight.

For observations from a ship at sea it would be difficult to keep the beam of the searchlight vertical, but it is not necessary to do so. In fact it is preferable to fix the searchlight permanently so that the beam of light is vertical* when the ship is steady without pitch or roll and to make no attempt to adjust the searchlight when the ship is pitching and rolling. The alidade is also fixed to the ship and the position of the patch of light on the cloud is measured by reference to an axis, fixed relative to the ship. This axis through the alidade is chosen so that it is horizontal when the ship is steady, i.e. when the searchlight beam is vertical: and the axis is in the vertical plane through the alidade and the searchlight.

Suppose this to be done and the distance of the observer from the searchlight beam (i.e. the length of the line ON from the observer at O perpendicular to the beam SNP) to be d (see Fig. 1). Let the angle between this line ON and the line OP from the observer to the patch of light on the cloud be α. Then the distance of the

* This is convenient though not essential. If the beam is in the vertical plane through the alidade and searchlight and is inclined at an angle β to the vertical (when the ship is steady), then for d tan α in para. 3 we must substitute d sin $(\alpha - \beta)/\cos \beta$. If β were large, the errors due to the pitching of the ship might become serious.

patch of light on the cloud from N is d tan α. The height H of the cloud base above N is then d tan α cos θ where θ is the angle which the searchlight beam makes with the

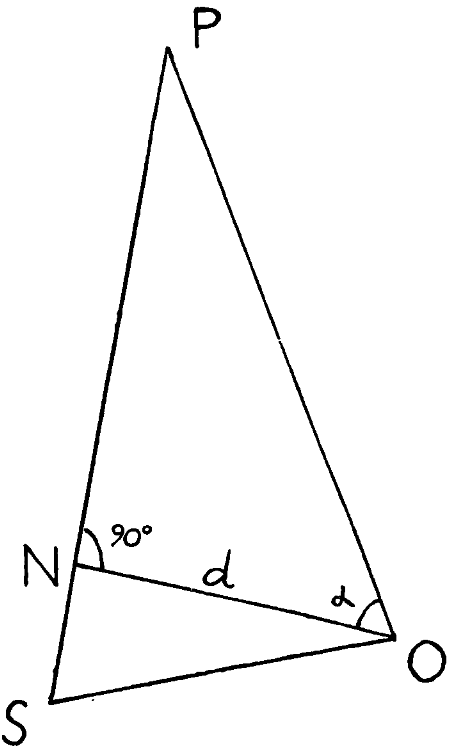

FIGURE 1.

vertical. When the ship is steady O and N are at the same level and we may therefore take the height above N to be the effective height of the cloud base above the ship.

If the height were taken to be d tan α, i.e. H=d tan α, the error in the value of H would be

$$\Delta H = d \tan \alpha \, (1 - \cos \theta) = H \, (1 - \cos \theta) \ldots\ldots (3)$$

As a general rule (1 - cos θ) is negligible for the values of θ likely to occur and the height may therefore be taken simply as d tan α. The error in H arising from the neglect of θ is less than 10 per cent. for values of θ up to 25°. It will practically always be possible to make an observation when the beam of the searchlight is within 25° of the vertical.

If on the other hand an endeavour is made to keep the searchlight beam vertical and to measure the elevation E of the light spot (above the horizon), then if the height is assumed to be $H = d \tan E$ the error due to the searchlight beam being at an angle φ from the vertical is

$$\Delta H = H \tan E \tan \varphi \quad \text{.............................. (4)}$$

Naturally if the searchlight were mounted on gimbals and its oscillations damped φ would be less than θ but this error (4) is appreciable even for small values of φ

Equation (4) may be written

$$\Delta H = H. \frac{H}{d} \tan \varphi \quad \text{.............................. (5)}$$

This shows that the percentage error in H is proportional to $\frac{H}{d}$. So long as d the length of the base line is comparable with H, the percentage error will not be large for small values of φ. But on a ship it will usually be possible to have only a relatively short base line, and if the height of the base of clouds at an appreciable height is to be measured, large values of $\frac{H}{d}$ must be allowed, i.e. values of 10 or 20. But if $\frac{H}{d}$ is 10 the error ΔH of equation (5) will be 50 per cent. of H for a value of φ less than 3° and if $\frac{H}{d}$ is 20 the error in H will be 50 per cent. for a value of φ of 1° 15′. It would be practically impossible to avoid errors of 2° or 3° in φ however carefully the searchlight might be mounted and its oscillations damped.

It follows that for observations at sea it is better to use a fixed searchlight and a fixed alidade than to endeavour to use a searchlight with a vertical beam and a sextant.

The fact that the base line on a ship is short makes it necessary to use values of d which are near 90° if the heights of clouds at a level of 4,000 or 5,000 ft. are to be measured. Consequently a small error in α produces a substantial error in $\tan \alpha$ and consequently in H. For values of α above 85° the error in H due to an error $\Delta\, \alpha$ in α may be written

$$\Delta\, H = H.\ \frac{H}{d}.\ \Delta\, \alpha \quad\quad\quad (6)$$

It is therefore important to know the degree of accuracy with which α can be measured. On land some tests made for me by Mr. R. M. Poulter show that careful measurement will give a value of α with an error not greater than one-tenth of a degree. But on a moving ship the error is likely to be greater than this although the fact that both the alidade and the searchlight are fixed relative to the ship and so move with it, will assist in securing a higher degree of accuracy than would be possible if the light spot on the cloud moved independently of the alidade. From the results of the tests on land I deduce that it will be possible on board ship to obtain values of α correct to the nearest two-tenths of a degree. If the height of the cloud is 20 times the length of the base, i.e. if $\frac{H}{d} = 20$, then the error in H due to an error of 0·2° in α will be approximately 7 per cent. and if $\frac{H}{d} = 30$, the error in H will be approximately 10 per cent. Thus with a base line of 200 ft. it should be possible to measure cloud heights up to 6,000 ft. sufficiently accurately for all practical purposes, provided the method of the fixed searchlight and alidade is used.

E. GOLD.

Meteorological Office,
May, 1939.

A July Frost in Herts

For the first time since the establishment of the climatological station in a deep, enclosed valley between Rickmansworth and Chorleywood, Herts, ten years ago, the air temperature there has fallen to the freezing-point during July. Early on July 2nd, 1939, a minimum of 31·8° F. was registered by the standard thermometer in the Stevenson screen. These readings from the thermograph trace indicate that the extreme occurred at about 4h.;

G.M.T.	°F.	G.M.T.	°F.
0h.	37·6	3h.	33·0
1h.	35·9	4h.	32·2 (min.)
2h.	34·2	5h.	39·5

A thermometer having its bulb one inch above short grass fell to 22° F.

On the synoptic charts for July 1st, 1939, reproduced in the International Section of the *Daily Weather Report* no cold front is marked as having crossed England that day. The appearance of the Rickmansworth thermogram strongly suggests, however, that such a front must have passed just after 18h., thus paving the way for the frosty night which followed. This supposition is upheld by the fact that a slight thunderstorm visited the neighbourhood round about 18h.

The period of the year during which the " screen " temperature at the Rickmansworth station has not fallen to 32·0° F. or lower since 1929 is now reduced to 49 days (July 3rd to August 20th). Having regard to minima of 32·2° F., 32·8° F., 34·6° F. and 36·1° F. recorded on July 31st, 1935, July 27th, 1936, July 22nd, 1936 and August 10th, 1931, respectively, there can be little doubt that over a long series of years no part of the summer would be found wholly immune from frost in this particular valley.

It may be of interest to append the lowest " screen " temperatures observed at the Rickmansworth station for each of the calendar months since registration was begun in May, 1929:—

	°F.	Year.	Date.		°F.	Year.	Date.
Jan. ..	9·0	1939	6, 7	July ..	31·8	1939	2
Feb. ..	7·5	1936	12	Aug. ..	30·0	1938	21
Mar. ..	4·7	1931	10	Sept. ..	26·0	1937	21
Apr. ..	16·4	1936	23	Oct. ..	14·8	1935	21
May ..	16·5	1935	17	Nov. ..	13·0	1937	21
June ..	28·1	1935	9	Dec. ..	6·7	1935	24

Over short grass (or at a snow-surface) – 2·8° F. was reached on March 10th, 1931, – 0·1° F. on January 18th, 1936, and 0·4° F. on December 24th, 1935. More exceptional, probably, were readings of 10·3° F. on May 17th, 1935, and 6·9° F. on October 21st, 1935.

E. L. HAWKE.

Ivinglea, Dagnall, Bucks.
July 30th, 1939.

The fronts published in the *Daily Weather Report* represent the main air mass boundaries, and cannot include all the small local fronts which form so readily in unstable polar air. The charts show a small irregularity in the isobars, and the associated front was originally a very minor one of a length not exceeding 100 miles. It intensified during the day owing to sunshine ahead of it, contrasting with a belt of cloudy, showery weather. At Welwyn, Herts, there was sunshine all afternoon, but there was a great bank of cumulonimbus clouds to north-east after 13h. G.M.T., which only approached very slowly, as the cloud motion was nearly parallel to the belt. Finally, at about 16h. G.M.T. a belt of broken cumulo-nimbus clouds came over, with a few peals of thunder and a slight shower, and surface wind veered temporarily from north-west to north-east.

C. K. M. DOUGLAS.

Unusual Electrical Discharge at Wellington

It has struck me that the " Unusual Electrical Discharge at Wellington " (described in the July issue of the magazine) might be explained by the headlights of motors shining on clouds. The clouds were very low, and it is very hilly round Wellington. The headlights of cars make curious effects on low clouds, as I know from observation here, and I think my explanation is more likely than an unknown and hitherto unrecorded form of electrical discharge. It so happened that I was out of doors at Wellington on the night of April 12th, and did not notice anything unusual, but then I must have gone to bed sometime before 23h. 25m.

C. J. P. CAVE.

Stoner Hill, Petersfield, Hants.
July 24th, 1939.

The Best Climate in the World

It would be interesting if any of your readers could put forward a local climate as generally favourable and pleasant for Europeans as that of the Nelson district of New Zealand.

The following figures compare Nelson, (N), with the South coast of England, (E):—

Season		Winter	Spring	Summer	Autumn	Year
Mean temp. °F.	N.	46	54	62	56	54·5
	E.	42	49	60	52	51·0
Mean Max. °F.	N.	54	62	70	64	62
	E.	47	55	67	58	57
Hours of Sun per day	N.	5·7	7·0	8·3	6·7	2500 (total)
	E.	2·3	6·1	7·5	4·1	1800 (total)

The chief advantage of the Nelson district compared with the best British climates is the bright winter with mild days and an absence of the long periods of overcast weather which we know so well here. The number of rain days is about 110 per year compared with about 150 in south England. There is no equivalent of our spring east winds, and the frequent strong winds which are an unpleasant feature of many parts of New Zealand, (and also some of our resorts), are not felt at Nelson, but the air is very clear with plenty of fresh cool winter mornings. Summer temperatures above 80° are almost unknown.

G. S. CALLENDAR.

Imperial College of Science, S.W.7.
June 28th, 1939.

The Best Climate in the World—A reply

If moderate warmth, equability and brightness really do represent the acme of climatological bliss then no doubt, as Mr. Callendar's comparison shows, the Nelson district on the north coast of the south island of New Zealand lies nearer the optimum than the south coast of England. In the present position of climatology however, it is unwise to use such phrases as " best climate in the World " in relation to a superficial comfort scale of this kind. Comparisons are often made between the somewhat similar climates of England and New Zealand usually to the advantage of the latter; but it is apt to be forgotten that the geographical position of England involves a more stimulating variety of temperature changes than in New Zealand, a greater complexity of weather moods and a more pronounced alteration between bracing and sedative types of weather, which are probably in the long run to be accounted as assets in their influence upon bodily and mental vigour. The mean winter temperature of 42° F. along the south coast of England is sufficiently mild but leaves a good margin for the incidence of frosts and tonic cold winds. Occasional spurts of warmth over 80° F. are probably no disadvantage in England as they save our summers from being chilly and featureless and seem, on the whole, to be thoroughly enjoyed. On the whole the south coast of England would seem to take high rank in general excellence when the combined influence of the more palpable and more subtle effects of climate are considered.

L. C. W. BONACINA.

13, Christchurch Hill, Hampstead, N.W.3.
July 2nd, 1939.

Note.—The claims of Funchal to " the finest climate in the world " are set out in *The Climate of Madeira,* reviewed by Dr. Fortescue Fox on pages 219–220.

Effect of Wind on the Temperature of a Thermometer

I have followed with great interest the discussion* on the effect of high wind speeds on the temperature indicated by a thermometer.

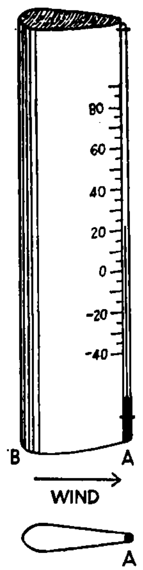

Fig. 1.

It seems that something very near the true temperature will be recorded by a thermometer set edgeways to the wind with the bulb at the trailing edge of its support. As indicated in the accompanying sketch, the usual support would be of streamline section with the thermometer at A, fitted carefully into the trailing edge and presenting a smooth finish. (Conversely, if the thermometer were placed in the leading edge, as at B, the maximum effect of adiabatic heating at the stagnation point might be expected.)

R. M. Poulter.

Meteorological Office, South Farnborough.
December 24th, 1938.

NOTES AND NEWS

Lunar Rainbows.

Although undoubtedly the majority of lunar rainbows in the vicinity of the British Isles occur during instability showers in a polar current, it is possible to observe them occasionally under other conditions provided the local topography is suitable. The number of places where it is so must be very few, but one such place is along the west Somerset coast where lunar rainbows of long duration have been seen during continuous rain. A magnificent bow occurred there during the evening of November 3rd, 1911. The synoptic charts of those days were very meagre as judged by present day standards, and " fronts "

* *Meteorological Magazine* 73, 1938, pp. 142, 211, 298.

were unknown; but from the information available it appears that the synoptic situation was approximately as follows. At 7h. on November 3rd a depression was stationary over Iceland while another vigorous one off north-west Ireland was moving north-east. At 18h. it was centred between Iceland and the Faroes, and was occluding. The occlusion was indicated from Thorshaven across north-east Scotland to Holyhead, thence as a warm front to west of Scilly, while the cold front extended south-westwards south of Ireland. This analysis fits in well with the conditions observed by the writer at Minehead.

Warm front rain accompanied by a SSW gale set in about 19h. and continued until 22h., after which the wind veered SW, moderating to a strong breeze with drizzle and further veered to WNW fresh, about midnight. The rainbow was first observed about 20h., and reached its greatest brilliance from 21h. to 22h. during the period of heaviest rain, after which it faded to a white arc as the moon became more obscured by drizzle and visibility deteriorated, finally disappearing when the cold front arrived. Peculiar conditions are necessary for such a rainbow. During strong south-westerly winds on this coast the " fohn " effect is very marked, and is sufficient to disperse even medium cloud just north of the culminating ridges of Exmoor along the coast, in spite of the fact that it may be raining. On the evening in question there were dense layers of alto-stratus and nimbo-stratus over the whole sky with some fracto-stratus over the sea and near the hills to the south, while the clear patch was unusually large and persistent. The moon was in this clear strip the whole time and a magnificent rainbow resulted, showing the four colours violet, green, yellow and red quite strongly, with a secondary bow showing the colours faintly. The elevation of the arc was roughly 15 to 20 degrees, but was not measured.

The moon's age was approximately 12 days 18 hours or 2 days 18 hours before full moon and it southed at 21h. 45m., about the time of greatest brilliance of the rainbow.

The following description appeared in the local paper and gives a fair idea of the phenomenon.

" Those students of astronomy residing in the district who were privileged to see it must have been keenly interested in the lunar phenomenon which graced the northern sky on Friday evening. Rising, as it were, from the bosom of the Channel was an enormous luminous arch, exhibiting the prismatic colours of the rainbow, while the myriad lights scintillating along the Welsh coast formed a fairy setting at the foot of the dome, altogether creating an effect which is beyond the power of the pen to adequately portray. Later the arch lost its colour, but far into the night it continued to shed its beauty over the heavens, looking like a clear white semi-circle of light traced on a background of dark cloud."

Solar rainbows of long duration are not uncommonly seen in west Somerset in similar conditions.

It would be interesting to know if there are other places in the British Isles where such a spectacle can be seen.

T. F. TWIST.

Noteworthy Cloud Formation at Hythe, Kent.

At about 17h. 50m. G.M.T., on June 22nd, a faint and prolonged rumble of thunder to the south-east attracted my attention to some noteworthy cloud formations.

Towards the south-east and in the direction of Calais, there was an ominous cloud mass, composed of cumulo-nimbus, alto-stratus, and nimbo-stratus, some distance in front of this and at a height of approximately 5,000 ft. appeared a greyish cloud of well-defined comb-like structure extending from about 150° to 210° azimuth, with the teeth uppermost and slightly curved backwards. The whole mass was moving quickly west-north-west and reached Dungeness, where a heavy thunderstorm was experienced. The peculiar comb-like cloud maintained its structure for at least 20 minutes, then became a confused, elongated mass and disappeared as it reached the coast. As this cloud dispersed a belt of extremely dense stratus cloud, moving rapidly along its own length, formed on the surface of the sea almost immediately below.

During the whole period a strong northerly wind was bringing low (500 ft. M.S.L.) fracto-stratus cloud which continually dispersed as it approached the coast-line. Thus there was a convergence of cloud with a clear area between which gradually narrowed to zero with the formation of the low stratus mentioned in the previous paragraph. At about 19h. 50m. the south-moving fracto-stratus receded about 1,000 yards and the other masses generally dispersed. After a brief interval the south-moving stratus quickly extended, and by about 20h. 30m. reached well out over the Channel. Over mid-Channel there now appeared a line of huge cumulo-nimbus clouds, which extended east to west for as far as one could see, and reached to approximately 25,000 to 30,000 feet in height; these gradually moved north and caused moderate to heavy thunderstorms for some considerable distance along the coast.

Throughout the evening and night, the wind, up to at least 1,000 feet, remained north to north northeast, with a mean velocity of 25 to 30 m.p.h. (frequent gusts of 45 m.p.h. were recorded at Lympne) until about 3h. on June 23rd, when it decreased to 10 to 15 m.p.h.

A. W. BERRY.

Dr. M. A. F. Barnett.

It is announced that Dr. M. A. F. Barnett has been appointed to the Directorship of the Meteorological Office in New Zealand in succession to the late Dr. E. Kidson. Dr. Barnett was formerly in charge of the section dealing with Aeronautical Meteorology.

A new Climatological Station.

A new " Health Resort Station " has been set up at Perranporth, Cornwall, under the auspices of the Perranporth Trustees and Hotels and Boarding Houses Association.

Mirage in Cardigan Bay.

Miss Cicely M. Botley reports a mirage on July 26th, 1939, between 12h. and 13h. G.M.T. The inverted images of buildings along the coast were seen through field glasses from the parade at Aberystwyth, looking across the Bay. The day was fine and warm with good visibility; the sky was clear overhead but cumulus was observed over the high land.

A Cloud-Pendant observed in Northern Ireland.

Mr. J. Porter reports a well-developed cloud-pendant from Garvagh, Londonderry, on July 7th, 1939, at 11h. G.M.T. The sky was almost covered with heavy clouds, chiefly cumulus and cumulo-nimbus. The pendant was estimated to be about 6 miles away in a south-easterly direction and appeared stationary until it broke up at 11h. 15m. A thunderstorm of moderate intensity was reported from a north-westerly direction during the afternoon.

Depths of Snow Lying at Nottingham

During the past winter the depth of undrifted snow lying at 9 a.m. at Nottingham has been measured at four different points from north to south in descending

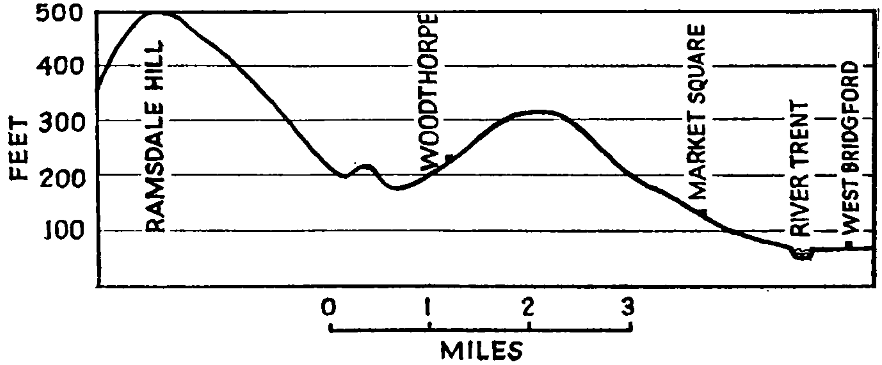

FIGURE 1. Section from Ramsdale Hill to West Bridgford.

heights. Ramsdale Hill is in open country; Woodthorpe and West Bridgford are residential suburbs, and the Market Square is in the centre of the business quarter of the city. An additional reading at 9 p.m. was made at Woodthorpe. The snow was measured on grass in each case.

The values given in Table I show how relatively small differences in height can affect the depth of snow lying. Woodthorpe, though only 150 feet higher than West Bridgford has consistently greater depths. Unfortunately the data for West Bridgford and the Market Square are incomplete.

TABLE I.—DEPTHS OF SNOW LYING

Date	Ramsdale Hill. 504 feet.	Woodthorpe 225 feet.		Market Sq. 120 feet.	West Bridgford. 78 feet.
	9 h. in.	9 h. in.	21 h. in.	9 h. in.	9 h. in.
Dec., 1938.					
19	..	..	Trace	..	Not taken, but observer reported : "Never more than 3 in."
20	0·75	1·00	2·50	0·50	
21	3·25	2·75	3·00	1·75	
22	7·00	4·75	2·50	3·75	
23	4·50	2·00	1·75	0·50	
24	4·50	1·75	1·75	0·50	
25	3·75	1·75	1·75	?	
26	4·25	2·25	1·75	?	
27	1·50	1·25	0·50	?	
28	0·50	0·50	0·00	?	
Jan., 1939.					
4	6·25	5·50	6·00	4·50	4·00
5	8·50	5·25	5·00	3·00	4·25
6	8·00	4·75	4·50	?	4·00
7	7·00	3·75	0·25	?	1·75
11	2·25	0·50	0·00	nil	nil
25	1·50	1·75	4·25	0·25	trace
26	4·50	1·50	0·00	nil	trace
27	1·00	nil	nil	nil	nil
28	0·50	0·25	nil	nil	nil

On January 4th, 1939, the Market Square and West Bridgford had similar amounts, but the reading on January 5th shows evidence of quicker thawing in the city centre.

ARNOLD B. TINN.

Engineering and Meteorology.

Recent issues of an American engineering publication *Heating, Piping and Air Conditioning* contain three articles of interest to meteorologists. Two of them deal with the effect of air conditioning on the " feel " of the air under different conditions. In the issue for July 1938 A. B. Newton and others describe " Shock experiences of 275 workers after entering and leaving cooled and air conditioned offices ". The report summarises about 22,000 daily questionnaire cards supplied by the staff of a large office in Minneapolis during 1937, each of whom described their sensations outdoors and inside the office and on entering or leaving, in terms of " ideal ", mildly or severely warm or cold. The standard of reference was the " effective temperature " which was determined from the dry bulb and relative humidity. The results are rather complex but show, as was to be expected, that the ideal indoor temperature fluctuates to some extent with that out of doors. With outside temperature below 53° F., the ideal for comfort is 66° F. or less on entering, but rises to about 70° F. for extended occupation. When the outside temperature is above 75° F. the ideal indoor temperature is 69–72° F. The ideal conditions for comfort change most rapidly when the outside temperature is about 60° F. The ideal outside temperature was also about 60° F., considerably lower than the ideal indoor temperature

In " Seasonal variations in effective temperature requirements " in the October issue F. E. Giesecke and W. H. Badgett describe experiments on ten male students under laboratory conditions at Texas. It is shown that the ideal indoor temperature has a range of 4–5° for different individuals but averages about 67° F. when the outside temperature is below that figure. As the outside temperature rises to 80 or 85° F. the ideal indoor temperature also rises to about 71° F. The results of the two investigations are thus in good agreement.

The same issue contains a description by E. C. Lundquist of experimental investigations into the air circulation in scale models of rooms. If the right air speed is selected the models fairly represent the circulation in the full size room. The experiments are reminiscent of those carried out by the late J. H. Field on a model of Gibraltar (*Geophysical Memoirs* No. 59). Mr. E. Gold suggests that other investigations into the atmospheric circulation over small scale models of mountainous regions or a steep escarpment might produce results of value.

Very severe thunderstorm with large hail on July 28th, 1205.

Ralph of Coggeshall has an account of this event in his Chronicon Anglicarium:—

Further, on the night of St. Felix (after the feast of St. James) there was so much crashing of horrible thunder and crackling of lightning, which ceased not to flash from the colliding clouds the entire night over the whole of England at one and the same time, that it was believed to be like the day of judgment: men and animals hardly breathed through the fear and trembling with anticipation which came upon the whole kingdom. For several people of both sexes in divers places were struck by lightning and perished. Also animals were similarly struck, houses thrown down and burned, crops broken by hailstones, which, in several places, were of the bigness of goose eggs and pointed on all sides. Several trees were torn up by the roots and carried away, some were twisted like ropes, and some were manifestly broken across the middle.

C. E. BRITTON.

Floods in the Tyne on August 12th, 1339.

The Chronicle of Lanercost Abbey gives an account of these floods:—

In the same year, on the third day before the assumption of the glorious Virgin, in the night, at Newcastle upon Tyne, there happened a marvellous inundation of waters whereby the wall of the town near to Walkenowe was broken down for a length of six perches, and 160 men and 7 priests, and more, were drowned.

Other records mention this calamity with varying figures for the casualties but all agree that the numbers were large. It is not possible to say whether the floods were due to heavy rains or exceptionally high tides.

C. E. BRITTON.

Sunshine, July, 1939.

The distribution of bright sunshine for the month was as follows:—

	Total hrs.	Diff. from average hrs.		Total hrs.	Diff. from average hrs.
Stornoway ..	57	−88	Chester ..	142	−31
Aberdeen ..	118	−34	Ross-on-Wye	124	−68
Dublin ..	105	−65	Falmouth ..	152	−65
Birr Castle ..	103	−46	Gorleston ..	204	− 7
Valentia ..	101	−56	Kew.. ..	186	− 8

Kew temperature, mean, 61·7° F.: diff. from average, −2·8° F.

REVIEWS

Temperatures and Humidities up to 3 kms. over Karachi. By P. R. Krishna Rao and K. L. Bhatia. Simla, Ind. Met. Dept. Sc. Notes VII, 78, 1938.

Officers of the India Meteorological Department are to be congratulated on their enthusiasm for extracting useful information from the observations at their disposal, instead of allowing valuable data to remain hidden on a shelf accumulating dust.

The note under review contains an analysis—rather too statistical—of the observations of upper air temperature and humidity made by the Royal Air Force Station at Drigh Road, near Karachi.

Tables are given of the mean monthly dry and wet bulb temperature, lapse-rate, humidity, vapour pressure, and air density at heights up to 3 kms. above sea level.

A comparison is made of the temperature and humidity data for Karachi with those for Quetta and Peshawar.

The discussion of the results, which is admittedly brief, would have been appreciated more readily if maps showing the mean pressure distribution had been incorporated in the paper. A forecaster would like to have seen, also, a detailed examination of more than one individual case to illustrate the predominant features of the structure of the upper air over Karachi. The single example given refers to the marked inversion between 1·0 and 1·5 kms., which is so persistent during the summer months. It is suggested that the development and maintenance of this inversion is attributable to the difference in radiative powers between layers of moist and dry air as well as to turbulence and convection in the moist air at lower levels. According to the authors, a detailed study is now being made of the inversions over Karachi. The results are awaited with interest.

R. G. VERYARD.

The Climate of Madeira, with a Comparative Study, by Hugo de Lacerda Castelo Branco (translated from the French). $10\frac{1}{2} \times 6\frac{1}{2}$, pp. 118 illus., Madeira: Delegaçao do Turiso da Madeira, 1938.

The study of Climate, especially at the winter health resorts, has been given a new amplitude and interest by the great work of Piéry*. He and his collaborators adduced conclusive evidence that the changing complex of climate was actually of governing importance, not only for aviation and agriculture but for the human organism, and was indeed a primordial therapeutic agent. This should hardly be surprising, considering that atmospheric influences operate on a breathing surface greatly exceeding that of the skin.

The present work, although it is not medical, nor very systematic, contains much interesting information. It exhibits in detail the meteorological elements and

* " Traité de Climatologie Biologique et Médicale ", 3 vols., 1935.

characters of what is described as the " finest climate in the world"* at Funchal on the south coast, in comparison with typical winter resorts in Europe. The outstanding feature at Funchal is the extraordinary equability of temperature, with only about eight degrees of seasonal range and none of the abrupt changes which are so injurious to winter invalids in colder latitudes. The Portuguese authority Narciso, with others, has described such climates as sedative over a wide range of functions, and as favourable to sleep and nutrition. Although often injurious in febrile diseases and advanced phthisis, they are clearly indicated in middle and later age for many nervous breakdowns and debility, the result of illness or overwork. Larger and more frequent thermal variations are undoubtedly more stimulating for healthy persons and for a different type of invalids. The winter warmth at Funchal is probably in large part due to the high temperature of the sea, 65° F. which the author compares with 53° at Estoril, 54° on the Cote d'Azur and 46° (?) at Mentone.

More precise observations on the climate of the island, both on the coast and at various altitudes in the hinterland (which rises to 1,800 metres) would undoubtedly throw light on its real value for health. Recent work shows that it is possible to measure the physiological reactions of climatic influences in various types of ill health, and that it is well to exchange the coast, at intervals, for a hill station. When these measurements can take the place of empirical impressions, the indications of a winter health resort can be put upon a scientific basis.

R. FORTESCUE FOX.

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* See letters on the " Best Climate in the World " on pages 208–209.

Daily Readings at Kew Observatory, July 1939

Date.	Pressure, M.S.L. 13h.	Wind, 13h. Dir.	Force	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS.
	mb.			°F.	°F.	%	in.	hrs.	
1	1012·8	WNW	3	50	65	48	trace	8·7	pr_0 18h.
2	1019·0	W	4	49	65	52	trace	7·0	pr_0 15h.
3	1021·1	SSW	4	55	69	56	—	7·2	
4	1012·6	SE	4	58	80	48	0·02	6·1	r_0–r 9h–10h, pr_0 11h.
5	1008·7	SW	5	64	70	53	0·05	5·5	r_0–r 7h–8h, pr_0 17h.
6	1017·0	SSW	5	56	63	67	0·15	4·1	pR 10h, r_0 15h–18h.
7	1013·1	SW	5	58	70	69	0·05	9·1	r_0 0h–1h & 4h–7h.
8	1012·0	SW	5	59	66	77	0·02	0·5	pr_0 16h, 18h & 19h.
9	1014·1	WSW	4	57	68	46	—	10·7	
10	1023·2	NW	3	53	68	58	—	8·1	
11	1023·2	NW	3	50	66	49	—	9·2	
12	1020·0	WNW	1	54	70	44	—	9·6	
13	1011·3	SW	3	53	69	53	—	9·9	
14	1002·1	SSW	4	53	67	69	0·07	5·3	r 3h–4h, d_0 9h & pr_0 14h.
15	1002·4	S	4	55	72	54	trace	10·1	pr_0 7h.
16	999·9	S	4	57	71	61	0·11	9·4	r_0 5h–6h, pr_0 9h.
17	1004·3	WSW	2	57	67	77	0·06	3·5	pr 10h, pr t 12h–14h.
18	1008·9	SSE	3	56	69	80	0·17	4·2	r 17h–18h, r–R 20h.
19	1003·4	SW	3	56	68	84	0·09	5·6	pr 9h, 10h & 13 h.
20	1010·7	SW	2	53	63	82	0·55	0·6	r_0–R 11h–16h, R 21h.
21	1013·3	S	3	58	65	78	0·26	0·5	tl r–r_0 14h–15h, t 19h.
22	1010·8	WSW	3	58	65	71	0·02	0·3	ir_0–r 19h–23h.
23	1008·5	W	3	55	65	51	0·01	4·1	pr 0h.
24	1001·5	NW	2	51	61	59	0·05	4·2	pr 7h & 16h, t 15h.
25	1015·3	NW	2	49	70	43	—	11·1	
26	1016·7	Calm		55	69	66	0·01	4·5	d_0 6h–7h, pr_0 9h & 13h.
27	1020·0	SW	4	51	70	55	trace	7·3	pr_0 17h & 21h.
28	1016·6	SSW	3	60	69	75	—	3·3	
29	1010·1	SSW	4	60	67	86	0·01	0·2	ir_0 8h–9h, pr_0 17h.
30	1006·8	W	3	62	72	57	0·01	7·6	pr_0 5h.
31	1011·6	WSW	3	57	67	78	0·08	8·1	rtl 13h, pr 14h & 16h.
*	1012·0	—		55	68	63	1·79	6·0	* Means or Totals

General Rainfall for July 1939

	Per cent.
England and Wales	171
Scotland	166
Ireland	145
British Isles	164

Rainfall: July 1939: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond'n	Camden Square......	1·62	68	*Warw*	Birminghm, Edgbaston	3·86	166
Surrey	Reigate, Wray Pk. Rd.	2·53	112	*Leics* .	Thornton Reservoir...	3·75	151
Kent .	Tenterden, Ashenden.	2·33	111	,, .	Belvoir Castle........	4·00	165
,, .	Folkestone, I. Hospital	1·90	..	*Rutl'd*	Ridlington	5·55	221
,, .	Margate, Cliftonville..	1·46	74	*Lincs* .	Boston, Skirbeck.....	2·25	102
,, .	Edenb'dg., Falconhurst	2·50	109	,, .	Cranwell Aerodrome..	2·46	106
Sussex	Compton, Compton Ho	3·72	131	,, .	Skegness, Marine Gdns	1·95	87
,, .	Patching Farm.......	2·33	97	,, .	Louth, Westgate.....	2·68	107
,, .	Eastbourne, Wil. Sq..	1·72	79	,, .	Brigg, Wrawby St....	5·09	..
Hants .	Ventnor, Roy.Nat.Hos.	2·43	120	*Notts* .	Mansfield, Carr Bank..	3·92	150
,, .	Southampton, East Pk	4·71	207	*Derby* .	Derby, The Arboretum	4·51	183
,, .	Ovington Rectory....	5·51	214	,, .	Buxton, Terrace Slopes	8·72	222
,, .	Sherborne St. John...	3·72	167	*Ches* .	Bidston Obsy........	6·12	236
Herts .	Royston, Therfield Rec	2·16	86	*Lancs* .	Manchester, Whit. Pk.	6·12	185
Bucks .	Slough, Upton.......	2·23	116	,, .	Stonyhurst College...	6·80	176
Oxford	Oxford, Radcliffe.....	4·18	176	,, .	Southport, Bedford Pk	5·82	203
N'hant	Wellingboro, Swanspool	2·34	102	,, .	Ulverston, Poaka Beck	8·26	182
,, .	Oundle	2·76	..	,, .	Morecambe..........	5·88	185
Beds .	Woburn, Exptl. Farm.	2·28	102	,, .	Blackpool...........	5·01	172
Cambs	Cambridge, Bot. Gdns.	1·38	64	*Yorks* .	Wath-upon-Dearne...	5·13	204
,, .	March	2·63	111	,, .	Wakefield, Clarence Pk.	5·83	230
Essex .	Chelmsford, CountyGns	3·53	166	,, .	Oughtershaw Hall....	7·12	..
,, .	Lexden Hill House....	1·95	..	,, .	Harrog'te, HarlowMoor	5·81	211
Suff .	Haughley House.....	2·66	..	,, .	Hull, Pearson Park...	2·27	97
,, .	Campsea Ashe, High Ho	3·10	135	,, .	Holme-on-Spalding...	5·90	228
,, .	Lowestoft Sec. School.	2·27	100	,, .	Felixkirk, Mt. St. John	4·25	156
,, .	Bury St. Ed., WestleyH	3·39	136	,, .	York, Museum.......	4·20	167
Norf. .	Wells, Holkham Hall.	1·82	78	,, .	Pickering, Houndgate.	2·01	75
Wilts .	Porton, W.D. Exp'lStn	5·55	280	,, .	Scarborough.........	2·32	95
,, .	Bishops Cannings	4·69	188	,, .	Middlesbrough.......	2·72	106
Dorset	Weymouth, Westham.	3·66	203	,, .	Baldersdale, Hury Res.	..	..
,, .	Beaminster, East St ..	6·27	241	*Durhm*	Ushaw College.......	3·99	143
,, .	Shaftesbury	5·37	..	*Norl'd*	Newcastle, Leazes Pk.	3·09	121
Devon .	Plymouth, The Hoe...	5·02	182	,, .	Bellingham, Highgreen	3·52	107
,, .	Holne, Church Pk.Cott	10·74	305	,, .	Lilburn Tower Gdns..	2·36	96
,, .	Teignmouth, Den Gdns	6·70	288	*Cumb* .	Carlisle, Scaleby Hall.	5·39	165
,, .	Cullompton	6·53	243	,, .	Borrowdale, Seathwaite	14·00	177
,, .	Sidmouth, U.D.C.....	4·78	..	,, .	Thirlmere, DaleHeadH.	10·42	174
,, .	Barnstaple, N. Dev.Ath	5·28	196	,, .	Keswick, High Hill...	7·69	200
,, .	Dartm'r, Cranmere P'l	12·10	..	,, .	Ravenglass, The Grove	5·86	156
,, .	Okehampton, Uplands.	8·34	257	*West* .	Appleby, Castle Bank.	3·85	122
Cornw	Redruth, Trewirgie...	7·37	242	*Mon* .	Abergavenny, Larchf'd	7·29	293
,, .	Penzance, MorrabGdns	5·15	189	*Glam* .	Ystalyfera, Wern Ho..	13·24	288
,, .	St. Austell, Trevarna..	8·15	243	,, .	Treherbert, Tynywaun	17·78	..
Soms .	Chewton Mendip.....	4·69	134	,, .	Cardiff, Penylan......	6·38	207
,, .	Long Ashton	4·46	158	*Carm* .	Carmarthen, M.&P.Sc.	..	..
,, .	Street, Millfield	4·27	174	*Card* .	Aberystwyth	7·95	..
Glostr.	Blockley	4·75	..	*Radn'r*	Bir. W. W. Tyrmynydd	9·37	228
,, .	Cirencester, Gwynfa ..	4·78	185	*Mont* .	Lake Vyrnwy........	10·46	305
Here .	Ross-on-Wye	3·95	174	*Flint* .	Sealand Aerodrome...	5·21	228
,, .	Kington, Lynhales....	6·34	261	*Mer* .	Blaenau Festiniog....	14·84	190
Salop .	Church Stretton......	6·38	..	,, .	Dolgelley, Bontddu...	9·86	231
,, .	Shifnal, Hatton Grange	5·30	236	*Carn* .	Llandudno	3·73	167
,, .	Cheswardine Hall	6·96	257	,, .	Snowdon, L. Llydaw 9	21·10	..
Worc .	Malvern, Free Library.	4·54	199	*Angl* .	Holyhead, Salt Island.	4·70	180
,, .	Ombersley, Holt Lock.	5·11	239	,, .	Lligwy..............	4·87	..
Warw	Alcester, Ragley Hall.	6·17	259	*I.Man*	Douglas, Boro' Cem...	4·10	134

Rainfall: July 1939: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Guern.	St.PeterP't.GrangeRd.	3·18	157	*R&C.*	Stornoway, C.G.Stn.	5·66	197
Wig	Pt. William, Monreith.	4·29	153	*Suth*	Lairg	4·38	140
,,	New Luce School	3·98	117	,,	Skerray Borgie	5·25	..
Kirk	Dalry, Glendarroch	5·35	149	,,	Melvich	5·33	190
Dumf.	Eskdalemuir Obs	7·21	176	,,	Loch More, Achfary	6·94	130
Roxb	Hawick, Wolfelee	3.43	111	*Caith*	Wick	4·66	177
,,	Kelso, Broomlands	3·01	114	*Orkney*	Deerness	5·29	206
Peebs	Stobo Castle	3·29	113	*Shet*	Lerwick Observatory.	3·67	160
Berw	Marchmont House	3·50	115	*Cork*	Cork, University Coll.	4·20	155
E.Lot.	North Berwick Res	2·75	107	,,	Roches Point, C.G.Stn.	5·28	183
Midl	Edinburgh, Blackfd. H	2·33	83	,,	Mallow, Hazlewood	3·23	..
Lanark	Auchtyfardle	2·65	..	*Kerry.*	Valentia Observatory.	6·15	163
Ayr	Kilmarnock, Kay Park	4·60	..	,,	Gearhameen	8·70	151
,,	Girvan, Pinmore	3·27	90	,,	Bally McElligott Rec.	5·05	..
,,	Glen Afton, Ayr San.	3·86	92	,,	Darrynane Abbey	5·28	139
Renf	Glasgow, Queen's Park	4·04	138	*Wat*	Waterford, Gortmore.	5·75	181
,,	Greenock, Prospect H.	5·39	146	*Tip*	Nenagh, Castle Lough.	3·03	96
Bute	Rothesay, Ardencraig.	7·24	183	,,	Cashel, Ballinamona	3·99	139
,,	Dougarie Lodge	5·34	168	*Lim*	Foynes, Coolnanes	3·27	106
Argyll	Loch Sunart, G'dale	7·36	158	,,	Limerick, Mulgrave St.	3·11	107
,,	Ardgour House	11·07	..	*Clare*	Inagh, Mount Callan	7·47	..
,,	Glen Etive	10·56	181	*Wexf*	Gorey, Courtown Ho.	5·31	181
,,	Oban	8·12	..	*Wick*	Rathnew, Clonmannon	3·37	..
,,	Poltalloch	7·25	176	,,	Blessington Rectory	4·85	..
,,	Inveraray Castle	10·56	212	*Carlow*	Bagnalstown FenaghH	6·52	207
,,	Islay, Eallabus	5·15	151	,,	Hacketstown Rectory.	4·70	136
,,	Mull, Benmore	14·70	146	*Leix*	Blandsfort House	3·58	114
,,	Tiree	..	..	*Offaly*	Birr Castle	3·59	122
Kinr	Loch Leven Sluice	4·84	168	*Dublin*	Dublin, Phoenix Park.	2·57	96
Fife	Leuchars Aerodrome	3·13	120	*Meath.*	Kells, Headfort	4·41	139
Perth	Loch Dhu	8·75	181	*W.M*	Moate, Coolatore	4·14	..
,,	Crieff, Strathearn Hyd.	5·47	184	,,	Mullingar, Belvedere	5·48	172
,,	Blair Castle Gardens	5·40	211	*Long*	Castle Forbes Gdns	4·39	141
Angus.	Kettins School	3·80	147	*Galway*	Galway, Grammar Sch.	4·11	128
,,	Pearsie House	4·70	..	,,	Ballynahinch Castle	4·32	104
,,	Montrose, Sunnyside	4·66	177	,,	Ahascragh, Clonbrock.	3·90	112
Aberd.	Balmoral Castle Gdns.	4·70	184	*Rosc*	Strokestown, C'node	4·56	163
,,	Logie Coldstone Sch	..	..	*Mayo.*	Blacksod Point	4·63	147
,,	Aberdeen Observatory.	4·88	174	,,	Mallaranny	7·01	..
,,	New Deer SchoolHouse	4.91	160	,,	Westport House	2·70	87
Moray	Gordon Castle	4·31	135	,,	Delphi Lodge	11·34	171
,,	Grantown-on-Spey	5·71	186	*Sligo*	Markree Castle	4·86	140
Nairn.	Nairn	6·31	235	*Cavan.*	Crossdoney, Kevit Cas.	4·64	..
Inv's	Ben Alder Lodge	5·37	..	*Ferm*	Crom Castle	5·20	149
,,	Kingussie, The Birches	5·26	..	*Arm'h*	Armagh Obsy	4·41	153
,,	Loch Ness, Foyers	..	..	*Down.*	Fofanny Reservoir	7·10	..
,,	Inverness, Culduthel R	5·15	198	,,	Seaforde	4·49	141
,,	Loch Quoich, Loan	9·27	..	,,	Donaghadee, C. G. Stn.	4·20	150
,,	Glenquoich	9·23	144	*Antrim*	Belfast, Queen's Univ	5·62	189
,,	Arisaig House	9·02	182	,,	Aldergrove Aerodrome	6·08	217
,,	Glenleven, Corrour	6·89	166	,,	Ballymena, Harryville.	5·44	159
,,	Ft. William, Glasdrum	8·08	..	*Lon*	Garvagh, Moneydig	4·76	..
,,	Skye, Dunvegan	7·86	..	,,	Londonderry, Creggan.	4·46	122
,,	Barra, Skallary	5·62	..	*Tyrone*	Omagh, Edenfel	4·23	124
R&C.	Tain, Ardlarach	7·87	266	*Don*	Malin Head	4·43	130
,,	Ullapool	7·41	234	,,	Dunfanaghy	4·28	146
,,	Achnashellach	7·24	141	,,	Dunkineely	3·92	..

Climatological Table for the British Empire, February, 1939

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1018·8	+ 2·8	56	28	48·0	37·2	42·6	+ 1·9	38·1	90	6·5	0·80	− 0·74	7	3·7	38
Gibraltar	1021·5	+ 1·5	63	42	58·6	49·8	54·2	− 1·6	49·3	78	5·3	3·33	—	10	6·4	59
Malta	1017·3	+ 1·2	62	45	59·7	51·5	55·6	+ 0·3	51·3	81	4·9	1·83	− 0·37	7	6·5	60
St. Helena	1015·1	− 0·8	72	58	69·1	60·7	64·9	− 0·3	61·8	93	9·4	5·03	+ 2·35	27	—	—
Freetown, Sierra Leone	1011·3	+ 2·2	89	72	86·4	74·7	80·5	—	72·5	85	6·0	0·22	− 0·08	2	—	—
Lagos, Nigeria	1009·3	− 0·4	90	70	87·3	74·3	80·8	− 1·7	75·0	93	6·2	1·78	− 0·12	4	5·9	50
Kaduna, Nigeria	1009·3	—	94	59	89·9	64·3	77·1	− 0·6	59·3	55	3·0	0·10	+ 0·08	1	8·1	69
Zomba, Nyasaland	1007·5	− 0·6	87	63	80·7	65·6	73·1	+ 1·1	70·3	80	7·4	3·54	− 7·11	17	—	—
Salisbury, Rhodesia	1008·3	− 1·8	81	58	76·0	60·4	68·2	− 0·6	63·5	84	9·0	16·81	—	25	4·6	36
Cape Town	1012·3	− 1·1	89	54	79·6	61·3	70·5	+ 0·2	62·9	77	3·3	1·60	+ 1·02	4	—	—
Johannesburg	1008·8	− 1·8	84	54	73·6	57·5	65·5	− 0·1	60·0	89	8·8	7·33	+ 2·11	17	4·7	36
Mauritius	1012·3	+ 1·5	93	69	87·4	73·9	80·7	+ 1·4	75·4	72	5·4	4·94	− 2·57	18	8·9	70
Calcutta, Alipore Obsy.	1013·4	+ 0·1	95	53	86·6	63·3	74·9	+ 3·7	63·7	86	3·5	1·48	+ 0·49	2*	—	—
Bombay	1012·3	− 0·4	90	65	83·7	69·1	76·4	+ 0·7	67·9	74	0·2	0·00	− 0·03	0*	—	—
Madras	1013·2	+ 0·3	89	60	85·7	66·8	76·3	− 1·4	69·6	78	1·7	0·00	− 0·30	0*	—	—
Colombo, Ceylon	1011·6	+ 0·8	92	63	87·5	69·4	78·5	− 1·9	73·0	69	2·1	0·05	− 1·89	2	10·1	85
Singapore	1010·5	+ 0·3	89	71	86·7	73·6	80·1	− 0·1	75·7	73	7·6	6·33	− 0·29	14	6·4	53
Hongkong	1019·2	+ 0·6	76	54	67·8	59·2	63·5	+ 4·4	58·5	76	7·1	0·02	− 1·81	1	4·9	43
Sandakan	1010·1	—	86	72	83·4	74·0	78·7	− 1·5	75·6	87	8·6	25·53	+14·56	14	—	—
Sydney, N.S.W.	1014·3	+ 0·4	102	59	80·8	67·3	74·1	+ 2·8	67·5	65	4·2	0·12	− 4·08	3	8·4	63
Melbourne	1013·5	− 1·0	107	50	80·0	58·2	69·1	+ 1·5	59·9	58	5·5	7·72	+ 6·01	10	7·3	54
Adelaide	1013·9	− 0·4	111	51	89·1	61·6	75·3	+ 1·3	62·1	38	3·4	1·74	+ 1·02	8	9·2	69
Perth, W. Australia	1013·1	+ 0·1	105	57	86·4	63·7	75·1	+ 1·0	63·4	50	2·9	1·14	+ 0·69	6	10·2	78
Coolgardie	1012·8	+ 0·4	107	50	89·9	63·0	76·5	+ 0·3	62·8	49	3·2	0·01	− 0·84	1	—	—
Brisbane	1015·3	+ 2·8	103	65	83·7	68·8	76·3	− 0·2	69·9	67	7·0	2·61	− 3·73	9	7·1	54
Hobart, Tasmania	1013·0	− 0·2	95	44	71·1	52·4	61·7	− 0·6	54·9	62	5·5	2·15	+ 0·67	8	7·7	56
Wellington, N.Z.	1015·4	− 0·4	74	44	67·8	52·9	60·3	− 2·3	56·8	73	6·7	0·68	− 2·46	7	7·4	54
Suva, Fiji	1007·9	+ 0·1	90	73	86·9	75·3	81·1	+ 0·8	76·1	83	6·2	5·71	− 5·01	21	6·6	52
Apia, Samoa	1008·3	− 0·1	87	74	83·6	75·7	79·7	+ 0·7	76·4	81	7·6	18·65	+ 3·36	19	5·4	43
Kingston, Jamaica	1016·1	+ 0·8	91	64	85·9	67·5	76·7	+ 0·2	64·2	79	1·5	0·73	+ 0·13	3	6·7	58
Grenada, W.I.	1010·6	− 2·9	90	72	87·0	74·0	80·5	+ 3·4	74·0	79	4	3·49	+ 0·71	14	—	—
Toronto	1017·2	− 0·8	46	−7	32·3	17·3	24·8	+ 3·7	21·5	77	7·2	3·62	+ 1·24	14	3·4	32
Winnipeg	1020·6	− 1·2	32	−38	0·2	−18·1	−8·9	− 9·0	—	—	4·1	1·48	+ 0·74	14	5·4	53
St. John, N.B.	1017·6	+ 3·7	50	−1	30·3	10·8	20·5	+ 0·6	15·8	75	1·5	6·30	+ 2·40	18	3·7	36
Victoria, B.C.	1018·5	+ 1·9	50	24	43·8	34·4	39·1	− 1·4	36·8	88	7·3	3·54	+ 0·28	15	3·1	30
Addenda: January. Grenada, W.I.	1009·9	− 2·9	91	72	88·0	74·0	81·0	+ 3·9	74·0	74	4	5·95	+1·57	23	—	—

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

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