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EXTREME WIND SPEEDS OVER GREAT BRITAIN AND NORTHERN IRELAND

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Introduction.—Requests are frequently received from design or consulting engineers for information on the maximum wind velocities which are to be expected in various parts of the country. This information is needed in order to calculate the greatest wind pressures which may effect a given structure so that this structure (which may be a tall building, a chimney stack, a tower, a bridge, etc.) can be designed to withstand such pressure. Thus the engineer requires from the climatologist estimates of the probable maximum velocity for a specified interval and the probable maximum gust at a given place and height above the ground.

The climatologist has at his disposal the anemograph records from a network of stations which may cover the country more or less adequately, although there may be important gaps. In the past the usual procedure has been to examine the wind records from the station, or stations, nearest to the site and to take out the highest speeds so far recorded. These have then been adjusted, using the appropriate velocity–height relations,[1, 2] so as to be representative of the desired height above the ground (which may be several hundreds of feet), and an approximate allowance made for difference in exposure. The anemograph will normally be on a fairly open and level site while the proposed structure may be sheltered by other buildings, etc. or may be on a hill-top.

Objections to the procedure outlined above are, first, that the absolute extreme value tends to increase as the length of record increases, whereas the periods over which wind records in this country are available vary from less than 10 years to a little over 40 years; and second, that it is statistically unsound to try to estimate the largest possible value without regard to the frequency with which very high values are likely to occur. What is really required is an estimate of the probability of occurrence of extreme values based not on one extreme alone but on all the values available. This should enable the engineer to design his structure economically on the basis of a calculated risk, that is, that it would fail within a specified time interval, say 100 years. The requirement can be met by applying to the data the statistical theory of extreme values, as developed by Gumbel[3] and others.

TABLE I—ANNUAL MAXIMUM WIND SPEEDS (GUSTS) AT CARDINGTON, 1932–54

Rank m	Highest gust x m.p.h.	Year	Plotting position $p = \frac{m}{n+1}$	Reduced variate $y = -\log_e(-\log_e p)$
1	55	1953	0·042	−1·16
2	59	1950	0·083	−0·91
3	60	1941	0·125	−0·73
4	61	1951	0·167	−0·58
5	62	1952	0·208	−0·45
6	63	1937	0·250	−0·33
7	63	1939	0·292	−0·21
8	64	1942	0·333	−0·09
9	65	1933	0·375	0·02
10	67	1949	0·417	0·13
11	68	1948	0·458	0·25
12	69	1945	0·500	0·37
13	71	1940	0·542	0·49
14	72	1934	0·583	0·62
15	72	1944	0·625	0·75
16	76	1954	0·667	0·90
17	78	1943	0·708	1·06
18	78	1946	0·750	1·25
19	81	1932	0·792	1·46
20	82	1936	0·833	1·70
21	86	1938	0·875	2·01
22	88	1935	0·917	2·44
23	93	1947	0·958	3·15

Application of extreme probability theory to annual extreme wind speeds.—Table I lists the highest gust speeds in miles per hour recorded at Cardington in the years 1932–1954 inclusive, arranged in order of size from the smallest to the largest. The fourth column gives the corresponding values of $\frac{m}{n+1}$ where m is the rank and n the number of observations, in this case 23; they provide plotting positions for use on extreme probability graph paper and may be regarded as representing the frequencies with which the corresponding values of x (highest gust) are not exceeded. Extreme value probability graph paper has a uniform scale along one axis, usually the vertical. This is used for the observed values. The horizontal axis is the probability scale and it is marked according to the formula $y = -\log_e(-\log_e p)$. On this scale the limiting values $p = 0$ and $p = 1$ are never reached but if $p = \cdot 01$ were taken as $y = 0$ then $p = \cdot 05$ would be 2·034 units, $p = \cdot 09$ would be 6·963 units and $p = \cdot 9999$ would be 10·877 units to the right of the origin. If a set of extreme values conforms to Gumbel's theory, then when those values are plotted again $p = \frac{m}{n+1}$ on extreme value probability paper the points obtained will lie along a straight line. If extreme value probability paper is not available then values of $y = -\log_e(-\log_e p)$ can either be computed or taken from published tables.[4] The extremes can then be plotted against y on ordinary graph paper. Values of y for the set of highest gust data from Cardington are given in the last column of Table I and Figure 1 shows the plotted data for both the highest gusts and the highest mean hourly speeds recorded at that station during the years 1932–1954 inclusive. Both the p and y scales are shown and also that of T, the return period in years, which is equal to $\frac{1}{1-p}$. This is the average time interval between recurrences of an event and is useful

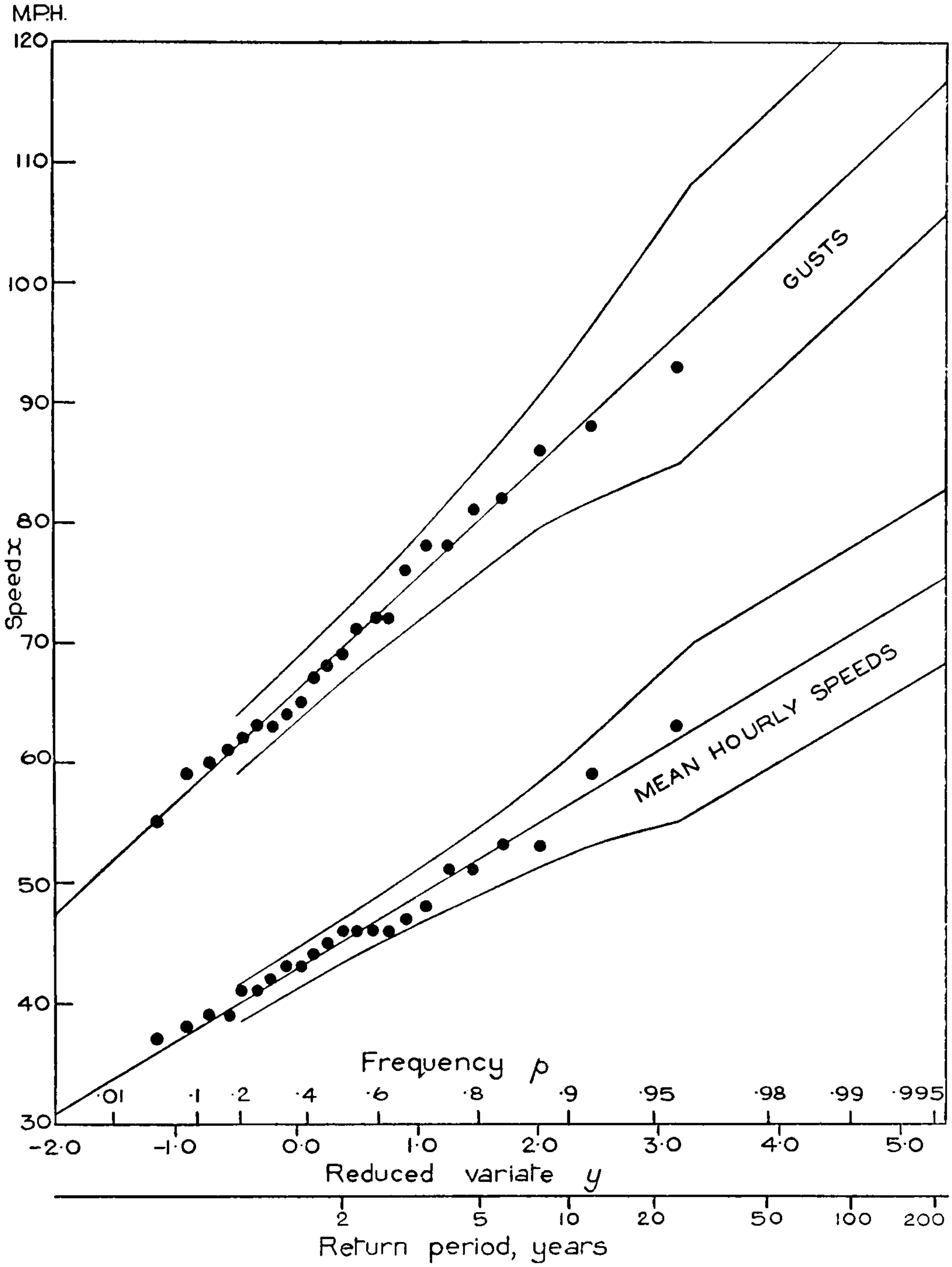

FIGURE 1—ANNUAL MAXIMUM WIND SPEEDS, CARDINGTON, 1932–54

because it allows the annual maximum value which may be expected to be exceeded on the average only once in any desired number of years to be read off directly from the graph.

It can be seen from Figure 1 that the Cardington wind data fit the theory quite well and the fitted straight lines have been computed and drawn in. The lines on either side are called control curves and they indicate the limits

TABLE II—MAXIMUM MEAN HOURLY WIND SPEEDS IN MILES PER HOUR AT 33 FEET ABOVE THE GROUND

Station	No. of years of record	Period of record used	Speeds likely to be exceeded only once in stated no. of years: 10	20	50	100	Highest on record	Mean annual maximum
Lerwick...	24	1931–54	67	70	75	79	73	57·7
Kirkwall	14	1930–43	58	61	65	69	59	50·1
Stornoway	18	1937–54	67	71	77	81	73	56·5
Aberdeen	15	1933–47	44	47	52	55	44	35·5
Balmakewan	21	1915–35	45	48	53	56	51	36·8
Bell Rock	25	1930–54	57	60	63	66	59	49·3
Edinburgh	38	1915–33 1936–54	56	59	63	65	59	49·5
Tiree	28	1927–54	62	67	73	77	64	51·5
Paisley ...	41	1914–54	41	43	46	48	43	36·2
Prestwick	11	1944–54	52	55	58	61	48	45·2
Eskdalemuir	32	1914–45	54	57	60	63	56	47·1
Point of Ayre	19	1936–54	59	63	67	71	63	49·9
Durham	17	1938–54	48	51	55	57	50	41·2
South Shields	21	1934–54	56	60	66	71	61	44·7
Catterick	10	1933–42	51	56	62	67	49	38·8
Spurn Head	29	1922–46 1948–50, 54	56	59	62	65	59	50·1
Cranwell	23	1928–42, 44 1947–48, 50–54	47	50	54	57	49	38·7
Gorleston	36	1913–31, 34–39 1941–46, 48, 51–54	50	53	57	59	55	43·8
Felixstowe	17	1931–35, 37–38 1944–52, 54	45	48	51	54	45	39·1
Mildenhall	17	1938–54	48	52	57	61	56	37·7
Cardington	23	1932–54	44	48	52	56	49	36·2
Shoeburyness	29	1926–54	46	49	52	55	48	39·7
Leicester	10	1938–40, 43–45 1947–50	45	50	56	61	42	33·0
Birmingham	31	1924–54	38	40	43	46	38	31·7
London (Kingsway)	11	1944–54	37	40	43	46	34	29·7
Croydon	23	1928–39 1944–54	41	44	47	50	45	34·8
Kew Observatory	24	1931–54	33	34	36	38	34	28·9
Dover	21	1924–39 1948–50, 53–54	44	45	48	50	46	39·1
Lympne	27	1923–29, 31–43 1945–51	48	50	54	56	52	42·0
Manston	12	1943–54	46	48	51	54	45	39·6
Thorney Island	12	1943–54	43	46	50	53	45	36·2
Calshot ...	24	1920, 22–41 1950–52	51	54	58	61	50	43·0
S. Farnborough	10	1945–54	50	55	62	68	49	36·8
Boscombe Down	22	1933–54	48	51	54	57	49	41·4
Larkhill...	24	1931–54	46	48	51	53	46	40·6

between which each extreme value should lie with a probability of ·68, the theory being accepted if all the observations lie between them. By extrapolating the fitted straight line it is possible to predict the return period corresponding to any desired speed or the speed which has any desired return period. With only 20 to 30 years of record available it would probably be unwise to carry the extrapolation very far, certainly not beyond 100 years. Thus from Figure 1 it may be inferred that the speeds which are likely to be exceeded only once in 50 years are 103 miles per hour in a gust and 66 miles per hour averaged over one hour. These speeds relate to the effective height of the Cardington anemograph, that is, 135 feet above the ground.

TABLE II—MAXIMUM MEAN HOURLY WIND SPEEDS IN MILES PER HOUR AT 33 FEET ABOVE THE GROUND (CONT.)

Station	No. of years of record	Period of record used	Speeds likely to be exceeded only once in stated no. of years 10	20	50	100	Highest on record	Mean annual maximum
Fleetwood ...	29	1924–43, 1946–54	61	65	70	73	62	52·5
Manchester Airport ...	10	1942–50, 1954	54	58	63	67	54	44·3
Southport ...	42	1913–54	60	63	68	71	65	51·0
Bidston	25	1929–44, 1946–54	57	60	65	68	62	48·3
Sealand... ...	19	1928–41, 1943–47	49	52	56	59	53	41·4
Holyhead ...	19	1933–51	61	64	69	73	64	51·7
Aberporth ...	10	1945–54	56	60	66	70	56	45·4
St. Ann's Head	14	1935–46, 1948–49	69	75	83	89	70	54·9
Plymouth ...	30	1921–43, 1947–48, 50–54	53	57	61	64	58	45·4
The Lizard ...	17	1935–42, 45–47, 1949–54	63	66	70	74	67	54·8
Pendennis Castle	20	1929–38, 1941–50	65	68	72	75	67	58·2
Scilly	28	1927–54	62	66	71	75	67	53·1
Aldergrove ...	25	1928–46, 1949–54	45	48	51	54	48	38·9

TABLE III—MAXIMUM GUST SPEEDS IN MILES PER HOUR AT 33 FEET ABOVE THE GROUND

Station	No. of years of record	Period of record used	Speeds likely to be exceeded only once in stated no. of years 10	20	50	100	Highest on record	Mean annual maximum
Lerwick... ...	24	1931–54	98	102	108	112	101	87·0
Kirkwall ...	14	1930–43	92	97	102	106	100	82·3
Stornoway ...	18	1937–54	103	110	119	126	107	85·7
Aberdeen ...	15	1933–47	78	83	89	93	83	67·8
Balmakewan ...	21	1915–35	76	82	89	94	87	62·8
Bell Rock ...	25	1930–54	90	95	101	106	91	77·2
Edinburgh ...	38	1915–33, 1936–54	86	90	96	99	87	76·7
Tiree	28	1927–54	96	102	111	118	106	79·7
Paisley	41	1914–54	87	93	99	105	104	74·7
Prestwick ...	11	1944–54	87	92	98	103	85	74·9
Eskdalemuir ...	32	1914–45	88	93	100	105	91	75·3
Point of Ayre ...	19	1936–54	88	93	99	104	90	75·9
Durham ...	17	1938–54	90	96	102	107	95	78·1
South Shields ...	21	1934–54	84	90	97	103	86	70·8
Catterick ...	10	1933–42	86	92	99	105	88	71·1
Spurn Head ...	29	1922–46, 1948–50, 54	85	90	96	101	91	73·7
Cranwell ...	24	1928–44, 1947–48, 50–54	88	96	106	113	108	68·7
Gorleston ...	36	1914–31, 34–39, 1941–48, 51–54	76	80	86	90	82	66·2
Felixstowe ...	17	1931–35, 37–38, 1944–52, 54	81	87	95	101	85	66·3
Mildenhall ...	17	1938–54	88	94	103	110	94	71·3

TABLE III—MAXIMUM GUST SPEEDS IN MILES PER HOUR AT 33 FEET ABOVE THE GROUND (CONT.)

Station	No. of years of record	Period of record used	Speeds likely to be exceeded only once in stated no. of years: 10	20	50	100	Highest on record	Mean annual maximum
Cardington ...	23	1932–54	78	84	91	97	83	63·1
Shoeburyness ...	29	1926–54	75	79	85	90	79	64·2
Leicester ...	10	1938–40; 1943–45, 47–50	83	91	101	108	84	65·2
Birmingham ...	31	1924–54	75	80	87	92	79	63·3
London (Kingsway) ...	11	1944–54	79	86	95	102	77	61·3
Croydon ...	23	1928–39; 1944–54	76	80	86	90	77	64·8
Kew Observatory	24	1931–54	71	74	79	83	71	61·9
Dover	21	1924–39; 1948–50, 53–54	74	78	84	88	85	63·5
Lympne ...	27	1923–29, 31–43; 1945–51	80	84	89	93	84	69·8
Manston ...	12	1943–54	78	82	87	91	80	68·1
Thorney Island	12	1943–54	79	83	89	94	81	68·3
Calshot	24	1920, 22–41; 1950–52	80	85	92	98	86	67·2
S. Farnborough	10	1945–54	78	82	89	93	79	66·0
Boscombe Down	22	1933–54	79	84	89	94	86	68·7
Larkhill... ...	24	1931–54	78	82	86	90	80	70·2
Fleetwood ...	29	1924–43; 1946–54	88	93	100	106	91	75·4
Manchester Airport ...	10	1942–50; 1954	91	97	105	111	90	75·7
Southport ...	42	1913–54	89	94	101	106	93	76·5
Bidston	25	1929–44; 1946–54	95	100	107	112	100	82·3
Sealand... ...	18	1928–41; 1944–47	82	87	93	97	86	70·7
Holyhead ...	19	1933–51	94	100	107	113	107	79·1
Aberporth ...	10	1945–54	93	100	110	117	92	75·2
St. Ann's Head	13	1935–45; 1948–49	105	112	122	128	>107	88·3
Plymouth ...	30	1921–43; 1947–48, 50–54	80	85	92	97	91	67·2
The Lizard ...	17	1935–42; 1945–47, 49–54	93	97	101	105	94	84·7
Pendennis Castle	20	1929–38; 1941–50	100	106	114	120	102	85·2
Scilly	28	1927–54	98	104	111	116	107	84·8
Aldergrove ...	25	1928–46; 1949–54	83	88	94	99	87	71·5

Results.—The wind data from 49 anemograph stations have been analysed in this way and the results are set out in Table II, which refers to mean hourly speeds and Table III, which refers to gust speeds. In every case the values refer to a height of 10 metres (33 feet) above the ground and have been reduced to that level using the formulae

$$v_{10} = v_h \left[\frac{10}{h}\right]^{0.17} \quad \text{for mean speeds[5] and}$$

$$v_{10} = v_h \left[\frac{10}{h}\right]^{0.085} \quad \text{for gusts,[6]}$$

where h is the effective height of the anemograph. The highest speeds on record, up to December 1954, the mean annual maxima and the number of years of the record are also given.

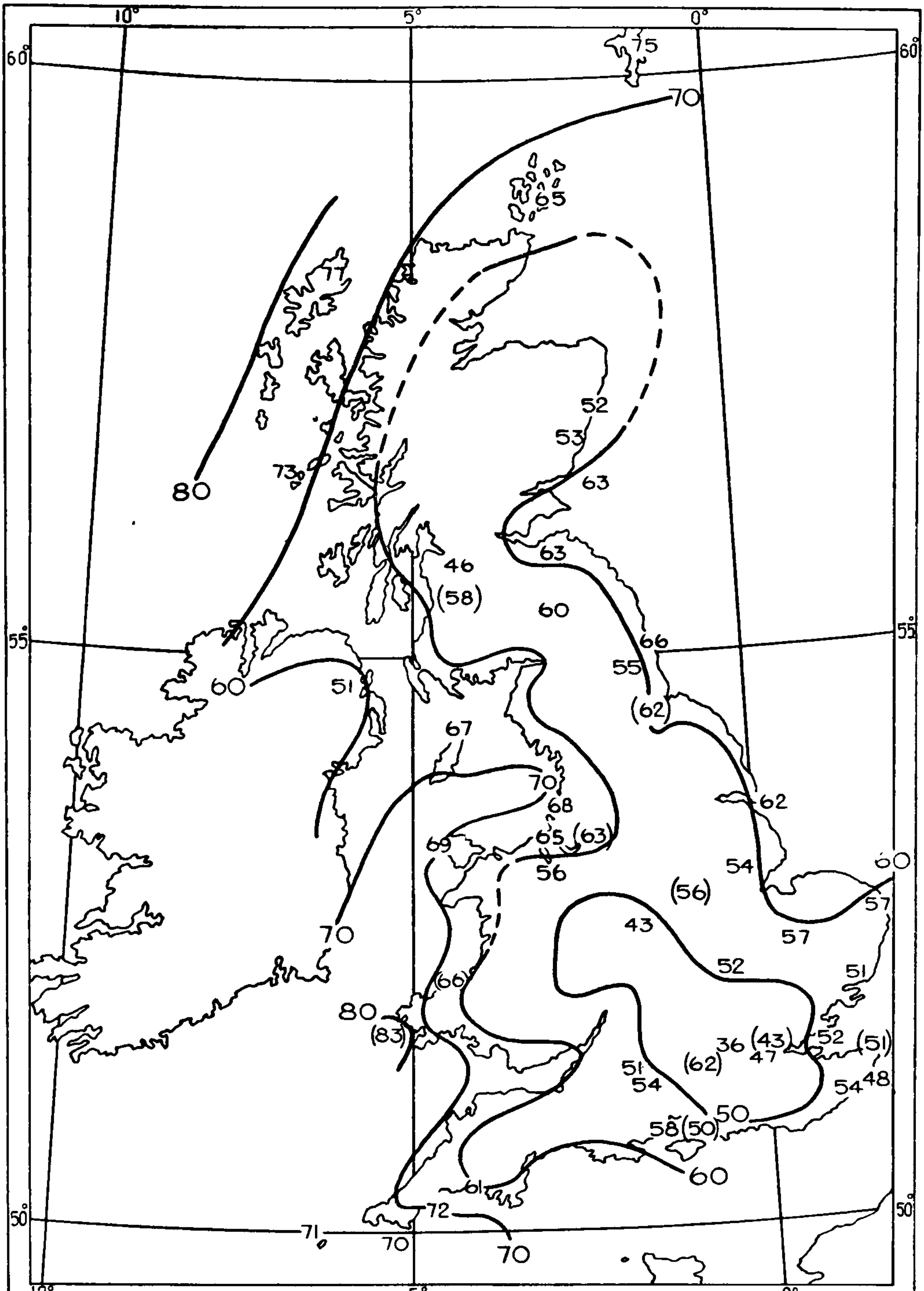

FIGURE 2—HIGHEST MEAN HOURLY WIND SPEED (MILES PER HOUR) AT 33 FEET, LIKELY TO BE EXCEEDED ONLY ONCE IN 50 YEARS

(values based on less than 15 years of record bracketed)

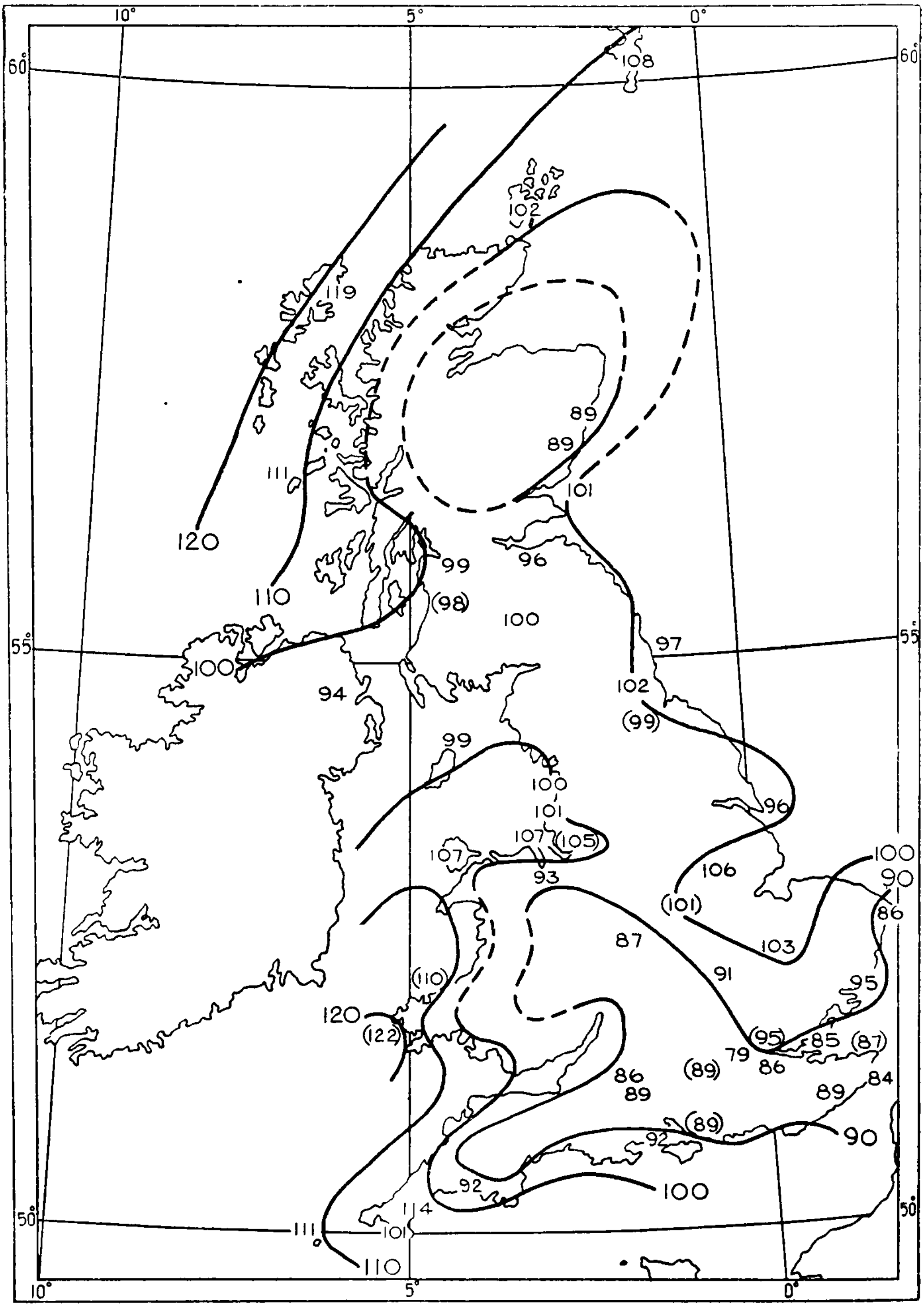

FIGURE 3—HIGHEST GUST SPEED (MILES PER HOUR) AT 33 FEET, LIKELY TO BE EXCEEDED ONLY ONCE IN 50 YEARS

(values based on less than 15 years of record bracketed)

The highest mean hourly speeds at 10 metres (33 feet) likely to be exceeded only once in 50 years are plotted in Figure 2 on a map of the British Isles on which tentative isopleths at intervals of 10 miles per hour have been drawn in to show the general distribution. Figure 3 has been drawn similarly to show the general distribution of gust speeds likely to be exceeded only once in 50 years. It must be emphasized that extreme wind speeds are greatly dependent on local topography and that these maps only represent a broad picture based on wind observations which, generally speaking, relate to open and level sites. Such maps must therefore be used with great caution, as values interpolated from them may need considerable adjustment in the light of a study of the actual exposure of any specified location. Nevertheless the author considers that Figure 3 is more satisfactory than a map which is simply based on the highest recorded gusts such as the one in the "Climatological atlas of the British Isles".[7]

It should be pointed out that the current Code of Practice concerned with the calculation of wind pressures on buildings[8] requires the use of the highest expected mean wind speed over one minute. The records from standard anemographs have too close a time scale for means to be measured over such a short period, however, and the available statistics are limited to means over one hour, together with details of the highest gusts. The highest mean over one minute will clearly lie somewhere between the highest hourly mean and the highest gust – the duration of a gust being of the order of 10 seconds. An examination by G. A. Bull (unpublished) of special anemograph records, obtained at Cardington, which had a much more open time scale, has shown that the highest one-minute mean lies much nearer to the highest hourly mean than it does to the highest gust and that it can be taken approximately as the highest hourly mean plus 10 miles per hour.

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THE ESTIMATION OF MAXIMUM DAY TEMPERATURE FROM THE TEPHIGRAM

By D. W. JOHNSTON, B.Sc.

In his paper on this subject, E. Gold[1] gave assessments of monthly values of the thickness of a surface layer, expressed in millibars, (Δp in the present note) which could be changed from an isothermal state at dawn to a state of dry adiabatic lapse rate in mid-afternoon as a result of solar radiation. His values are given overleaf.

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Δp mb.	60	80	95	110	120	125	120	110	100	85	60	50

It is suggested by the present writer that this way of expressing the facts is more useful than the more familiar reference to squares on the T-Φgram, and leads to a simple graphical method of determining the day maximum temperature.

Dealing first with the case in which convection cloud is not expected to develop, the method is as follows. Since radio-sonde observations are now made at midnight instead of near dawn, it is first necessary to modify the lowest part of the T-Φgram selected as representative of the place for which the forecast is to be made by using reported values of the dawn screen temperature.

Next, the isobars p_0 (surface pressure), AB, and $p_0-\Delta p$, CD, should be drawn on the T-Φgram (Figures 1 and 2). Then a point, P, on the $p_0-\Delta p$ isobar should be selected such that the isothermal, PE, and the dry adiabatic, PF, through that point enclose with the p_0 isobar and the modified temperature curve, equal positive and negative areas. This construction is facilitated by having a piece of perspex with two lines at right angles scribed on it, the point of intersection being slid along the $p_0-\Delta p$ isobar until the positive and negative areas become equal. The point, F, where the dry adiabatic intersects the p_0 isobar represents the day maximum temperature.

The case in which convection cloud is expected to develop is naturally rather more difficult, but a similar sort of method can be used.

As before, the p_0, AB, and $p_0-\Delta p$, CD, isobars should be drawn (Figure 3). A point, P, should then be selected on CD such that the isothermal PE, the dry adiabatic FPS up to the saturation level, and the saturated adiabatic SG from the saturation level upwards, enclose with the modified temperature curve and the p_0 isobar equal positive and negative areas. The point, F, where the dry adiabatic intersects the p_0 isobar represents an upper limit for the afternoon temperature—an upper limit because the convection cloud which develops will prevent a portion of the solar radiation being used to raise the temperature of the surface layers.

The technique of matching an area on the T-Φgram with a triangle was used by Jefferson[2] to determine the temperature rise occasioned by the addition of a specific amount of solar energy. A set of values of Δp could be worked out for this purpose also.

The method outlined above has the advantage of balancing out small areas on the T-Φgram instead of estimating a relatively large area. Also, no separate measuring scale is necessary, the millibar scale over the T-Φgram itself being the only one required. However the operation can be facilitated by the use of a piece of perspex with lines at right angles ruled on it. The method is independent of the scale of the T-Φgram and of the temperature units used. It could be adapted for use with any aerological diagram in which equal areas represent equal amounts of energy.

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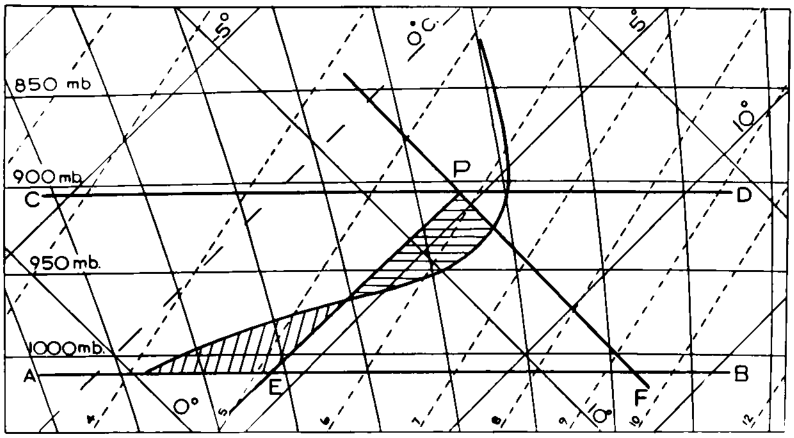

FIGURE 1—ESTIMATION OF MAXIMUM DAY TEMPERATURES
Convection cloud not expected

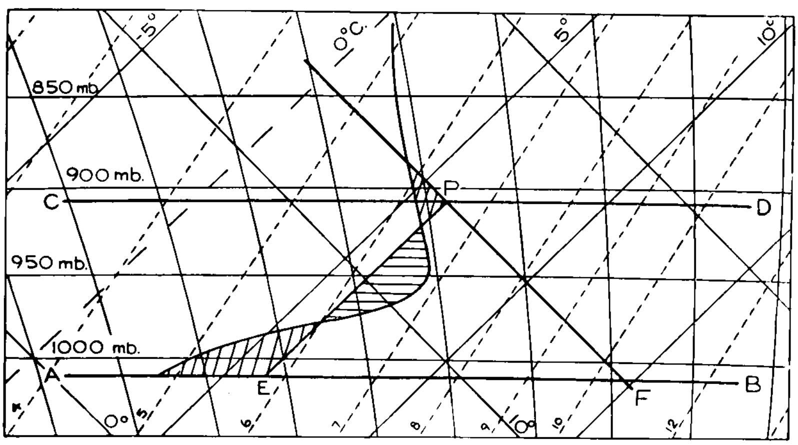

FIGURE 2—ESTIMATION OF MAXIMUM DAY TEMPERATURES
Convection cloud not expected

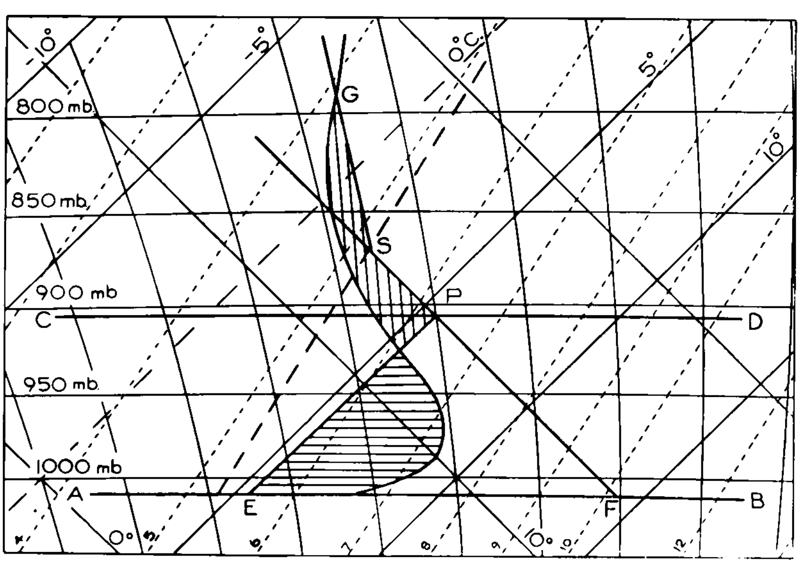

FIGURE 3—ESTIMATION OF MAXIMUM DAY TEMPERATURES
Convection cloud expected to develop

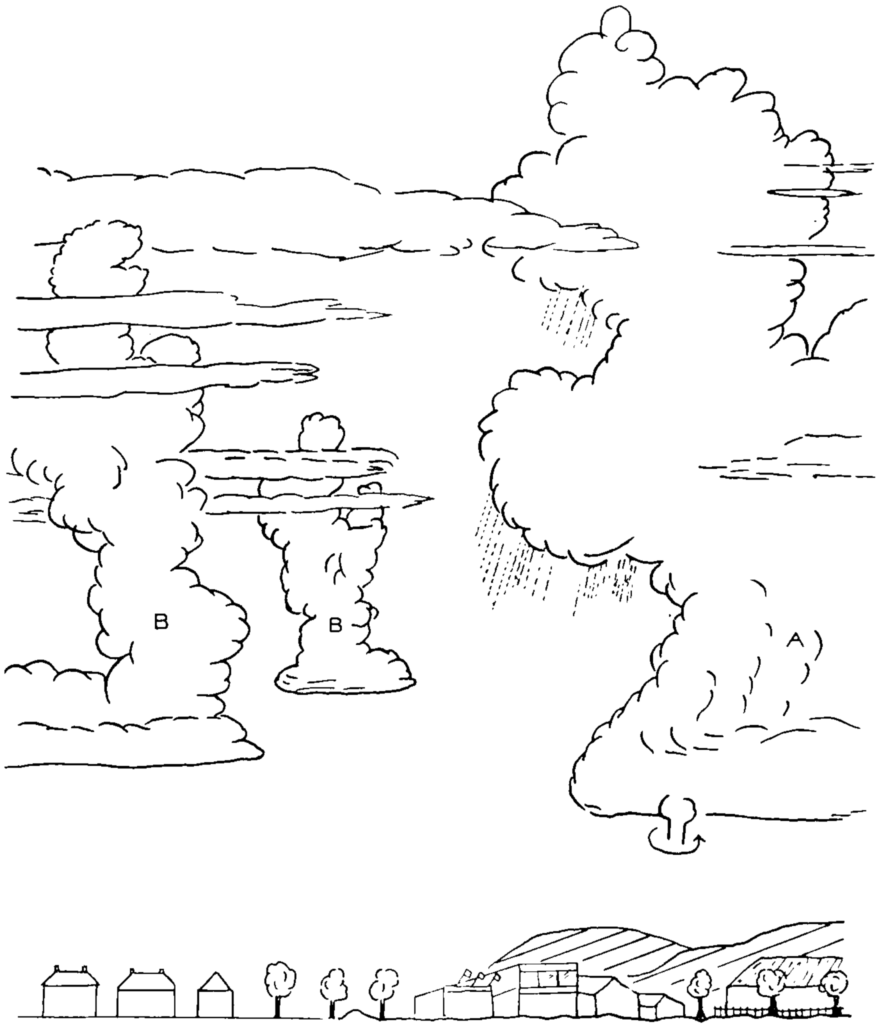

FIGURE 1—CUMULONIMBUS DEVELOPMENT AT RENFREW 1645 G.M.T. 28 APRIL 1957
View from Meteorological Office looking north-west

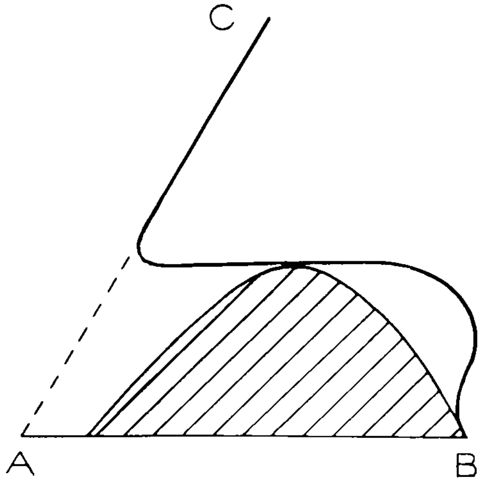

FIGURE 2—A VERTICAL CROSS-SECTION SHOWING THE DISTORTION OF A COLD FRONTAL SURFACE OVER THE GRAMPIANS (HEIGHT 3,000–4,000 FEET)

BC is the frontal surface. The unretarded frontal surface extended meets the ground at A. B is the surface position of the retarded front.

RAPID DEVELOPMENT OF CUMULONIMBUS CLOUD BEHIND A WEAK COLD FRONT AT RENFREW

By A. McEWAN

At 1500 G.M.T. on Sunday 28 April 1957, a weak occlusion from the Isle of Man to North Berwick was moving slowly south-east. Behind this occlusion and parallel to it was a weak cold front from Aldergrove to just north of Renfrew to Lossiemouth. To the rear of the occlusion the weather was cloudy with a little light rain, gradually clearing, and by mid-afternoon the temperature was 57°F., about 6°F. higher than the general temperature in mid-Scotland. Cumulus cloud developed slowly to about half-cover with no showers and the tops were 5,000 to 6,000 feet.

The weak cold front passed through Renfrew at 1630 G.M.T. and the only significant changes in weather were a veer in wind from 210° 8 knots to 330° 5 knots and a slight drop in dew point. Immediately behind the cold front, however, three cumulus clouds began to develop rapidly.

At 1635 G.M.T. the observing assistant noticed a funnel cloud protruding from the base of the cumulus cloud immediately above the airfield. From the Meteorological Office, looking north-west, the funnel was clearly visible and although much of this cloud was overhead (base 1,800 feet), the funnel was silhouetted against blue sky and was approximately 2,500 feet away (horizontally). The funnel was clearly seen to be revolving in an anticlockwise direction at one revolution in 4 seconds, the timing being taken from the ragged edges which, in one part of the funnel circumference, hung further down than the rest of it.

Precipitation began to fall from the over-hang of this cumulus cloud, which had now become very dark underneath, but did not reach the ground. Two neighbouring clouds, (B) in Figure 1, had also developed rapidly and had penetrated thin layers of altocumulus at about 10,000–12,000 feet. By 1645 G.M.T. from observations of smoke from factory chimneys there was a 10–15 knot easterly wind to the north-west of the airfield and a similar speed but westerly to the south-east. Other observations in different directions more or less confirmed that a circulation had been set up at ground level corresponding to the direction of rotation of the funnel.

The funnel slowly disappeared at 1650 G.M.T. and almost immediately the rain area from cloud (A) spread rapidly towards (B). The space between the three clouds filled up very quickly into what looked like very turbulent convection cloud and the precipitation reached the ground. It started as a slight shower at Renfrew at 1700 G.M.T. but soon turned to hail and heavy rain. A total of 9·6 millimetres of rain fell by 1800 G.M.T., most of it in 25 minutes. Almost as soon as the precipitation ceased a thunderstorm commenced to the east and south-east of the airfield.

No other showers were reported in the cold air over west and north-west Scotland and two aircraft, inbound to Renfrew from Dublin and London, reported that this was the only cloud of significant development over their respective routes. Both aircraft found other cumulus tops to be 6,000 feet with stratocumulus to the north of Renfrew and unlimited visibility in this direction. The pilot of one of the aircraft found no turbulence until he was about 4 miles from this developing cloud. From this point onwards the turbulence increased progressively and became so severe within the rain area associated with the cloud that avoiding action had to be taken.

The timing of cold fronts approaching Renfrew from the north is complicated by the high ground of the Grampians which acts as a barrier to the first 3,000–4,000 feet of the frontal surface. Although the reasons may be more complex, the following gives a forecaster a rough method of forecasting the true clearance of the front and, in this case, explains the isolated thunderstorm.

Figure 2 is a schematic diagram showing a vertical cross-section through the high ground to the north of Renfrew and the suggested configuration of the frontal surface. A temporary clearance is usually found when point A reaches Renfrew and in many cases the front appears to be through. However, the surface position of the front at B may be several hours later in reaching Renfrew and a deterioration to pre-frontal conditions occurs. After the surface position B moves south the cold air has now attained considerable depth due to the distortion of the frontal surface by the high ground.

On this occasion the front was so weak that there was no weather associated with it (at B) and the cold air behind it overran the valley in which Renfrew lies. The relatively warmer air in the valley rose rapidly into the cold air thus causing the exceptional instability and the phenomena as described.

FITNESS FIGURE STATISTICS AS AN AID IN LOCAL FORECASTING

By J. E. ATKINS

Summary.—A comparison of airfield weather fitness figures at Stradishall for south-easterly winds, with those for winds of other directions, shows a marked tendency for poor flying conditions with the south-easterly winds during the winter months. Reasons for this tendency are discussed, and similar figures for Waterbeach show the extent to which this is a purely local characteristic.

Local topography (Figure 1).—Although the East Anglian ridge is only some 400 feet above mean sea level in Suffolk, forecasters appreciate it as a significant local factor in weather. Stradishall is situated near the crest of the ridge and slightly on the south-eastern side, at a height of 385 feet above mean sea level and with up-sloping ground from the south-east. Waterbeach lies north-west of the ridge, about 16 nautical miles from Stradishall and at a height of only 23 feet above mean sea level.

An example of poor conditions in south-easterlies.—In general one would expect lower cloud bases at Stradishall than at Waterbeach, solely on account of the difference in heights. However, it has been noticed that flying conditions tend to be particularly bad at Stradishall in south-easterly surface wind situations—to an extent not accounted for merely by the height above sea level.

For example, on 8 November 1955, the 0600 G.M.T. chart (Figure 2) shows widespread fog or low stratus over East Anglia. There was a fairly rapid clearance during the morning to the north-west of the East Anglian ridge, and at 1000 hours a pilot flying north-westward from Stradishall reported a sudden break in the low cloud and fog, commencing at Newmarket. By 1200 hours (Figure 3) most of the airfields north-west of the ridge show visibilities of about

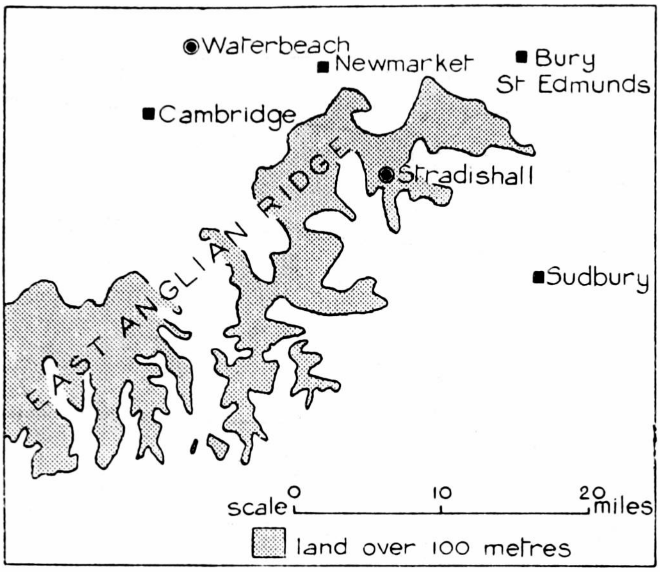

FIGURE I—TOPOGRAPHY OF THE STRADISHALL AREA

4 nautical miles, and only well broken stratus at 600–1,000 feet. On the south-east slope of the ridge, however, there was no substantial improvement, the cloud only lifting to 200–300 feet and soon after, falling to the surface again. The up-slope on the south-east side of the ridge appears to have been a significant factor affecting the persistence of fog and stratus.

Fitness figure analysis.—Appendix IV of the "Observer's Handbook"[1] contains a description of the airfield weather fitness number and its computation. The following is an extract:

"Fitness numbers give a measure of the fitness of an airfield for the landing of aircraft; they take account of the meteorological elements which affect such landings, i.e. visibility, height of cloud base, amount of cloud, precipitation, wind.

"The scale of fitness numbers is 0–9, figure '0' referring to the worst conditions, and figure '9' to the best conditions."

As the poor conditions discussed here are frequently due to a combination of low cloud, poor visibility, and sometimes a drizzly type of precipitation, the airfield fitness figure provides a convenient and simple index. The following analysis (Table I) was made in the hope that the available records held at Stradishall (some seven years) could show the extent to which the situation described above is a recurring feature. No regular observations were available for the night period, the records normally being from 0600 to 1800 G.M.T. In the day-time during summer the up-slope effect is probably masked by surface heating, but with the small degree of day-time heating during winter, the up-slope effect consequently becomes more significant. This investigation was therefore limited to the months of November to February. The choice of limits for the south-easterly direction was rather arbitrary and was made from personal experience of these situations. The figures in Table I confirm the definite bias towards bad flying conditions with south-easterly surface winds during the winter months.

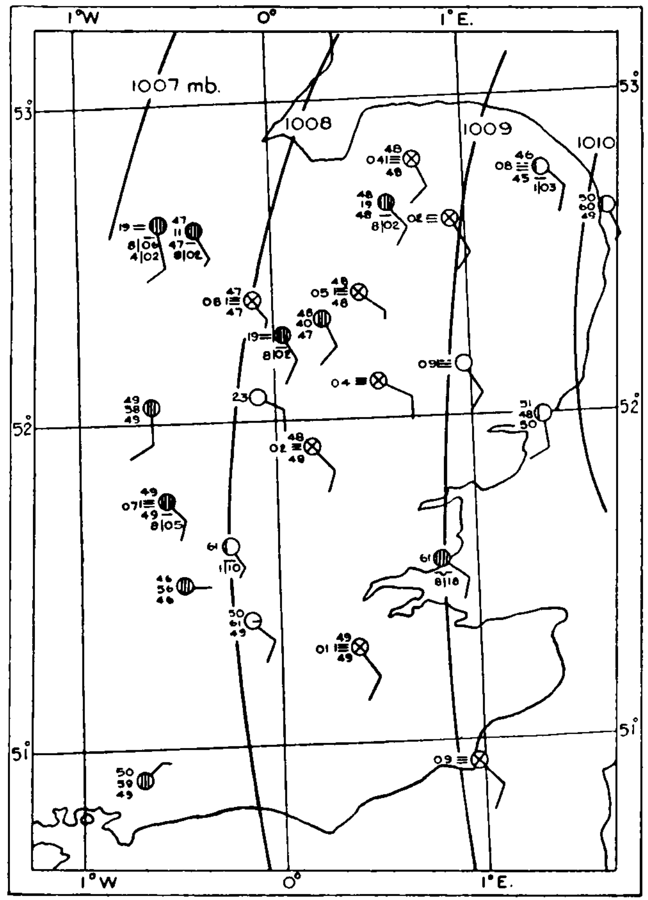

FIGURE 2—SYNOPTIC CHART FOR 0600 G.M.T., 8 NOVEMBER 1955

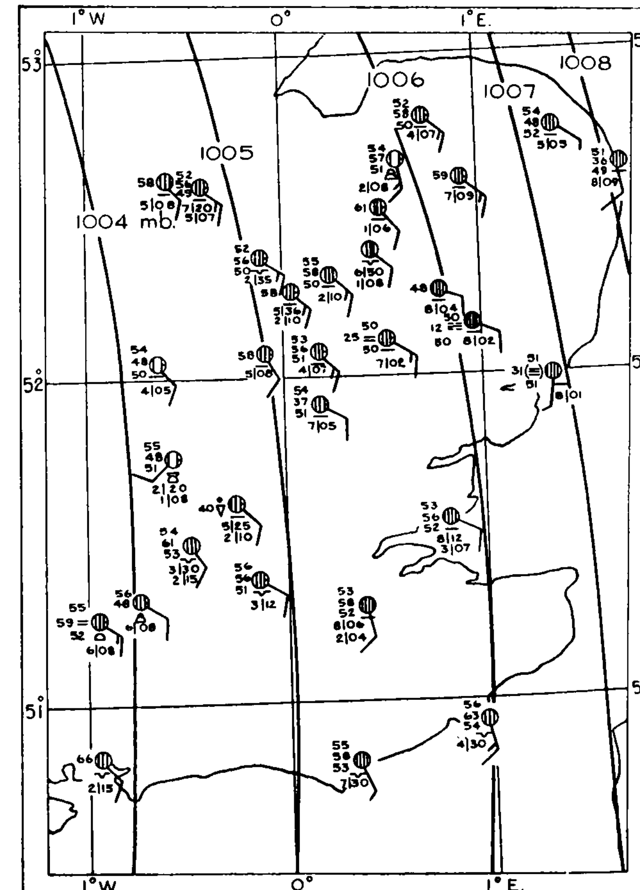

FIGURE 3—SYNOPTIC CHART FOR 1200 G.M.T.

TABLE I—PERCENTAGE FREQUENCIES FOR EACH AIRFIELD WEATHER FITNESS FIGURE: STRADISHALL 0600 TO 1800 G.M.T. SEVEN WINTERS (NOVEMBER TO FEBRUARY), 1949 TO 1956

Surface wind	Fitness figures 0	1	2	3	4	5	6	7	8	9	Total no. of hourly obs.
	per cent										
120°—160°	19·1	9·4	11·7	8·2	10·0	10·9	13·0	10·1	7·1	0·5	814
Other directions and calm	7·3	3·8	7·9	5·6	7·6	11·5	15·6	18·5	16·6	5·6	7495

A further analysis (Table II) of the Stradishall fitness figure frequencies according to time of day shows that even in the midday period the prevalence of poor flying conditions with south-easterlies persists.

TABLE II—PERCENTAGE FREQUENCIES OF DIFFERENT RANGES OF FITNESS

Time	Fitness figures 0, 1 and 2	3, 4 and 5	6, 7, 8 and 9
G.M.T.	*per cent*		
0600	43·7 (22·6)	25·0 (23·4)	31·3 (54·0)
0700, 0800 and 0900	48·2 (20·4)	28·5 (27·2)	23·3 (52·4)
1000, 1100 and 1200	35·5 (18·1)	31·7 (25·2)	32·8 (56·7)
1300, 1400 and 1500	34·8 (16·8)	29·2 (21·2)	36·0 (62·0)
1600, 1700 and 1800	40·4 (19·9)	28·4 (25·0)	31·6 (55·1)

The percentage frequencies for wind directions other than south-easterly are given in brackets

Another feature of these situations is the frequency of fog with relatively strong winds. Over the same seven winter periods the following fog frequencies were recorded with surface wind 120°—160°:

Wind range	Observations below 1,100 yd.	Total no. of obs.
kt.	%	
10–14	19·9	271
15–18	15·7	140

A single observation of fog with a wind of 20 knots was recorded. On only two of the above observations was the deterioration in visibility caused by snow.

Fitness figures for the same seven winters, 0600 to 1800 hours, were also analysed for Waterbeach; the results are in Table III. They reveal a slight

TABLE III—PERCENTAGE FREQUENCIES FOR EACH AIRFIELD WEATHER FITNESS FIGURE: WATERBEACH

Surface wind	Fitness figures 0	1	2	3	4	5	6	7	8	9	Total no. of hourly obs.
	per cent										
120°–160°	3·3	3·8	10·6	7·7	8·7	19·2	20·1	17·1	9·1	0·4	548
Other directions and calm	3·6	2·1	8·2	7·7	7·1	14·2	16·1	22·0	14·7	4·3	6574

tendency for poorer landing conditions with south-easterly winds. However, the outstanding comparison is that for the south-easterlies between the two stations, and this shows the importance of the local orographic factor.

The fitness figures quoted in this article include an element for the component of wind across the direction of the main runway (060° to 240° at Stradishall) which is, strictly speaking, irrelevant to the purpose of this inquiry. The correction for wind across the runway is zero for all winds of less than 17 knots, and for winds of less than 33 knots from within 20° of the runway (see *Observer's Handbook*[1], p.187). In the extreme case of a wind of 34 to 40 knots from a direction between 60° and 90° of the runway it is 5. Usually the correction is zero. The same correction is included in the figures for Waterbeach where the runway is in almost the same direction (040° to 220°) and so does not affect the comparison.

The difference between the Stradishall and Waterbeach figures emphasizes that the poor weather in south-easterly winds at Stradishall is not due solely or even mainly to low cloud and drizzle before eastward-moving warm fronts and occlusions.

Conclusions.—In the case of Stradishall, the figures only confirm a tendency which is probably well known by forecasters with a few years' experience of the area. However, they are considered to be of some value as a substitute for experience to the newly arrived forecaster. Although this is a rather crude analysis, taking no account of synoptic situation, the figures are fairly forceful, particularly in view of the fact that only one forecast parameter (the surface wind direction) is involved. In effect it would make the forecaster very wary of forecasting good conditions with south-easterlies in winter, unless some clearly overriding factor, for example, the advection of dry continental air, were evident.

There is a possibility that even relatively slight up-slope motion may be a significant local factor affecting the persistence of winter fog throughout the day.

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1. London Meteorological Office; Observer's Handbook. London. 1956, p. 182.

MEASUREMENTS OF RADIATION INSIDE A STEVENSON SCREEN ABOVE A SNOW SURFACE

By R. A. HAMILTON, M.A.

The main problem in designing a screen for use in polar regions is, as pointed out by Stewart,[1] to maintain proper ventilation of the thermometers and yet prevent the fine drift snow from entering the screen and settling on the instruments. There is another difficulty that must not be overlooked, the adequate screening of the instruments from solar radiation diffusely reflected from the snow surface.

During the summer at "Northice" (78°N.,38°W., 2341 metres) the station on the Greenland ice sheet established by the British North Greenland Expedition, I noticed that the readings of two dry-bulb thermometers, in the normal positions for the dry- and wet-bulb thermometers in the large Meteorological Office Stevenson screen, differed at times by as much as 0·5°F., the one on the right being the higher even if the thermometers were interchanged. In this position the thermometer was comparatively close to the black case of the hygrograph, and if this was removed from the screen the thermometer readings agreed. It appears that sufficient radiation entered the screen to raise the temperature of the hygrograph and of the nearby thermometer appreciably above air temperature.

In order to obtain some measurement of the amount of radiation entering the screen I mounted a Weston exposure meter by means of a wire frame so that it stood on the floor of the screen. The sensitive side was vertical and faced the south side of the screen, and the dial faced the opening. When the opening was gradually closed the meter reading would fall to a value which changed little after the opening was half closed. The meter was read just before the screen opening was finally closed: this was taken as a measure of the radiation entering the closed screen.

Readings taken at noon in the period 19 July to 2 August 1953 when the sun's elevation was about 31°, varied from about 130 units for a sky clear or with only small amounts of high cloud, to about 30 for an overcast sky. When the sun was approximately east or west, at an altitude of about 19°, the readings varied from 50 for a clear sky to 20 for an overcast sky.

In order to compare these readings with those in a screen under normal conditions, I made similar measurements with a different exposure meter by the same manufacturer in the screen at Prestwick (56°N.,05°W.) standing on a grass plot. The readings varied from 3 to 5 with a clear sky and the sun at an elevation of 30° to 40°.

Solar radiation is very strong in the summer in the polar regions and the amount which enters a normal Stevenson screen standing on snow is of the order of 20 times that entering a normal screen in the British Isles. It is clear that screens for use over snow surfaces must be designed to exclude diffusely reflected solar radiation.

I wish to thank Chief Officer E. O. Jones, who took all but the first few readings.

REFERENCE

1. STEWART, R. H. A.; Trans-Antarctic Expedition, 1955-58. *Met. Mag., London*, **85**, 1956, p. 78.

WORLD METEOROLOGICAL ORGANIZATION

The Tenth Session of the Executive Committee

By the Director-General

The Executive Committee held the final regular session of the present financial period in Geneva from 29 April to 17 May. There was a full attendance of members and in addition, Dr. Bleeker, the former President of the Commission for Synoptic Meteorology and Mr. Mezin, the former President of the Commission for Bibliography and Publications, were present to explain the work of their Commissions. A particularly memorable visitor to a special meeting of the Executive Committee was Mr. Dag Hammarskjöld, the Secretary-General of the United Nations.

The session was a busy one, as usual, but particularly so this year because of preparation for the Third Congress, which will be held in Geneva from 1–29 April 1959. Among other things, the Executive Committee examined the Secretary-General's estimates of expenditure for the Third Financial Period (1960–63). It is inevitable that these show a considerable increase on the maximum expenditure approved by Second Congress for the present financial period, and it remains to be seen whether the next Congress will accept the estimates or will insist on substantial modifications. The Executive Committee also dealt with certain administrative matters relating to its own rules of procedure and the internal staff rules of the Secretariat.

In technical matters, the Committee gave a long and detailed examination to the meteorological problems which will arise when jet aircraft are introduced for civil aviation on a global basis. At its Ninth Session in 1957 the Executive Committee heard from Mr. de Azcarraga about the findings of the Jet Operations Requirements Panel (J.O.R.P.) of the International Civil Aviation Organization, and it appointed a Panel of Experts to examine the matter. As a result of the work of this Panel, the Executive Committee decided to invite Members who have some experience in high-level forecasting to collaborate in the preparation of a Technical Note devoted to descriptions of the methods they use for analysis and forecasting at high levels, the texts being sufficiently detailed to permit the practical use of these methods for routine forecasting. Such a Technical Note should be of the greatest interest to meteorologists everywhere, and is a good illustration of the kind of work which W.M.O alone can do.

The Technical Note will be considered by a Panel of Experts, who will attempt to define as clearly as possible any special problems related to the improvement of high-level analysis and forecasting with a view to meeting the J.O.R.P. requirements, which are very exacting. Certain special problems, notably the forecasting of hail, turbulence, icing and dense cirrostratus cloud and the density of networks required for improving high-level wind and temperature forecasts were referred to C.S.M.; the Commission for Aerology was asked to study the potentialities of numerical prediction for high-level forecasts. It was also decided to explore the desirability of arranging international symposia on the problems of the atmosphere at the levels at which jet airliners operate.

The Executive Committee also gave considerable attention to the proposal that W.M.O. should extend its activities in hydrology. The general feeling was in favour of an initial approach on a broad front and it was finally agreed to recommend to Third Congress that the future policy of the Organization should be to accept responsibilities in all aspects of hydrology which involve meteorological considerations. It was also generally agreed to support the view that a Commission for Hydrology should be established by Congress, but there was little enthusiasm for a change in the name of the Organization at this early stage, and no recommendations for amending the Convention to include hydrology more specifically have been made.

The I.G.Y. was very much in evidence during the discussions, but the Executive Committee felt that it could not support a proposal to make the Data Centre a permanent feature of international meteorology now, although it recognized that in the future such a centre might be desirable for the collection of data in aerology, ozone and radiation.

Two events, of a non-technical nature, made this session memorable. One was the laying of the corner stone of the new W.M.O. building by the President, who placed in a cavity a sealed box containing certain documents.

The other event, which has given great pleasure to meteorologists in the United Kingdom and elsewhere, was the award of the I.M.O. Prize for 1958 to Mr. Ernest Gold, F.R.S., formerly Deputy-Director of the Meteorological Office.

It is evident that Third Congress will have a lengthy programme to consider and its decisions may well be critical for the future of W.M.O. By careful management, the Organization has weathered a period of world-wide financial instability, and in the opinion of the writer is now well established as an essential factor in the development of our science. The attainment of this position is to be attributed to two factors: the whole-hearted voluntary co-operation of the national services in the work of the Technical Commissions, Regional Associations and the many working groups and panels of experts, and the skilled and devoted services of the Secretariat under the able direction of the Secretary-General.

LETTERS TO THE EDITOR

Atmospheric chemistry and chemical aeronomy

The April issue of the *Meteorological Magazine* includes a report[1] of the Meteorological Office Discussion held on December 16 1957, devoted to Atmospheric Chemistry. This very interesting report is a welcome sign of the growing interest among meteorologists in the chemistry as well as in the physics of the atmosphere. This interest was certainly much stimulated by that great meteorologist, the late Dr. C.-G. Rossby, whose influence furthered the inclusion of atmospheric chemistry in the meteorological programme of the International Geophysical Year. The results of this work will be eagerly awaited by oceanographers, chemists and aeronomers as well as by meteorologists.

This note is written to draw attention to the existence of problems of atmospheric chemistry that were left wholly unmentioned in the report of the discussion. The standpoint there adopted is indicated in one of the last reported sentences in the excellent review by Mr. Oddie, who opened the discussion: "The behaviour of the simple inorganic salts in the air is still, however, the central problem of atmospheric chemistry." If the words "one branch of" were inserted before the last two words of this sentence, all might agree on its truth. As stated, however, the sentence expresses a subjective view, and others might locate the central problem elsewhere.[2]

Among these may be the highly skilled and respected meteorologists who specialize in the study of atmospheric ozone, a branch of atmospheric chemistry that has much association with important weather changes, and perhaps with the general circulation of the atmosphere.

Consideration in 1929 of the chemical aspects of ozone formation and destruction in the atmosphere[2] opened a new chapter in the chemical exploration of the upper atmosphere, far above the "weather" region. It led to the recognition that the chemical state of the atmosphere at heights above about 60 miles differs greatly from that of the lower atmosphere. In particular, the oxygen of the air above 60 miles is mainly in the atomic form, although molecular oxygen is still present in a minor degree up to heights of many hundred kilometers. Nitrogen also is partly dissociated into the atomic form, though far less so than oxygen.

Atomic oxygen is highly reactive; in conjunction with molecular oxygen and molecular and atomic nitrogen it forms ozone and oxides of nitrogen in the upper atmosphere.

Watei vapour at high levels—of order 50 miles—is dissociated by sunlight[3] into atomic hydrogen and hydroxyl (OH). The latter reveals its presence strongly in the airglow—the intrinsic luminosity of the high atmosphere, whose observation in many regions of the earth is an important part of the programme of the International Geophysical Year. Atomic oxygen is another notable contributor to the airglow. Atomic sodium also reveals its presence in the upper atmosphere by emitting the light nowadays made familiar to the public by the use of sodium vapour lamps. There must be molecular sodium and also sodium oxide in the upper air. Twilight emission of light by ionized calcium atoms in the upper atmosphere has also been observed, following notable meteor showers.[4]

This branch of atmospheric chemistry impinges on the sphere of interest of workaday meteorologists mainly because of the part played by ozone. But a much wider group of scientists are interested in it. Already the literature of the subject has attained considerable dimensions. One token of this is a recent volume[5] on chemical aeronomy—a report of a conference on the subject, held in 1956, and attended by many American, British and other workers in that field. The word aeronomy signifies the science of those regions of the upper atmosphere where dissociation and ionization are important. Aeronomy has numerous branches, static, dynamic, electromagnetic, etc., and *chemical* aeronomy is a part of the wider subject of atmospheric chemistry. It is now an experimental as well as an observational science. Following a suggestion made by Prof. D. R. Bates in 1950, atomic sodium has been injected into the air at high levels by means of rockets[5, 6] and has produced artificial luminosity by consequent chemical reactions there. More recently nitric oxide[5] and ethylene[5] have similarly been injected, with very interesting results.

S. CHAPMAN

Geophysical Institute, College, Alaska; and High Altitude Observatory, Boulder, Colorado.*

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* Professor Chapman is engaged in a joint programme of research supported by the National Bureau of Standards and the Air Force Cambridge Research Center.

Reply by B. C. V. Oddie

It would no doubt have been better to give the Meteorological Office discussion the title "The chemistry of the lower atmosphere". But the use of the term "atmospheric chemistry", in this sense, is to some extent sanctioned by custom. It has, after all, hardly been used except by workers of the Swedish school inspired by Rossby and Egner, and has naturally come to connote the kind of activity in which they specialized. Not that the Swedish workers intended the term to be exclusive: but it is a fact that chemical aeronomers have never rallied to the cry of atmospheric chemistry. For example, chemical aeronomy has scarcely figured at all in the annual Conferences on Atmospheric Chemistry held in Stockholm since 1954. I do not know why this is, but it can of course be very reasonably argued that chemical aeronomy deals with such a very different class of problems, and uses such very different tools, that it is best treated as a subject separate from the chemistry of the lower atmosphere. But of course the two are closely related, and some way of keeping them in touch is very desirable.

I agree, however, with Professor Chapman that the term "atmospheric chemistry" ought not to apply exclusively to the lower layers. We need a new name—"tropospheric chemistry", perhaps.

A green sun after sunset

On 10 April 1958, after an almost cloudless day, the sun set (as seen from our house at Upper Duntuilm, Skye) behind the Sound of Harris.

At 1925, about two minutes after the sun had gone, a perfect "sun" appeared low on the horizon where it had vanished. The disc of this "sun" was pale green and what was surprising was that there was no mistiness or faintness in its outline. Thinking my eyes might have deceived me through watching the actual sun I went into the house, but when I came out at the door, I had my second view of the "sun".

I then called to my wife and when she came out we agreed that the disc of this "sun" had now changed in colour to pale pink.

It gradually faded as we watched.

Any "mock sun" that I have seen has had a misty outline but this had the edges extremely clear and distinct, although faint. It was something quite new to me.

Upper Duntuilm, Isle of Skye. SETON GORDON, C.B.E.
12 *May* 1958.

[The phenomenon reported by Mr. Seton Gordon was probably due to a change in the refractive properties of the atmosphere beyond the normal horizon of such a kind that the rays from the sun to the observer there became more concave with respect to the earth. Such a change in curvature would cause an apparent elevation of the sun. The necessary meteorological condition is that the air should be markedly warmer than the sea. This is supported by the way in which the sun faded away and perhaps by the colour effects, though the latter might be due to retinal fatigue. An even more remarkable occurrence of the same type is that of the S.S. *Theliconus* off Gibraltar[1] when five successive images of the sun reappeared.

Temporary reappearances of the sun have frequently been observed in the polar regions at the beginning of the polar night. The phenomenon is very rare in temperate latitudes.

It is interesting to note that an almost identical observation has since been reported to the Marine Branch. The details are: *S.S. Arabia.* 11 June 1958 in lat. 55°46'N., long. 32°56'W. (North Atlantic). As the upper limb of the sun set below the horizon there was a distinct green flash lasting about half a second. The upper limb of the sun then reappeared for about six seconds and set again with a further distinct green flash.—Ed. *M.M.*]

REFERENCE

1. Abnormal refraction. *Mar. Obs., London,* **22,** 1952, p. 125.

Observation of optical phenomena at Sirah Island, Aden, 7 October 1957

At 1915 hours local time a very pale green glow was observed in the southern sky, over the Indian Ocean. The glow was marked by a very faint ill-defined boundary about 25 degrees above the southern horizon lowering to about 20 degrees on the south-western horizon. It was impossible to see the southern horizon as vision was obscured by rocks rising to about 600 feet high. The phenomena lasted from approximately 1915 (when it was first observed) to 2130 hours when it faded completely. About 2125 hours a russet-coloured band of light was observed low down on the southern horizon just before the glow faded completely. Throughout the whole period there were occasional rays of light mostly orange in colour at infrequent intervals. These never rose to above 3 degrees above the southern horizon. Stars in the sky at about 15 degrees above the horizon were seen to be changing colour quite frequently (mostly red and green). At times the colour of the stars was observed to be particularly bright, predominantly green. The glow was at its brightest between 1915 and 1930 hours but after 1930 hours the glow was observed to brighten occasionally for periods not exceeding five minutes. The weather at the time was fine. There was a bright moon almost overhead. There was no cloud, a light wind and the sea was practically calm. A sketch is attached (see Figure 1).

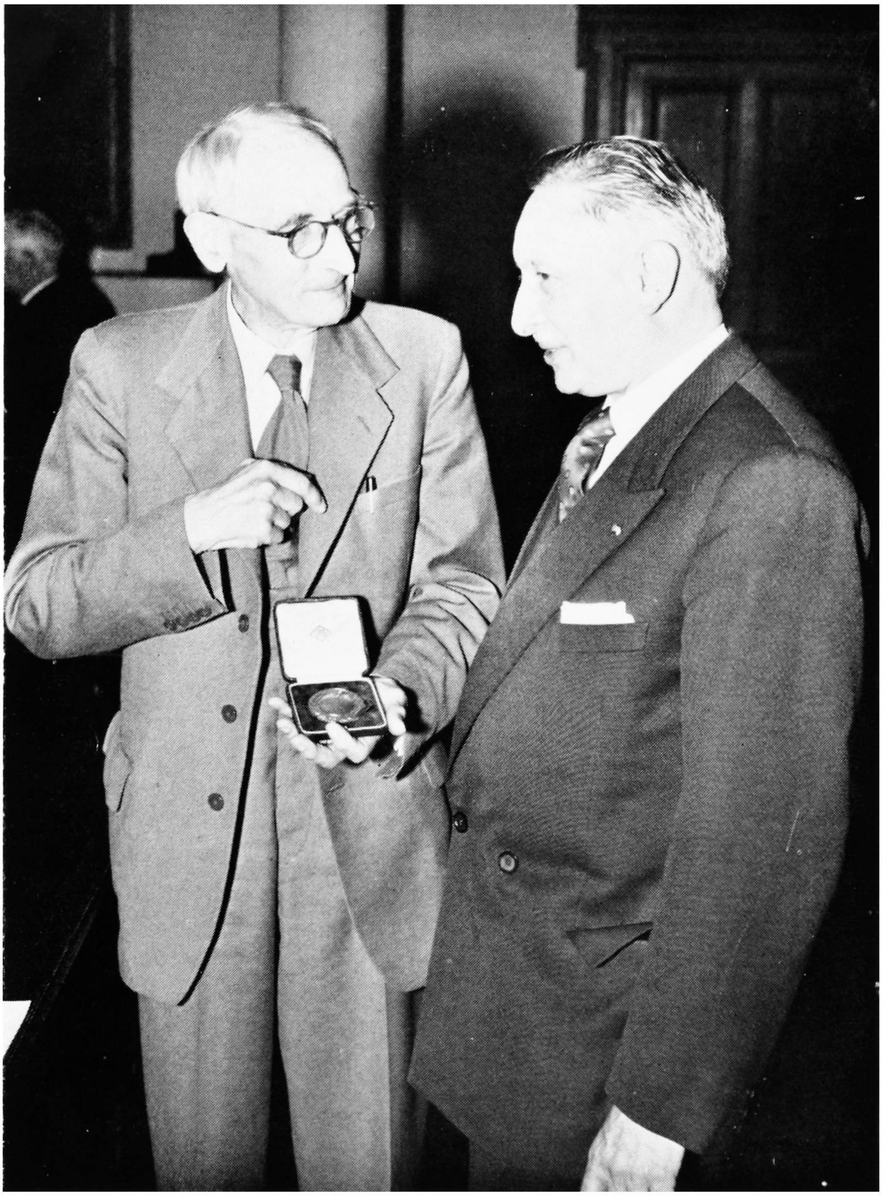
Royal Air Force, Khormaksar, Arabian Peninsula. N. F. HIRST
26 November 1957.

[At Aden (latitude 12°46'N.) on 7 October sunset was at 1746 local mean time and civil, nautical and astronomical twilight 1808, 1833 and 1858 respectively. No reports of aurora have been received at the Balfour Stewart Auroral Laboratory, Edinburgh University, and Mr. McInnes of that laboratory states that 7 October 1957 was a very quiet day magnetically. Mr. McInnes suggests it may have been air-glow or moonlight reflected from dust layers.—Ed., *M.M.*]

[To face p. 278

PRESENTATION OF THE INTERNATIONAL METEOROLOGICAL ORGANIZATION PRIZE TO MR. E. GOLD, F.R.S., BY M. ANDRÉ VIAUT, PRESIDENT OF THE WORLD METEOROLOGICAL ORGANIZATION 30 JUNE 1958.

MR. GOLD SHOWS THE MEDAL AND DIPLOMA TO OTHER METEOROLOGISTS.



MR. GOLD DISCUSSES THE MEDAL WITH M. VIAUT (see previous page).

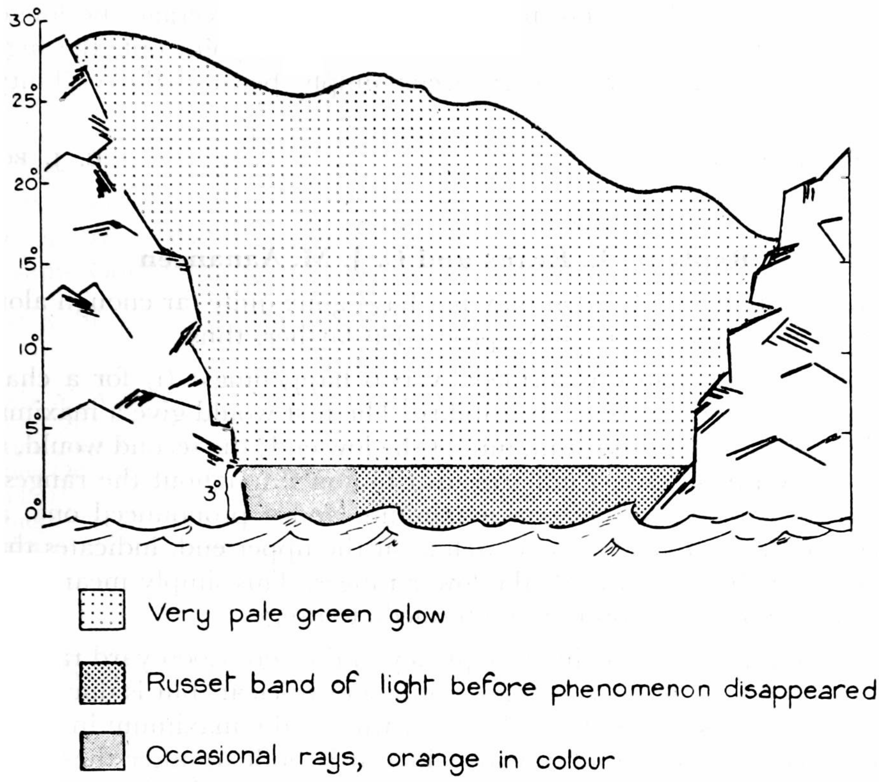


FIGURE I—A SKETCH OF THE OBSERVED PHENOMENA

The left-hand scale shows the angular elevation from the point of observation.

Deterioration of visibility in radiation fog

A recent note entitled "Deterioration of visibility in radiation fog"[1] claims to give some support for the belief that visibility in fog decreases comparatively rapidly through the intermediate ranges. It is not at all clear, however, that the statistics given provide any information about the changes in an individual fog.

Table I gave frequencies of visibilities on radiation nights within consecutive 200-yard ranges. Now there are two happenings which contribute to a low frequency in a particular range, such as appears for 600–800 yards. One is a rapidly changing visibility passing quickly through this range. The other is a visibility which throughout the night remains higher than the upper limit of the range. This second factor would have raised the frequencies in the upper ranges and it is therefore probable that the percentage frequencies in fogs which became thick would have been lower for higher visibilities than the figures given in Table I. Moreover, this adjustment might well remove the minimum shown for a visibility of 600–800 yards.

Table II seems to be open to a similar criticism. If I understand it correctly, it deals with 154 fogs, of which more than half cleared within three hours. Most frequency figures in the table are compounded of some visibilities that had become worse, some that had improved and some that remained in the same range. The high frequency in the 800–1,000-yards range is presumably due to the fogs that were at their thickest and were about to clear. The only figures which it seems might be relevant to the behaviour of an individual fog are the higher frequencies after the fourth hour in the 200–400-yards range, though these may indicate no more than that on the average the longer the fog lasts the thicker it is likely to get. As the writers point out, the high frequencies in the 0–200-yards range occur simply because the visibility can fall no further.

Central Forecasting Office. C. J. BOYDEN
24 *March* 1958.

Reply by E. Evans and C. J. M. Aanansen

It would seem that Mr. Boyden may not have gone quite far enough along his line of reasoning, but should have proceeded farther, thus:

In Table I, each figure is formed by two happenings: (i) for a changing visibility and (ii) for a stationary visibility. The first would give a maximum at the high and a tapering to a minimum at the low end; the second would, unless biassed at any range, give a uniform distribution throughout the ranges. The fact that the combination gives a maximum, and a pronounced one, at the lower end of the visibility range as well as at the upper end, indicates that the second factor is biassed towards the lower ranges. This simply means that the visibility does not often stop in the intermediate ranges.

In Table II, similarly, the high frequency in the 800–1,000-yard range is not due to fogs that were at their thickest and about to clear, but is due to all fogs passing through this range. The relevant feature is the maximum in the lowest range coupled with the rapidity with which it is built up after the first hour, whereas the 400–600-yard range, for example, shows little change with time indicating comparatively little halting of the visibility in this range: in other words, the visibility tends to pass through this range quickly.

It is not correct to deduce from Table II that 84 (154—70) fogs cleared within three hours. As stated, the nightly period examined ended with the last hour before sunrise. (A number of the 84 fogs continued into daylight, some with marked thickening.) Each hour is a self-contained analysis and, as stated above, the intermediate ranges show no significant change from hour to hour.

Mr. Boyden's second sentence is, of course, strictly correct. But does one expect statistics to say what any individual fog will do, or give an indication of the general behaviour?

REFERENCE

1. EVANS, E., AANANSEN, C. J. M. and WILLIAMS, T. E.; Deterioration of visibility in radiation fog. *Met. Mag., London,* **87,** 1958, p. 33.

NOTES AND NEWS

Meteorological Office Awards to Captains and Navigators of Civil Aircraft

The Meteorological Office Awards for 1958 to captains and navigators of civil aircraft for long and meritorious service in the provision of weather reports were presented on 15 July 1958 by Dr. J. M. Stagg, Director of Services. The presentation was made at the Royal Aero Club in a small ceremony held under the auspices of The Guild of Air Pilots and Navigators with the Master of the Guild, Sir Frederick Tymms, in the chair.

Dr. Stagg, before making the presentations, spoke of the mutual understanding which existed between meteorologists and pilots and navigators. He emphasized the great value of the reports, in providing information from the wide spaces between upper air reporting stations and in increasing knowledge of the atmosphere, especially at the greater heights at which aircraft were now beginning to fly. He assured all aircrew that all these reports were used and that more were needed. He then presented brief-cases to Captain R. H. Rose, D.S.O. of British European Airways and to Captain W. J. Wakelin, D.F.C. of the same Corporation.

Awards of suitably inscribed books will be sent later to the following officers:—

Captain G. M. Allcock	B.O.A.C.	Navigating Officer A. P. Hossack	B.O.A.C.
Navigating Officer G. F. Andrews	B.O.A.C.	Captain G. P. Neil	B.O.A.C.
Navigating Officer J. S. Blair	B.O.A.C.	Captain R. H. Payne	B.E.A.
Navigating Officer E. A. Brownjohn	B.O.A.C.	Navigating Officer A. A. Payton	B.O.A.C.
Captain L. H. Carey	B.O.A.C.	Navigating Officer V. R. Pitcher	B.O.A.C.
Navigating Officer W. L. Chander	B.O.A.C.	Captain D. F. Redrup	B.O.A.C.
Navigating Officer W. F. A. Haines	B.O.A.C.	Navigating Officer M. B. Richards	B.O.A.C.

Captain J. R. Turner B.E.A.

Mr. J. S. Sawyer—Special Merit Promotion to Deputy Chief Scientific Officer

The many colleagues and friends of Mr. Sawyer, Assistant Director of Dynamical Research in the Meteorological Office, will have been delighted to learn of his promotion to Deputy Chief Scientific Officer on "Special Merit" and it is a task particularly congenial to me, as one who has been closely associated with him in the past 10 years of his remarkably productive research career, to express, on behalf of the Director-General and the staff, our heartiest congratulations to Mr. Sawyer on the well-earned award and our gratitude to him for the distinction which the award, recommended by the Interdepartmental Scientific Panel, brings to the Office.

It is inevitable that in the Government service, as indeed in most public bodies including the Universities, the number of higher posts should be determined by requirements and that promotion should depend on the occurrence of vacancies created for the most part by retirements on superannuation. In filling the normal vacancies considerations of individual merit are always in the forefront and the need for special machinery in a scientific service arises, not only because the exceptional man may be held back by lack of a suitable vacancy, although this must arise from time to time, but even more because, at the higher levels, normal promotion means new duties, wider administrative responsibilities, with less opportunity for personal scientific work. The enlightened provision for exceptional promotion by "Special Merit", independent of establishment vacancies, permits the advancement of the outstanding research worker while avoiding interruption in his work. It is a relief to know that Mr. Sawyer will be able to continue in his present post and to lead his group in dynamical research on the promising lines which he personally has done much to pioneer.

Mr. Sawyer's contributions to the scientific literature include some 50 papers which evidence not only an exceptionally wide knowledge of the atmosphere as it is observed to behave but also a remarkable equipment of basic skills in cartographical, statistical and dynamical analysis. There would be inspiration to others in a survey of his original work but to do justice to it would call for a longer essay than is perhaps appropriate here. Suffice it then to remark that the major preoccupation of his group at the present time is the development of numerical forecasting, starting from the differential equations which express the hydrodynamics and thermodynamics of the atmosphere. With the electronic computer shortly to be provided at Dunstable it will be possible to accelerate the quantitative exploration of the mathematical-physical ideas which Mr. Sawyer and his group are elaborating. This line of research is without any doubt the most exciting thing in the science of weather forecasting since the concept of fronts emerged in Norway 40 years ago. The practicability of numerically integrating certain approximations to the basic equations in a time acceptable for use in daily forecasting was first recognized and tested in America where the modern electronic calculating machine first became available. But Mr. Sawyer was quick to realize the potentialities and the Sawyer-Bushby model of 1953 has been the basis of much later work on the baroclinic atmosphere. Military authorities do not, if they are wise, change the commander when the campaign is going well although he may gain promotion. It is good that in scientific research we should from time to time have evidence of comparable administrative wisdom.

R.C.S.

Dust in the stratosphere over western Britain on 3 and 4 April 1956

An article of the above title[1] published in the October 1956 number of the *Meteorological Magazine* presented evidence that dust from an eruption in Kamchatka on 30 March 1956 travelled across the Arctic basin and Greenland to Great Britain by 3 April.

The computed trajectory is supported by the statement in an article in the January 1958 number of the Russian periodical *Priroda* (Nature)[2] that the dust trail from the eruption was to the north-east. The eruption is described in the article as an explosion comparable with those of Krakatoa (1883), Katmai (1912) and Pelee (1902). The article states further that the explosion produced a rise of pressure of 23·5 millibars at a point 45 kilometres from the volcano and one millibar at a point in north-east Siberia 1,100 kilometres away while the pressure wave was traced on sensitive barographs for $1\frac{1}{2}$ circulations of the globe.

G. A. BULL

REFERENCES

1. BULL, G. A., and JAMES, D. G.; Dust in the stratosphere over Western Britain on April 3 and 4, 1956. *Met. Mag., London,* **85,** p. 293.
2. GORSHKOV, G. S.; Unusual eruptions in Kamchatka. *Priroda, Leningrad,* No. 1, 1958, p. 61.

OFFICIAL PUBLICATION

PROFESSIONAL NOTES

No. 123—*Forecasting cirrus cloud over the British Isles.* By D. G. James, Ph.D.

Some synoptic features are presented which are known to be associated with four oktas or more cirrus cloud over the British Isles. A combination of 13 of these features is suggested for use in forecasting the occurrence of cirrus cloud up to 9 hours ahead, the features being evaluated from the current synoptic charts. For forecasts of up to 24–36 hours ahead, a combination of six of the features is suggested, the evaluations in this case being made from forecast charts.

OBITUARY

Sir Ernest Maclagan Wedderburn, O.B.E., D.L., M.A., LL.D., D.Sc., F.R.S.E.

When Sir Ernest Maclagan Wedderburn died in Edinburgh on 3 June 1958, the country, and Scotland in particular, lost a loyal and able servant.

Sir Ernest was indeed a "man o' pairts", and the range of his interests and talents was so great that it would be impossible in a brief note to attempt even an outline of his activities and attainments. In fact he was so unassuming and unobtrusive in his work that a complete list of his public services may never be put on record. It must suffice to say that his status in the legal profession was such that he resigned the Chair of Conveyancing at the University of Edinburgh to become Deputy Keeper of the Signet in 1935. He was in turn Chairman of the Joint Committee of Legal Societies in Scotland, Chairman of the General Council of Solicitors and Chairman of the Law Society of Scotland—in short the leader and guiding mind of the legal profession in Scotland.

In scientific circles he was probably best known for his work on the movement of water in large lakes. After studying the barometric *seiche* under Professor Crystal, he tackled the problem of temperature oscillations, a problem which gave full scope to his mathematical ability, physical insight and powers of painstaking analysis. For this work he was awarded, in addition to a D.Sc., the Makdougall-Brisbane prize of the Royal Society of Edinburgh, and he later became the Treasurer and then Vice-President of that Society.

His association with meteorology can be dated from 1908, when he became a member of the Scottish Meteorological Society. He was Joint Honorary Secretary and then Honorary Secretary of the Society in the troubled years which followed; he was, in fact, destined to be the last to hold that position, as he played a leading part in the negotiations at the end of the First World War which led to the Meteorological Office taking over the organizational functions of the Society, and the amalgamation of the Scottish Society with the Royal Meteorological Society. It was particularly fitting that Sir Ernest also played a leading part in the formation of the Scottish Branch of the Royal Meteorological Society at the end of the Second World War. He was Vice-President for Scotland during the period 1950–52 and again in 1955–56, the latter period covering the Centenary of the old Scottish Meteorological Society.

In the meantime, however, Sir Ernest's meteorological activities had ranged far afield. He volunteered for service in 1914 and was placed in charge of the meteorological unit with G.H.Q., Mediterranean Expeditionary Force. During this period he was twice mentioned in dispatches, and was later awarded the O.B.E. (Military Division). It was also during this period that he produced the work best known to meteorologists, although his name is seldom associated with it. In the course of his duties he evolved the concept of "equivalent constant wind" in applying ballistic corrections to artillery fire, a revolutionary idea at the time which has since become an accepted part of the standard practice of gunnery.

After the First World War Sir Ernest returned to the legal profession, but he continued his association with meteorology in an advisory role. He represented the Royal Society of Edinburgh on the Meteorological Committee for a number of years and served on the Advisory Committee on Meteorology for Scotland from its inception in 1921 until he retired in 1952, representing in turn the Royal Meteorological Society, the University of Edinburgh and the Royal Society of Edinburgh.

Those who had the pleasure of attending the Centenary Dinner of the Scottish Meteorological Society in 1955 will have a clear picture of Sir Ernest as his friends remember him. He presided with genial informality and infectious good humour, starting the conversational ball rolling with tales of his own discomfiture as a forecaster during the Gallipoli Campaign and afterwards. He was always approachable and always helpful, with the deceptive air of having the leisure to devote his attention to any problem put to him, however trivial. He will be greatly missed.

R. CRANNA

METEOROLOGICAL OFFICE NEWS

Retirement.—*Mr. J. S. Smith*, Senior Experimental Officer, retired on 8 July 1958. He joined the Office as a Technical Assistant in February, 1920, after service in the Meteorological Section of the Royal Engineers from February 1917 until November 1919. His 38 years' service has been spent at aviation outstations including tours of duty in the Middle East from 1935–38 and 1946–53. From 1954 until his retirement he served at Wyton.

Mr. W. J. Hotten, Senior Assistant (Scientific), retired on 18 June 1958. He joined the Office from the Air Ministry in September 1923. Nearly all his service has been spent at Headquarters in the Forecast Division. From 1949 until his retirement he was engaged on administrative duties at the Central Forecasting Office at Dunstable.

Award.—While on detached duty at Stansted, Mr. J. S. Barnes, Assistant (Scientific) was awarded a Flying Scholarship by the Air Training Corps. He trained at Cambridge Airport and has qualified for his private pilot's licence.

Sports activities.—The Air Ministry Annual Sports were held at the White City Stadium on 11 June 1958. The Office regained the Bishop Shield (awarded to the department gaining the highest number of points in all the Air Ministry sports competitions held during the year) which they had failed to retain last year after eight consecutive years. The Office also won the Tug-of-War Shield and the Jones Aggregate Cup. Miss M. Boucher and Mrs. A. Brown shared the Victrix Ludorum Cup. Mr. C. E. Fairbrother won the Men's High Jump at 6 ft. 5 in., a new Air Ministry record (previously 5 ft. 6 in.). Mr. Fairbrother is the present holder of the Scottish High Jump Championship and he was nominated for the Empire Games at Cardiff.

The annual Sports Meeting organized by the Harrow Social and Sports Committee was held on the evening of 5 June at the Headstone Manor Ground. Events were open to all members of the Meteorological Office and there were many entries. Five new records were established for these Sports. They were:—

100 yd. Men (Meteorological Office Championship) 10·6 sec. by P. H. Anderson (Kew Observatory).

Half-mile Men (Meteorological Office Championship) 2 min. 3·7 sec. by R. Stratton (Harrow).

One mile Men (Meteorological Office Championship) 4 min. 42·5 sec. by R. Stratton (Harrow).

Men's High Jump. 5ft. 0¾ in. by S. Spurrier (Harrow).

Men's Long Jump. 18 ft. 1 in. by C. Kensett (London Airport).

The fourth Meteorological Office Championship, the Ladies 100 yds. was won by Mrs. A. Brown (Harrow).

The weather was ideal and many visitors came from Dunstable, London Airport, Kew Observatory and Victory House as well as from Harrow to enjoy a pleasant evening's sporting entertainment. The prizes were presented by Mrs. A. G. Forsdyke.

LATE RAINFALL REPORTS—1958

Great Britain and Northern Ireland

Month	County	Station	Inches	Per Cent Average
January	*Caith*	Lairg, Crask	5·82	101
March	*E. Loth.*	N. Berwick	2·61	162
March	*Argyll*	Morven, Drimmin	2·48	69
March	*Argyll*	Poltalloch	0·83	23

Correction to Rainfall Table—1958

April	*Notts.*	Mansfield, Carr Bank	0·77	39

WEATHER OF MAY 1958

Northern Hemisphere

The most striking feature of the mean pressure chart for the month was a well-marked ridge of high pressure extending northwards from the Azores anticyclone at about 40°W. and linking with the polar anticyclone. Pressure anomalies were positive over Greenland, Iceland and the Atlantic north of 30°N. (excluding coastal waters of the British Isles) and reached +10 millibars off Cape Farewell. The centres of both the Azores and polar anticyclones were near normal in position and intensity. The Icelandic low was not present in its usual form, but low pressure areas were centred over Sandinavia and eastern Canada (Quebec) the lowest pressure being 1009 millibars in each case. Associated areas of small negative pressure anomalies extended over the British Isles, Scandinavia and north-west Russia, and over the Hudson Bay region and the Canadian Arctic. Over the Pacific, the Aleutian low was near its normal position but was some 3 millibars deeper than usual, giving small negative pressure anomalies between Kamchatka and the Aleutians. A slight westward displacement of the North Pacific high produced small negative anomalies off the west coast of the U.S.A. and small positive anomalies further west.

The largest temperature anomalies in the hemisphere occurred in western areas of the U.S.A. and Canada, reaching +5°C. at stations in Alberta and Montana. This abnormal warmth was apparently due to a combination of more anticyclonic conditions than usual and reduced northerly advection. Unusually strong southerly advection resulting from the higher pressures than normal over the Atlantic gave mean temperatures 3° or 4°C. above average in Newfoundland, Labrador and Baffin Island. Temperatures were also above average over all Europe apart from the north-west, and over the Mediterranean and north-west Africa. Anomalies of +4°C. occurred in Czechoslovakia and Hungary, where the usual north-easterly advection was absent. All the negative temperature anomalies in the Northern Hemisphere were small, although they extended over wide areas including most of the Atlantic and Arctic oceans and Siberia.

Rainfall totals for the month were near or above the average in northern and central Europe, but below average over the Mediterranean and the Balkans. An excess of rainfall was reported in north-east Canada and also in the Caribbean area, while the month was unusally dry in districts just east of the Rockies between 40°N. and 50°N. Amounts of rainfall were well above normal in southern India, suggesting an earlier onset of the monsoon than usual.

WEATHER OF JUNE 1958

Great Britain and Northern Ireland

During the first week pressure remained low to the south-west of the British Isles and thundery rain belts moved northwards across the country. About the middle of the month high pressure from the Azores extended north-eastwards and weather became drier for several days, but from the 19th a succession of Atlantic depressions brought a return of unsettled conditions which lasted until the end of the month.

The month began with widespread thunderstorms over England and Wales followed by a night of extensive fog. On the 2nd exceptionally heavy rain occurred over a broad area from Wales to Kent associated with a depression over the Midlands—some places recorded more than 2 inches—but in Scotland it was relatively dry and sunny. Apart from heavy local rain in North Devon and Somerset on the 3rd, which resulted in severe flooding in the Boscastle area, weather in general was warm and sunny and relatively dry from the 3rd to the 5th; on the 5th temperature exceeded 70°F. at many places and parts of East Anglia had more than 15 hours sunshine. Renewed outbreaks of heavy rain occurred on the 6th and 7th, particularly in Devon and Cornwall, the southern part of the Pennines and locally in Northern Ireland, and also on the 9th and 10th in south-east England. Over the country as a whole weather was mostly cool from the 6th to the 12th with rain at times, sunny periods and occasional thunderstorms.

On the 13th an anticyclone from the Azores became centred over Southern England and for the first time since the beginning of the month there was no appreciable frontal activity over the country and weather became relatively dry for several days. On the 15th and 16th temperature reached the middle seventies in parts of England, but cooler air from the Atlantic was spreading slowly south-east and temperature in London on the afternoon of the 17th only reached 60°F., 17°F. lower than the previous day's maximum temperature. Slight ground frost was recorded locally in the west midlands that night.

Weather became unsettled with widespread rain on the 19th as a complex depression from the Atlantic extended eastward across the country and there-after cool cloudy conditions persisted for several days with an increasing tendency for thunder. Heavy thunderstorms occurred in Lancashire and Yorkshire on the 22nd and thunderstorms were widespread over England during the next two days.

During the 25th, a depression approaching from the south-west moved up the Irish Sea bringing gales and heavy rain to many districts; $4\frac{1}{4}$ inches fell in the Mourne Mountains (Fofanny Reservoir), County Down in 24 hours. Another depression moved northward from France to give heavy rain in south-east England during the night of the 26th–27th.

Fine warm weather was experienced over much of the country on the 29th with temperatures well into the seventies, but it was cool on some eastern coasts where fog persisted all day. On the 30th temperature reached 74°F. at Lerwick, the highest temperature ever recorded there this century.

The month as a whole was generally cool and dull especially in north-east England where day temperatures were 2–3°F. below the average and sunshine in places 70–80 hours below the normal. It was the wettest June in England and Wales since 1912 and in Northern Ireland since records began in 1920. Less than average rainfall occurred over the greater part of Scotland north of a line from the Firth of Clyde to Montrose, but over three times the average fell in the Mendip hills, over the east midlands and the southern part of East Anglia. Four times the average fell locally in the Royston area.

After a period of very promising early growth the wind and heavy rain spoiled prospects of heavy harvests of grass, cereals and soft fruit. Large quantities of hay went to waste and many farmers turned to silage to cut losses. There was serious laying of corn crops and strawberries suffered severely. Blight affected early varieties of potatoes in many areas and at the end of the month was spreading to main crops some three or four weeks earlier than usual.

WEATHER OF JULY 1958

The general character of the weather is shown by the following provisional figures:—

	AIR TEMPERATURE			RAINFALL		SUNSHINE
	Highest	Lowest	Difference from average daily mean†	Per-centage of average*	No of days difference from average*	Per-centage of average†
	°F	°F	F	%		%
England and Wales ...	85	32	−0·7	117	+2	97
Scotland	85	29	0·0	121	0	115
Northern Ireland ...	76	36	+0·2	128	+1	112

*1916-1950 †1921-1950

RAINFALL OF JULY 1958
Great Britain and Northern Ireland

County	Station	In.	*Per cent of Av.	County	Station	In.	*Per cent of Av.
London	Camden Square Gdns.	2·29	95	*Carm.*	Pontcrynfe	5·58	128
Kent	Dover	3·20	136	*Pemb.*	Maenclochog, Ddolwen B.	6·43	125
,,	Edenbridge, Falconhurst	1·69	63	*Radnor*	Llandrindod Wells ...	4·87	154
Sussex	Compton, Compton Ho.	2·09	69	*Mont.*	Lake Vyrnwy	5·21	118
,,	Worthing, Beach Ho. Pk.	2·23	104	*Mer.*	Blaenau Festiniog ...	8·93	96
Hants.	St. Catherine's L'thouse	1·25	58	,,	Aberdovey	6·10	158
,,	Southampton, East Pk.	1·78	74	*Carn.*	Llandudno	3·26	157
,,	South Farnborough ...	1·45	57	*Angl.*	Llanerchymedd ...	3·51	121
Herts.	Harpenden, Rothamsted	1·88	70	*I. Man*	Douglas, Borough Cem.	4·73	154
Bucks.	Slough, Upton ...	3·12	133	*Wigtown*	Newton Stewart ...	4·05	113
Oxford	Oxford, Radcliffe ...	2·50	105	*Dumf.*	Dumfries, Crichton R.I.	4·70	122
N'hants.	Wellingboro' Swanspool	2·51	112	,,	Eskdalemuir Obsy. ...	6·69	134
Essex	Southend W.W. ...	2·38	118	*Roxb.*	Crailing...	5·18	179
Suffolk	Ipswich, Belstead Hall	2·52	117	*Peebles*	Stobo Castle	6·02	194
,,	Lowestoft Sec. School	2·08	90	*Berwick*	Marchmont House ...	4·41	150
,,	Bury St. Ed., Westley H.	2·80	99	*E. Loth.*	N. Berwick	5·25	196
Norfolk	Sandringham Ho. Gdns.	3·29	121	*Midl'n.*	Edinburgh, Blackf'd H.	6·47	214
Dorset	Creech Grange... ...	2·42	91	*Lanark*	Hamilton W.W., T'nhill	5·25	180
,,	Beaminster, East St. ...	2·62	86	*Ayr*	Prestwick	4·67	158
Devon	Teignmouth, Den Gdns.	2·27	104	,,	Glen Afton, Ayr San. ...	4·41	109
,,	Ilfracombe	2·12	71	*Renfrew*	Greenock, Prospect Hill	6·30	155
,,	Princetown	6·74	102	*Bute*	Rothesay, Ardencraig...	5·27	123
Cornwall	Bude	2·85	106	*Argyll*	Morven, Drimnin ...	3·50	83
,,	Penzance	3·29	120	,,	Ardrishaig, Canal Office	5·26	111
,,	St. Austell	4·30	127	,,	Inveraray Castle ...	4·76	80
,,	Scilly, St. Mary ...	2·09	94	,,	Islay, Eallabus ...	3·40	88
Somerset	Bath	3·51	127	,,	Tiree	1·82	54
,,	Taunton	1·90	85	*Kinross*	Lock Leven Sluice ...	5·33	142
Glos.	Cirencester	3·07	108	*Fife*	Leuchars Airfield ...	5·17	182
Salop	Church Stretton ...	4·06	137	*Perth*	Loch Dhu	5·90	113
,,	Shrewsbury, Monkmore	4·18	174	,,	Crieff, Strathearn Hyd.	4·32	126
Worcs.	Worcester, Red Hill ...	2·33	104	,,	Pitlochry, Fincastle ...	4·06	120
Warwick	Birmingham, Edgbaston	3·41	119	*Angus*	Montrose Hospital ...	5·61	191
Leics.	Thornton Reservoir ...	4·34	159	*Aberd.*	Braemar	3·53	118
Lincs.	Cranwell Airfield ...	4·56	181	,,	Dyce, Craibstone ...	5·89	177
,,	Skegness, Marine Gdns.	4·82	217	,,	New Deer School House	5·25	162
Notts.	Mansfield, Carr Bank...	4·87	182	*Moray*	Gordon Castle	6·63	215
Derby	Buxton, Terrace Slopes	6·02	154	*Inverness*	Loch Ness, Garthbeg ...	3·48	100
Ches.	Bidston Observatory ...	3·35	121	,,	Fort William	3·27	61
,,	Manchester, Ringway...	4·30	139	,,	Skye, Duntulm... ...	1·75	46
Lancs.	Stonyhurst College ...	4·61	114	,,	Benbecula	0·92	25
,,	Squires Gate	2·18	96	R. & C.	Fearn, Geanies ...	1·88	70
Yorks.	Wakefield, Clarence Pk.	4·32	170	,,	Inverbroom, Glackour...	2·13	57
,,	Hull, Pearson Park ...	3·24	134	,,	Loch Duich, Ratagan...	2·87	48
,,	Felixkirk, Mt. St. John...	2·65	90	,,	Achnashellach	2·61	45
,,	York Museum	2·87	116	*Suth.*	Stornoway	1·44	47
,,	Scarborough	2·55	103	*Caith.*	Lairg, Crask	0·00	000
,,	Middlesbrough... ...	2·23	82	,,	Wick Airfield	2·14	83
,,	Baldersdale, Hury Res.	3·02	98	*Shetland*	Lerwick Observatory ...	3·65	144
Nor'l'd	Newcastle, Leazes Pk....	3·49	122	*Ferm.*	Belleek	4·92	114
,,	Bellingham, High Green	5·80	177	*Armagh*	Armagh Observatory ...	5·44	165
,,	Lilburn Tower Gdns. ...	4·00	134	*Down*	Seaforde	4·53	124
Cumb.	Geltsdale	4·23	108	*Antrim*	Aldergrove Airfield ...	3·92	129
,,	Keswick, High Hill ...	3·26	74	,,	Ballymena, Harryville...	4·75	118
,,	Ravenglass, The Grove	3·83	98	*L'derry*	Garvagh, Moneydig ...	5·26	135
Mon.	A'gavenney, Plâs Derwen	3·68	121	,,	Londonderry, Creggan	4·55	108
Glam.	Cardiff, Penylan ...	3·42	100	*Tyrone*	Omagh, Edenfel ...	4·37	119

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