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OCCURRENCE OF FÖHN WINDS IN THE BRITISH ISLES

By J. G. LOCKWOOD, Ph.D.

Introduction.—The föhn is a warm dry wind that sometimes blows down Alpine valleys. The word has come to have a wider meaning to meteorologists, who use it to refer to any wind that has recently come across a mountain range, and in so doing has been warmed. Reports of the occurrence of föhn winds within the British Isles have been made by Mossman[1], McCaffery[2], Lawrence[3] and Manley[4]. These authors have shown that föhn winds do occur in this country, but they do not attempt any detailed investigations into the problem of the nature and distribution of föhn winds. This paper gives the results of a small investigation into British föhn winds. In particular it is suggested that föhn winds in this country can arise from downcurrents associated with large-amplitude lee waves.

The problems associated with föhn winds.—The first tenable explanation of föhn was given by Hann[5] in 1866, this being his now classic thermodynamic föhn theory. Moist air traversing a mountain range precipitates moisture while ascending the windward slopes and gains the latent heat released; subsequent descent of the air down the lee slopes takes place dry adiabatically and the air arrives at lower altitudes drier and warmer than it was at corresponding elevations during the ascent. This explanation is found today in many text-books. The difficulty with Hann's theory is that in a stable atmosphere there is no reason why warm air having ascended a mountain range should descend and displace cold air on the lee side, moreover in cases of föhn there is by no means always evidence that precipitation occurred on the windward slope.

The descent of the warm föhn air, in a stable atmosphere, is the central problem concerning föhn. Although various theories[7] have been advanced to explain the descent of warm föhn air, no satisfactory explanation has yet been achieved. The Austrian researchers, Hann[5] and von Ficker[8], simply considered, in the case of Alpine föhn, that the descent was an immediate consequence of the withdrawal of the cold surface air from the lee valleys, the mass of the Alps to the south preventing replacement from anywhere except aloft. Kuttner[9], basing his conclusions on the results of sailplane flight data in Germany, stated that warmer air penetrates to the valley floors when, under certain conditions, standing waves are set up in the airflow downwind from the barrier and these attain sufficiently great amplitudes.

Hoinkes[10] considers that northerly föhn can arise in the Alps when a cold front approaches from the north and comes to lie along the northern edge of the range. The föhn is regarded as due to flow down the upper surface of the cold front, the subsiding air carrying on across the mountain range and reaching the surface on the lee side. Scorer and Klieforth[11] suggest that föhn winds will occur if an airstream reaches a mountain, say on the arrival of a cold front, whose height exceeds the value of π/l in the airstream. In this expression l is the Scorer[12] stability parameter*.

The evidence for British föhn winds.—In this investigation a föhn wind was considered to be blowing if unusually high temperatures for the season of the year were reported from the immediate lee of an upland area. The high temperatures were normally restricted to the immediate lee of the upland area, and were considerably higher than those reported from the neighbouring lowlands. Using this criterion, it was possible to select six situations between 1944 and 1958, when föhn occurred with enough data to justify investigation. The dates selected are given in Table I. The number of föhn occurrences found was small because of the erratic nature of the phenomenon and the small number of observing stations in suitable mountainous locations. To these six examples was added an example of a föhn wind in 1901, in Glen Nevis, which was described by Mossman[1]. Because of insufficient observational data, it was impossible to make any use of the two föhn examples described by McCaffery[2] and Lawrence[3].

It is seen from Table I that föhn winds in the British Isles are most frequently observed to the north of the Cairngorms, in the counties of Nairn, Morayshire and Banffshire. There are few reports from the Lake District or from the Pennines, but this is probably due to lack of suitably placed observing stations rather than a real lack of föhn winds. It is from Scotland and North Wales that the data used in the investigation were mostly drawn. The data mostly consisted of hourly observations from airfields (such as Kinloss and Lossiemouth) and daily observations from climatological stations. Brief descriptions of the föhn winds used in the investigation are contained in Table I and descriptions of two typical examples of föhn are given below.

(i) *The föhn of 24 March 1945 in North Wales.*—A warm anticyclone was situated to the east of the British Isles, while a deep southerly airstream covered the country. This airstream was warm, dry and nearly cloudless. Föhn winds were reported along the North Wales coast. In Table II are reproduced hourly observations from some of the airfields in North Wales (see also Figure 1).

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*The Scorer stability parameter, l, is defined by:

$$l^2 = \frac{g\beta}{U^2} - \frac{1}{U} \cdot \frac{\partial^2 U}{\partial Z^2}$$

where g = acceleration due to gravity
U = horizontal wind perpendicular to the mountain ridge
Z = the height measured upwards
$\beta = \frac{1}{\theta} \cdot \frac{\partial \theta}{\partial Z}$, where θ is the potential temperature.

Unless the wind shear is changing rapidly with height, $\frac{1}{U} \cdot \frac{\partial^2 U}{\partial Z^2}$ is small, and is usually ignored when calculating l^2.

TABLE I—LIST OF BRITISH FÖHN WINDS BETWEEN 1944 AND 1958 USED IN INVESTIGATION

Date	Area	Notes on occurrence	Approx. value of π/l in the inversion layer* *nautical miles*	Average height of mountain range* *nautical miles*
23/3/45	North Wales and Scotland	Warm anticyclone situated to east of British Isles. Stable SE'ly airstream over North Wales, stable SW'ly airstream over Scotland. Föhn winds along North Wales coast and to north of Scottish Highlands.	0·6 (N. Wales)	0·5 (N. Wales)
24/3/45	North Wales	Warm anticyclone situated to east of British Isles. Stable SE'ly airstream over North Wales. Föhn winds along North Wales coast.	0·75	0·5
6/3/53	Aberdeenshire	Anticyclone centred over southern Britain. W'ly airstream over Scotland. Föhn wind at Huntly in morning.	0·8	0·7
12/3/54	Morayshire	Anticyclone over Scandinavia, low over Biscay. SE'ly airstream over Scotland. Föhn winds reported along Moray coast.	Wind speed in lower levels of Leuchars ascent too low to make it typical of airstream over Scottish Highlands.	
15/10/56	Morayshire	Anticyclone over Scandinavia, low over Biscay. SSW'ly airstream over Scotland. Föhn winds reported along Moray coast.	0·6	0·7
12/3/57	Morayshire	Anticyclone over Germany, low to SW of Ireland. S'ly airstream over Scotland. Föhn winds reported along Moray coast.	1·0	0·7

* See page 63.

Typical föhn characteristics are reported from the airfield at Llandwrog to leeward of Snowdonia. The start of the föhn on the morning of the 24th is very similar to the start of a föhn in an Alpine valley. At 0600 GMT there is calm, the temperature is 53°F and the relative humidity is 49 per cent; at 0700 GMT the

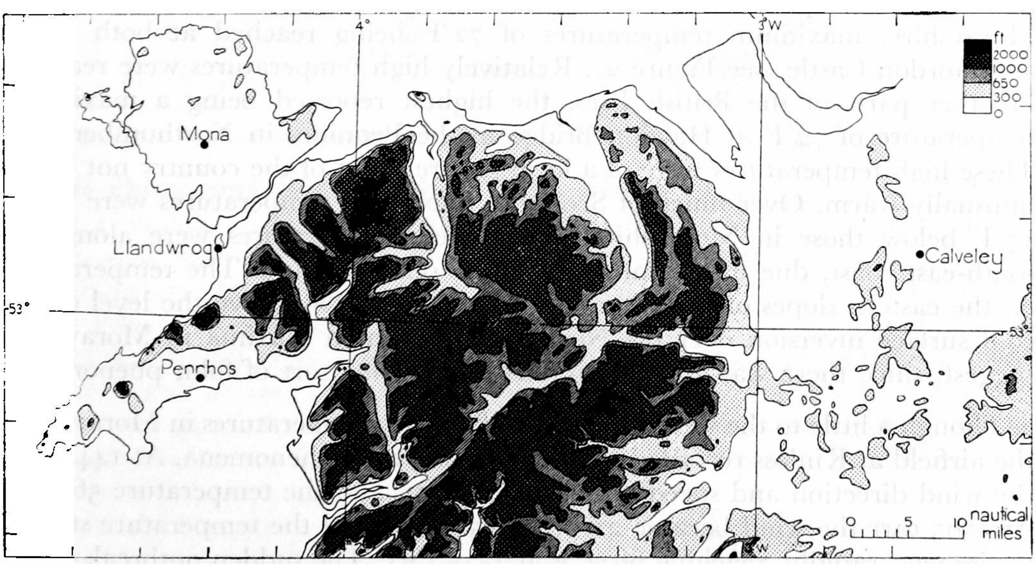

FIGURE 1—LOCATION OF AIRFIELDS IN TABLE II

TABLE II—METEOROLOGICAL OBSERVATIONS FROM AIRFIELDS IN NORTH WALES FOR 24 MARCH 1945

	Llandwrog			Mona		
Time	Temperature	Relative humidity	Wind	Temperature	Relative humidity	Wind
GMT	°F	%	m.p.h.	°F	%	
0001	61	42	SSE 18	53	64	SE force 2
0100	61	42	SSE 18	52	63	SSE force 2
0200	59	38	SSE 15	52	74	SSE force 2
0300	58	42	SE 6	54	55	SSE force 2
0400	52	54	NE 9	51	56	SSE force 1
0500	52	55	NNW 4	52	56	SSE force 1
0600	53	49	Calm	48	60	SE force 2
0700	63	23	SSE 26	56	39	E'S force 2
0800	62	33	SSW 16	59	41	SW force 2
0900	64	34	S 26	63	42	S force 3

	Penrhos			Calveley		
Time	Temperature	Relative humidity	Wind	Temperature	Relative humidity	Wind
GMT	°F	%		°F	%	
0001	53	71	SE force 4	51	82	SE force 2
0100	53	70	ESE force 4	48	86	SE force 2
0200	52	73	ESE force 4	48	84	SE force 2
0300	51	72	ESE force 3	48	86	SE force 3
0400	51	72	ESE force 2	47	85	SSE force 2
0500	51	73	ENE force 2	46	85	SE force 3
0600	52	63	NNE force 2	44	89	SE force 3
0700	50	73	Calm	46	87	SSE force 4
0800	56	57	E force 4	50	73	SSE force 4
0900	57	64	E'S force 5	54	61	SSE force 4

The term "force" in this table refers to Beaufort force.

wind speed is 26 miles per hour, the temperature has risen by 10°F to 63°F, and the relative humidity has fallen to 23 per cent. The suddenness of the arrival of the warm, dry air is one of the characteristics of Alpine föhn.

(ii) *The föhn of 12 March 1957 in north-east Scotland.*—On this occasion the highest temperatures in Scotland were recorded along the coast of Morayshire, maximum temperatures of 72°F being reached at both Elgin and Gordon Castle (see Figure 2). Relatively high temperatures were reached in other parts of the British Isles, the highest reported being a maximum temperature of 74°F at Haydon Bridge in the Pennines in Northumberland. These high temperatures were of a local nature, most of the country not being unusually warm. Over much of Scotland, maximum temperatures were up to 15°F below those in Morayshire. The lowest temperatures were along the south-east coast, due to the influence of the onshore wind. The temperatures on the eastern slopes of the Cairngorms were measured above the level of the cold surface inversion over the North Sea. The high maxima in Morayshire suggest, since there was a southerly airstream, some sort of föhn phenomena.

Though a little to the west of the zone of highest temperatures in Morayshire, the airfield at Kinloss recorded some interesting föhn phenomena. At 1444 GMT the wind direction and speed were 360°, 1 knot, and the temperature 56·1°F. At 1505 GMT the wind became 210°, 10–15 knots, and the temperature started to rise very rapidly, reaching 68·1°F at 1515 GMT. The sudden outbreak of the föhn so impressed the meteorological observers that they noted the above details in the airfield meteorological logbook. The autographic records (see Figure 3) from Kinloss airfield provide further evidence for the suddenness of the arrival of the föhn.

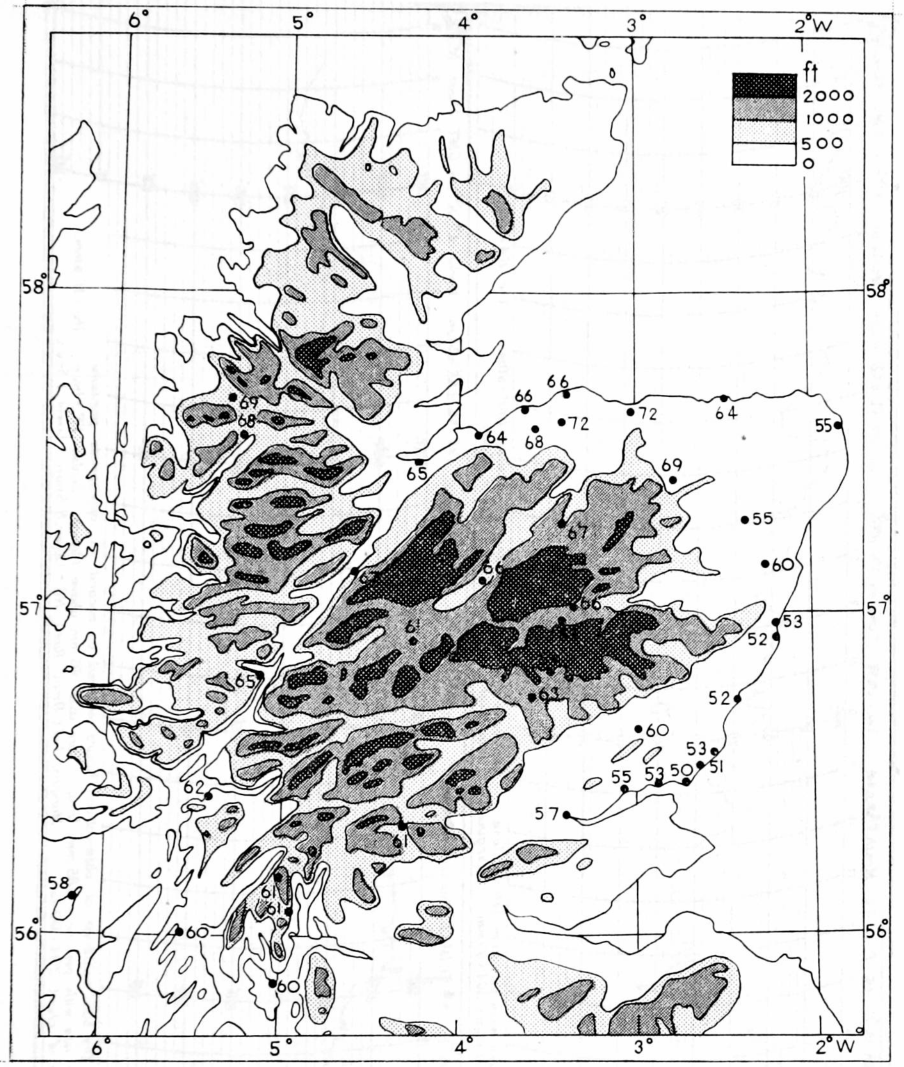

FIGURE 2—DISTRIBUTION OF MAXIMUM TEMPERATURES, 12 MARCH 1957

The characteristics of British föhn winds.—Investigation showed (see Table I) that the six British föhn winds considered were mainly associated with warm, dry, stable airstreams, there often being a warm anticyclone in the neighbourhood of the British Isles. In the six föhn winds considered and also in the föhn wind described by Mossman[1] in Glen Nevis, there was either nil or negligible rainfall over the mountain ranges to windward. Therefore föhn theories, such as the 1866 theory due to Hann[5], involving thermodynamic heating due to condensation and rainfall over the mountains to windward, do not apply. This is not a new discovery; many recent writers[9, 10, 11] on föhn winds have come to a similar conclusion.

In the six föhn airstreams described in Table I there was to windward of the mountain ranges marked stability from the surface to near a level corresponding to the top of the generating mountain range (see Figures 4, 5 and 6). Above this

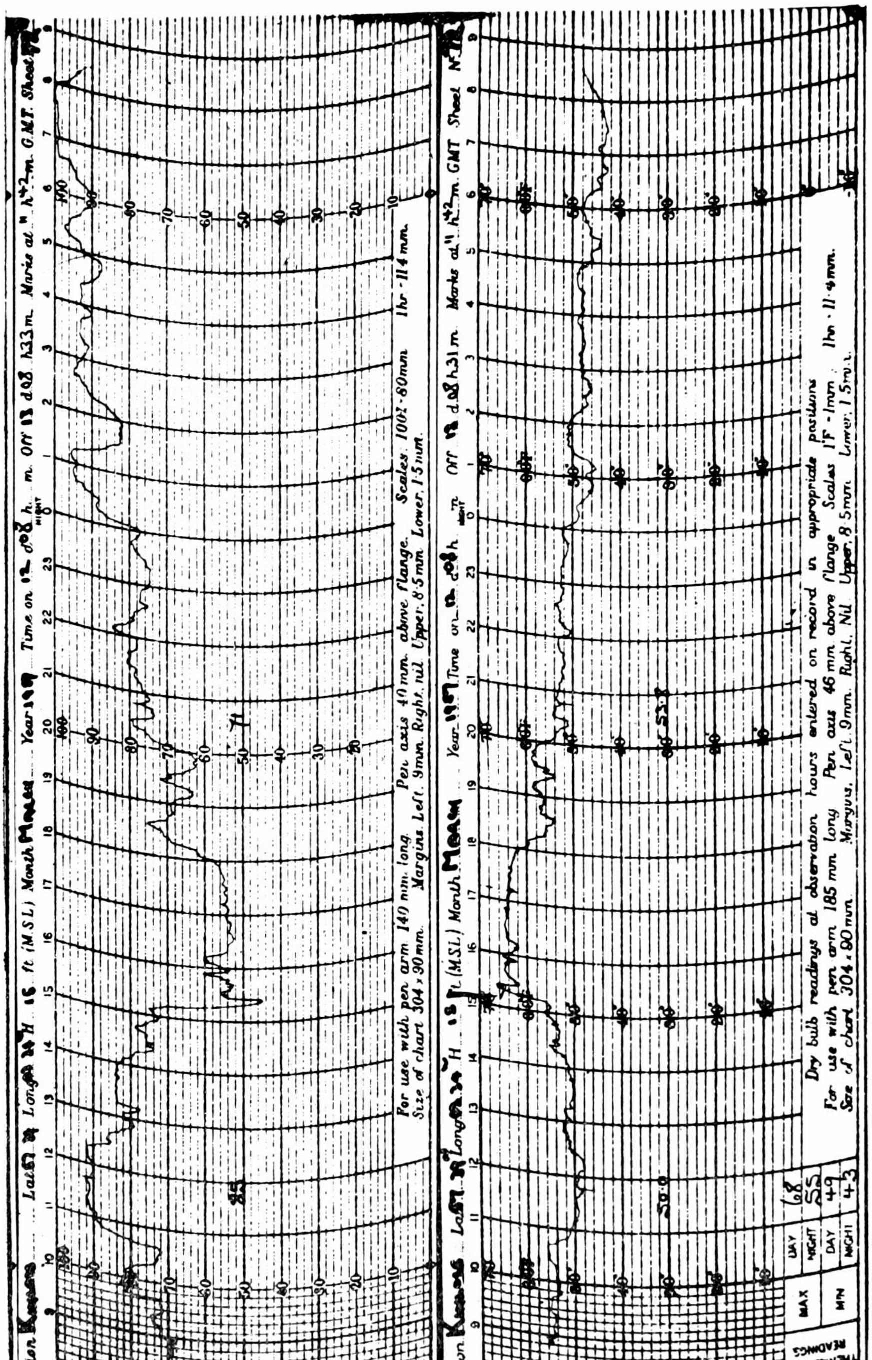

FIGURE 3—HYGROGRAM AND THERMOGRAM FOR KINLOSS, 12 MARCH 1957

layer there was a marked decrease in the stability. Scorer and Klieforth[10] have suggested that föhn winds might occur if an airstream reaches a mountain whose height exceeds the value of π/l in the airstream. To test this theory the values of π/l were calculated for the surface inversion layer in five föhn airstreams (see Figure 4). The results are given in Table I.

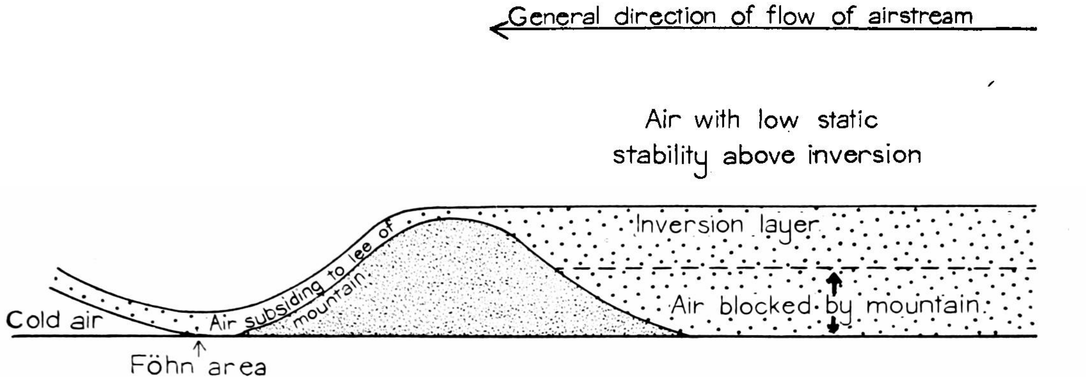

FIGURE 4—A TYPICAL FÖHN AIRSTREAM

The method used to calculate the values of l was that suggested by Corby[13]. The average value of $g\beta$ through a layer of suitable thickness (normally 50 mb) was measured using a scale. The average value of l^2 through the layer was then obtained by dividing $g\beta$ by the square of the average wind speed through the layer. The process is then repeated for the remaining layers. Unless the wind shear is changing rapidly with height, the value of $\frac{1}{U}\frac{\partial^2 U}{\partial Z^2}$ is small and is usually

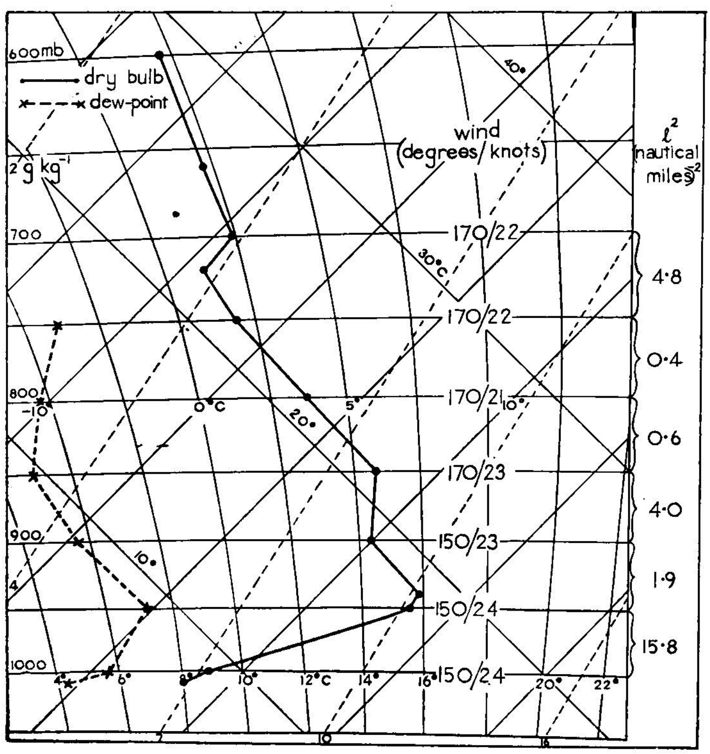

FIGURE 5—TEPHIGRAM FOR LIVERPOOL, 0600 GMT, 24 MARCH 1945, WITH WIND AND VALUES OF l^2

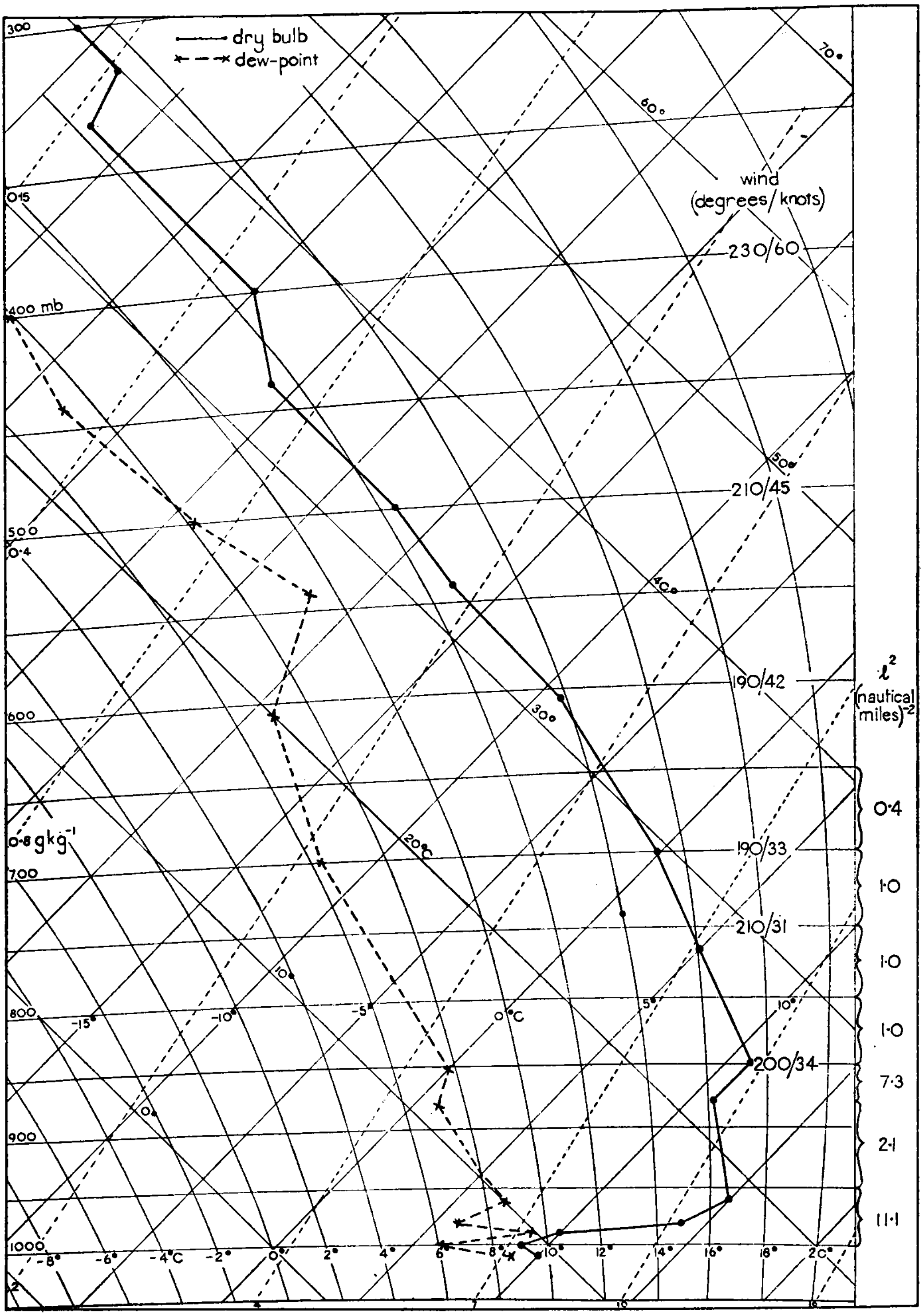

FIGURE 6—TEPHIGRAM FOR LEUCHARS, 1400 GMT, 12 MARCH 1957, WITH WINDS AND VALUES OF l^2

neglected in calculating l. To calculate l a radiosonde ascent near to the area of föhn winds was used and where possible was chosen upwind of the mountains. The Liverpool ascent was used for the North Wales föhn and Leuchars for the Morayshire föhns. Because of the distance of Leuchars from Morayshire, the ascent cannot be regarded as being completely typical of the airstream over the Cairngorms, but it is the best available.

It is seen from Table I that the values of π/l are usually approximately equal to or slightly greater than the height of the generating mountain range. With the mountain height greater than π/l, Scorer and Klieforth[11] suggest that the lower layers of the airstream might be blocked and become stationary with the upper layers descending to the surface on the lee side of the mountain. There is some evidence from the observations that even when the heights of the mountains are slightly less than π/l the lowest layers of the inversions considered did not flow across their respective mountain ranges.

The l^2 profiles to windward of the mountains in five föhn airstreams were examined. Two examples are shown in Figures 5 and 6. In each case the value of l^2 decreased with height. The value of l^2 is always greatest in the inversion layer and low in the layer immediately above. Now according to Corby and Wallington[14] these conditions could be suitable for large-amplitude lee waves in the inversion layer. It is known from aircraft reports that very large-amplitude lee waves can occur in inversion layers. Kuttner[9], using sailplane flight data, has already suggested that föhn winds might be partly due to large-amplitude lee waves.

It is suggested therefore that föhn winds in this country arise from two main causes. Firstly, there is some subsidence of the upper layers to the surface, in the lee of the mountains, due to the blocking of the lower layers of the airstream by the mountain range. Secondly, the subsidence to leeward is probably aided by the downcurrents arising from the presence of large-amplitude lee waves in the upper part of the low-level inversion layer. From the six föhn winds examined, it appears that a wind speed of at least 15 knots throughout the first 10,000 feet of the atmosphere is necessary for the production of marked föhn winds. The maximum temperatures reached in the föhn winds were usually about equal to the potential temperature just below the top of the stable surface layer.

REFERENCES

1. MOSSMAN, R. C.; The meteorology of Glen Nevis from October 1901 to February 1902. The meteorology of the Ben Nevis observations, Part IV, 1898–1902. *Trans. roy. Soc., Edinburgh*, **44**, 1910.
2. MCCAFFERY, W. D. S.; Föhn effect over Scotland. *Met. Mag., London*, **81**, 1952, p. 151.
3. LAWRENCE, E. N.; Föhn temperature in Scotland. *Met. Mag., London*, **82**, 1953, p. 74.
4. MANLEY, G.; Climate and the British scene. London, 1952.
5. HANN, J. von; Zur Frage über den Ursprung des Föhn. *Met. Z., Wien*, **1**, 1866, p. 257.
6. HANN, J. von; Zur Theorie der aufsteigenden Talwinde. *Met. Z., Braunschweig*, **27**, 1910, p. 492.
7. DEFANT, F.; Local winds. Compendium of meteorology, Boston, Mass., 1951, p. 655.
8. FICKER, H. von and RUDDER, B. de; Föhn und Föhnwirkungen. Der gegenwärtige Stand der Frage. *Probleme der Bioklimatologie*, **1**, Leipzig, 1943.
9. KUTTNER, J.; Moazagotl und Föhnwelle. *Beitr. Phys. frei. Atmos., Leipzig*, **25**, 1938, p. 79.
10. HOINKES, H.; Über Nordföhnerscheinungen nördlich des Alpenhauptkammes. 1. Mitt. Der kurze Nordföhn vom 28. September 1940. *S.B. Akad. Wiss., Wien*, **160**, IIa, 1951, p. 267.
11. SCORER, R. S. and KLIEFORTH, H.; Theory of mountain waves of large amplitude. *Quart. J. R. met. Soc., London*, **85**, 1959, p. 131.
12. SCORER, R. S.; Theory of waves in the lee of mountains. *Quart. J. R. met. Soc., London*, **75**, 1949, p. 41.
13. CORBY, G. A.; Air flow over mountains. *Met. Rep., London*, **3**, No. 18, 1957.
14. CORBY, G. A. and WALLINGTON, C. E.; Airflow over mountains: the lee-wave amplitude. *Quart. J. R. met. Soc., London*, **82**, 1956, p. 266.

551.557.33

STRATOSPHERIC WIND REVERSALS OVER NANDI, FIJI

By E. FARKAS

New Zealand Meteorological Service

Introduction.—The wind régime of the equatorial stratosphere has recently received some attention[1,2,3] in conjunction with the discovery of an apparent two-yearly fluctuation in the zonal component of wind at various equatorial stations. At some of these stations the change-over from easterly to westerly wind components, and vice versa, occurred first at the highest levels and appeared progressively later at lower levels, the phenomena becoming less distinct and regular in the low stratosphere. The purpose of this note is to draw attention to a similar apparent periodicity in the stratospheric zonal wind components at Nandi, Fiji (17°45′S, 177°27′E).

Data.—The period covered by the observations commences in October 1951 for the 50 mb level, in January 1953 for the 30 mb level and in June 1957 for the 20 and 15 mb levels. Data have been analysed up to July 1961 for all levels except the 15 mb level, for which satisfactory data are not available beyond April 1961. The number of observations above the 30 mb level falls off rather rapidly with height and in most cases monthly averages at the highest level are based on less than 10 observations. However, it appears that in the high stratosphere even these sparse data are sufficient to give a reasonably adequate indication of the magnitude and direction of the average zonal component of wind in each month. Figure 1 shows monthly mean zonal wind components for several stratospheric levels (50 mb and above) for the above period. Monthly means based on less than 10 observations are marked by crosses. Figure 1 also shows 12-monthly running means of the monthly mean zonal wind components. This serves the purpose of filtering out of the record the seasonal and annual variations. These are more pronounced at a subtropical station such as Nandi than they are in the equatorial regions[3].

Discussion.—The following points may be seen from Figure 1.

(i) At all levels analysed an approximate two-yearly fluctuation of the monthly mean zonal winds existed during the period covered by the observations. This fluctuation is manifest at the 15 and 20 mb levels in the alternation between easterly and marked westerly wind components during every second (southern hemisphere) winter from 1957 onwards. Westerly zonal wind components occurred during one or two winter months in 1953, 1955, 1957, 1959 and 1961 at the 30 and 50 mb levels also, but at these lower levels westerly components also occurred in July 1958 and June 1960. However, even at these levels an approximate two-yearly periodicity in the magnitude of the (southern hemisphere) late summer easterly components may be seen from January 1955 onwards.

(ii) No significant phase shift of the zonal wind fluctuations appeared between the levels analysed.

(iii) At levels above 30 mb the occurrence of the wintertime westerly components at Nandi coincided with the occurrence of westerly wind régimes in the equatorial stratosphere,[1,2,3] while in the years when easterlies prevailed over the equator, only a decrease in magnitude of the mean easterly wind components during the winter months was observed at Nandi.

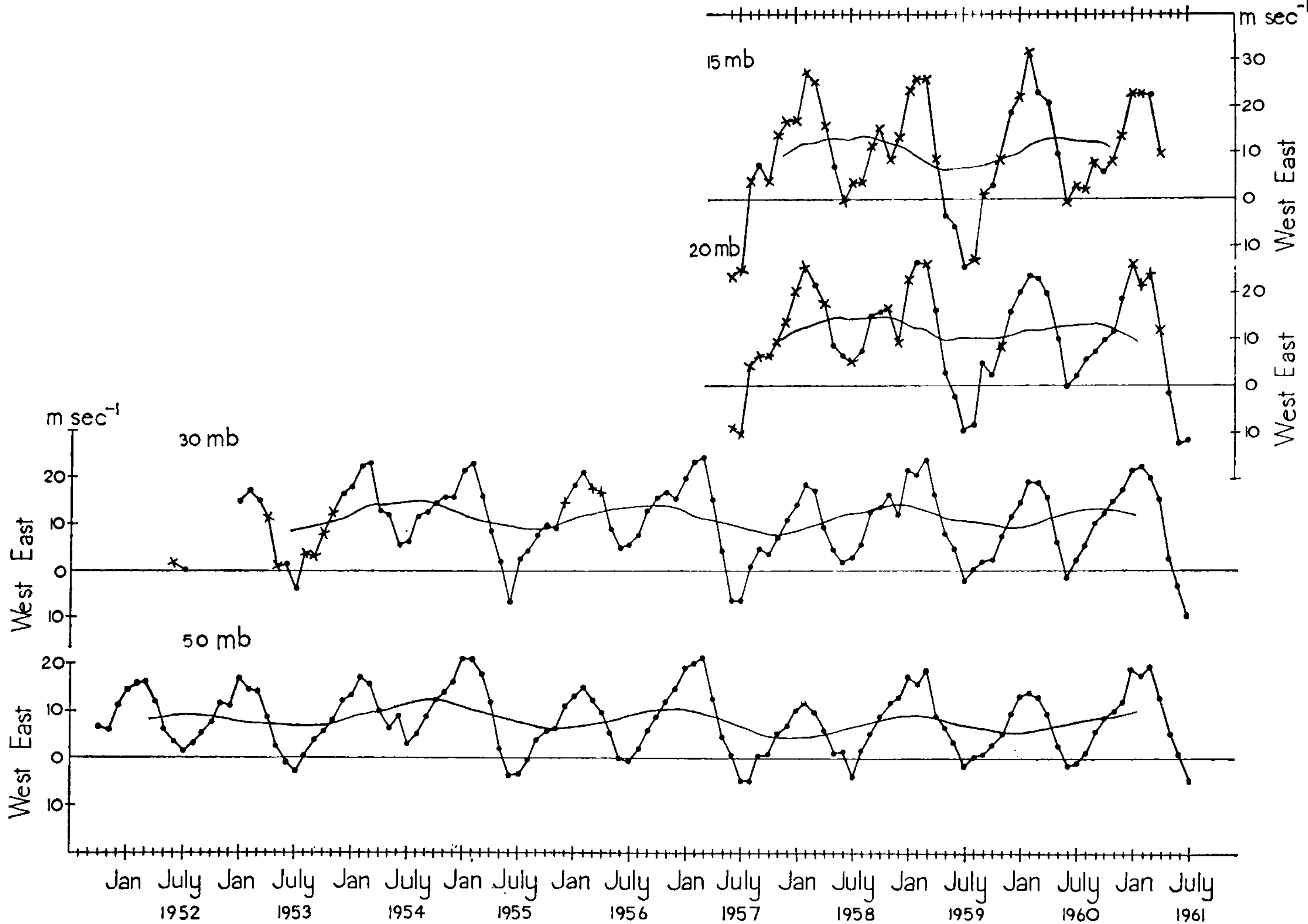

FIGURE 1—MONTHLY MEAN ZONAL WIND COMPONENTS AND THEIR 12-MONTHLY RUNNING MEANS FOR NANDI, FIJI
Monthly means based on less than 10 observations are marked by crosses.

Conclusion.—At Nandi the analysis of nearly 10 years of wind observations for the 50 and 30 mb levels and 4½ years for the 20 and 15 mb levels shows that the two-yearly zonal wind fluctuation found in the equatorial stratosphere also exists in the stratosphere over Nandi. However, at Nandi, the small amplitude of the two-yearly fluctuations of the mean zonal wind components at all levels analysed, as compared with the corresponding amplitudes observed in the equatorial regions, makes it likely that Nandi, although clearly influenced by the prevailing equatorial wind régime, lies fairly close to its southern boundary.

REFERENCES

1. EBDON, R. A. and VERYARD, R. G. Fluctuations in equatorial stratospheric winds. *Nature, London*, **189**, 1961, p. 791.

2. REED, R. J., CAMPBELL, W. J., RASMUSSEN, L. A. and ROGERS, D. G.; Evidence of a downward-propagating, annual wind reversal in the equatorial stratosphere. *J. geophys. Res., Richmond, Va.*, **66**, 1961, p. 813.

3. VERYARD, R. G. and EBDON, R. A.; Fluctuations in tropical stratospheric winds. *Met. Mag. London*, **90**, 1961, p. 125.

551.5:526.8

CONSTRUCTION OF MAPS AND CHARTS USED IN METEOROLOGY

By P. B. SARSON, M.A.

The standard projections of maps and charts recommended for meteorological use[1] are

Mercator projection (for maps near the equator) with scale true in latitude 22½°.

Lambert's conformal conic projection with two standard parallels at 30° and 60° or 10° and 40°.

Polar stereographic projection (circumpolar maps) with scale true in latitude 60°.

All these projections are orthomorphic so that, even though the scale varies with latitude, the scale at any individual point is the same in all directions thus preserving shape over small areas with no distortion of direction locally. Since meridians and parallels are both straight lines intersecting at right-angles, the normal Mercator projection has the additional property that all straight lines are rhumb lines, that is, lines of constant bearing. Construction of the charts on Mercator and stereographic projections offers little difficulty when once the distances between different parallels of latitude have been calculated. In constructing a conic projection, however, particularly those on a larger scale, it is usually necessary to calculate the intercepts of the meridians with the borders of the chart (because even a beam compass has limitations in size and accuracy) and also the intercepts of the parallels along the meridians. The scale at each latitude is also required.

If s is the scale at the standard latitude (s) of each chart, ϕ the latitude, R the earth's radius, s_ϕ the scale at latitude ϕ, d_ϕ the distance (on the chart) from the equator in Mercator projections, and from the pole in the other projections, and ϕ_1 the latitude of the standard parallel in the Mercator, ϕ_2 and ϕ_3 the latitudes of the standard parallels in the conic and ϕ_4 the latitude of the standard parallel in the stereographic projections, then the required formulae are:

Mercator projection

$$s_\phi = \frac{\cos\phi_1}{\cos\phi}\, s$$

$$d_\phi = Rs \cos\phi_1 \log_e \tan\left(\frac{\pi}{4} + \frac{\phi}{2}\right)$$

Lambert's conformal conic projection

k is the constant of cone (semi-vertical angle $= A$), that is

$$k = \sin A = \frac{\log_e(\cos\phi_2/\cos\phi_3)}{\log_e\left\{\tan\left(\frac{\pi}{4} - \frac{\phi_2}{2}\right)\Big/\tan\left(\frac{\pi}{4} - \frac{\phi_3}{2}\right)\right\}}$$

$$s_\phi = \frac{\cos\phi_2}{\cos\phi}\left\{\frac{\tan\left(\frac{\pi}{4} - \frac{\phi}{2}\right)}{\tan\left(\frac{\pi}{4} - \frac{\phi_2}{2}\right)}\right\}^k = \frac{\cos\phi_3}{\cos\phi}\left\{\frac{\tan\left(\frac{\pi}{4} - \frac{\phi}{2}\right)}{\tan\left(\frac{\pi}{4} - \frac{\phi_3}{2}\right)}\right\}^k$$

$$d_\phi = \frac{\cos\phi_2}{k}\left\{\frac{\tan\left(\frac{\pi}{4} - \frac{\phi}{2}\right)}{\tan\left(\frac{\pi}{4} - \frac{\phi_2}{2}\right)}\right\}^k = \frac{\cos\phi_3}{k}\left\{\frac{\tan\left(\frac{\pi}{4} - \frac{\phi}{2}\right)}{\tan\left(\frac{\pi}{4} - \frac{\phi_2}{2}\right)}\right\}^k.$$

The angle on the chart between longitudes λ_1 and λ_2 is

$$(\lambda_1 - \lambda_2)\sin A = k(\lambda_1 - \lambda_2).$$

Polar stereographic projection

$$s_\phi = \frac{1 + \sin\phi_4}{1 + \sin\phi}\, s$$

$$d_\phi = Rs \tan\left(\frac{\pi}{4} - \frac{\phi}{2}\right)(1 + \sin\phi_4).$$

Gnomonic projection.—One further projection is used meteorologically. This is the gnomonic projection with the valuable property that all great circles on the globe are reproduced as straight lines and vice versa. This is a perspective projection from the centre of the earth on to a tangential plane. The chart is seen as if from the side of the plane opposite to the centre of the globe. The chart is quite easy to construct if the tangential plane touches the earth's surface at the pole. However, in practice, for use in thunderstorm location, the oblique case is required and the tangential point (O in Figure 1) may be anywhere on the earth's surface. Meridians (being great circles) are reproduced as straight lines through the pole, the equator is a straight line at right-angles to the meridian through the tangential point and all other parallels are either ellipses or hyperbolae.

The scale of a gnomonic chart increases with distance from the tangential point, becoming infinite at a distance equal to a quarter of the globe's circumference. Figure 1 shows some of the triangles used to determine the more important formulae needed to construct a gnomonic chart. C is the centre of the earth and O is the tangential point of the projection on which P is the pole and EE_λ is the equator on the chart. The co-ordinates of O are ϕ_0 and λ_0. For any general point G (ϕ, λ) the projected point is G'. α is the angle on the chart

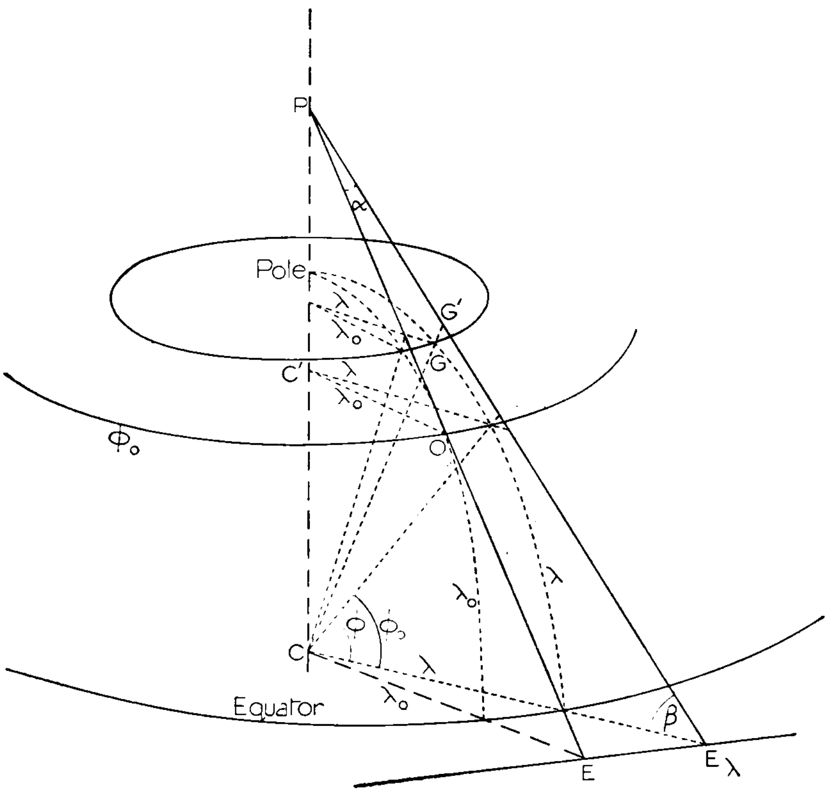

FIGURE I

between longitudes λ and λ_0; β is the angle between the longitude λ (on the chart) and the line drawn from latitude 0° on longitude λ to the centre of the earth. The formulae are:

$$PE = 2Rs \operatorname{cosec} 2\phi_0$$

$$\tan \alpha = \tan (\lambda - \lambda_0) \sin \phi_0$$

$$\tan \beta = \cos (\lambda - \lambda_0) \cot \phi_0$$

$$PE_\lambda = \frac{Rs}{\sin \beta \sin \phi_0}$$

$$PG' = \frac{Rs \cos \phi}{\sin \phi_0 \sin (\phi + \beta)} \qquad \ldots (1)$$

$$G'E_\lambda = \frac{Rs \sin \phi}{\sin (\phi + \beta) \cos \phi_0 \cos (\lambda - \lambda_0)}. \qquad \ldots (2)$$

Formula (1) leads to inaccuracies for tangential points near the equator; formula (2) leads to inaccuracies for tangential points near the pole; and it is best to use one or the other formula, depending on the position of the tangential point.

[To face p. 70

PLATE I—METEOROLOGICAL OFFICE, ROYAL AIR FORCE, FELIXSTOWE

The wooden building on the left is the earliest office from 1918–28. The brick building on the right was used from 1929–37.

(see p. 81)

PLATE II—METEOROLOGICAL OFFICE, ROYAL AIR FORCE, FELIXSTOWE

This office was occupied from 1937–61.

(see p. 81)

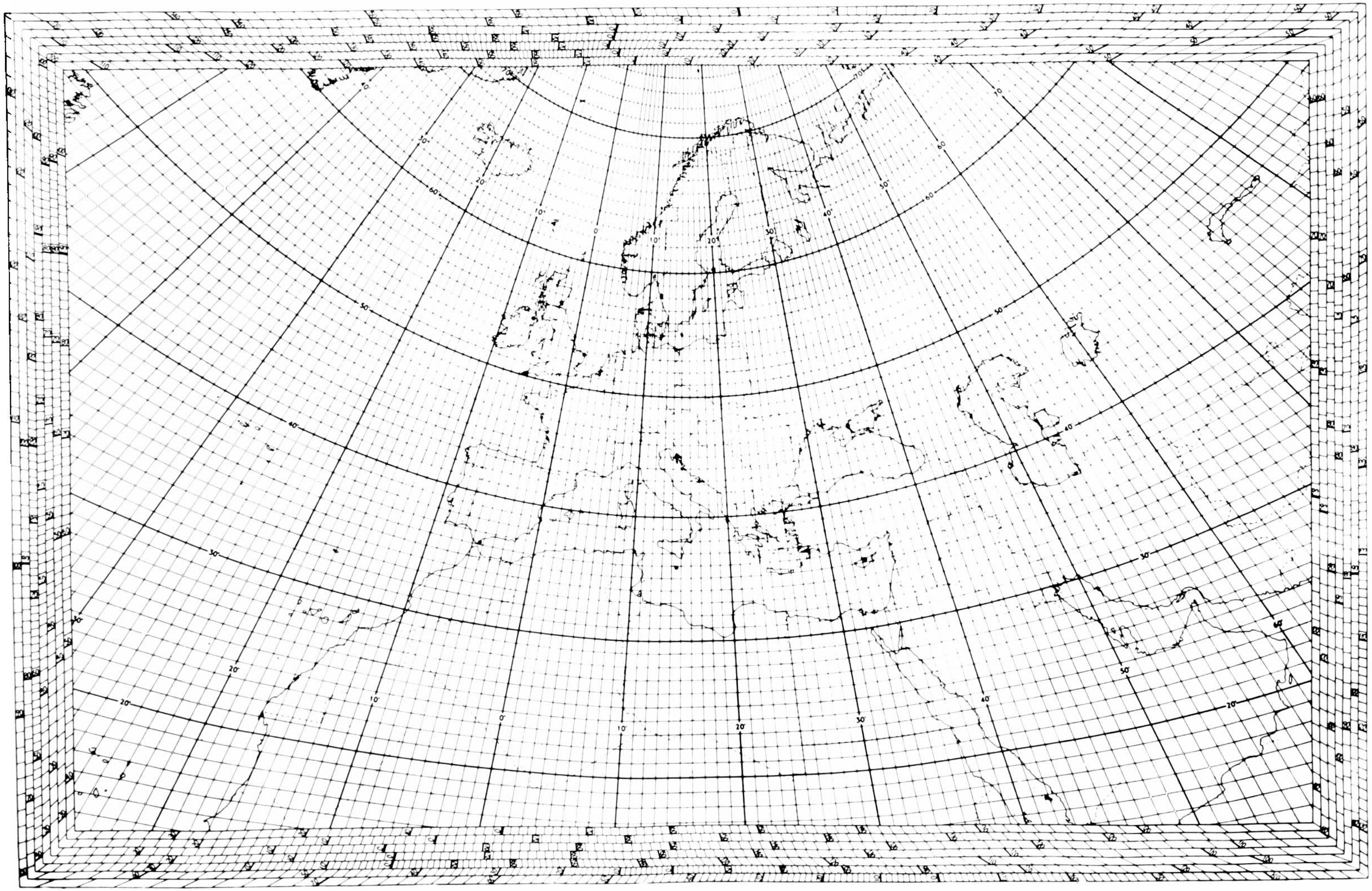

FIGURE 2—OBLIQUE GNOMONIC PROJECTION

The tangential point is at the centre of the chart (45°48′N, 15°58′E). The direction roses, in succession outwards from the edge of the chart, are centred on: Hemsby 52°41′N, 1°41′E; Shanwell 56°26½′N, 2°52′W; Longkesh 54°29′N, 6°06′W; Camborne 50°13′N, 5°19′W; Gibraltar 36°09′N, 5°21′W; Malta 35°50′N, 14°27′E; Nicosia 35°09′N, 33°17′E

For SFLOCS use, the bearings of a lightning flash from several points on the chart are plotted almost instantaneously. It is therefore necessary to draw direction roses round the borders of the chart, one for each SFLOCS station, as in Figure 2. The chart is not orthomorphic, and therefore the angles between the corresponding bearing and the sides of the chart have to be calculated for every required bearing round the compass. If e and e' are the chart distances of the SFLOCS station from the polar and western edges of the chart, a' and b' are the similar distances for the tangential point, and δ is the angle between the bearing required and the meridian through the SFLOCS station, the formulae are:

$$\left.\begin{aligned} e &= \frac{Rs \cos\phi \sin\alpha}{\sin\phi_0 \sin(\phi+\beta)} + a' \\ e' &= Rs\left\{\frac{\cos\phi\cos\alpha}{\sin\phi_0\sin(\phi+\beta)} - \cot\phi_0\right\} + b' \end{aligned}\right\} \text{for stations not near the equator}$$

or

$$\left.\begin{aligned} e &= Rs\left\{\frac{\tan(\lambda-\lambda_0)}{\cos\phi_0} - \frac{\sin\phi\sin\alpha}{\cos\phi_0\cos(\lambda-\lambda_0)\sin(\phi+\beta)}\right\} + a' \\ e' &= Rs\left\{\tan\phi_0 - \frac{\sin\phi\cos\alpha}{\sin(\phi+\beta)\cos\phi_0\cos(\lambda-\lambda_0)}\right\} + b' \end{aligned}\right\} \text{for stations not near the pole}$$

and the angle δ is given by:

$$\tan(\delta-\alpha) = \frac{\{\cos\phi_0\cos\phi+\cos(\lambda-\lambda_0)\sin\phi_0\sin\phi\}\sin T-\sin\phi_0\sin(\lambda-\lambda_0)\cos T}{\cos T\cos(\lambda-\lambda_0)+\sin(\lambda-\lambda_0)\sin\phi\sin T}$$

where T is the true bearing of the lightning flash from the SFLOCS station.

These formulae are rather cumbersome to work out by hand and, before the use of electronic computers, the direction roses never were calculated. By choosing the tangential point near the centre of the network of SFLOCS stations the chart was assumed to be orthomorphic at each station. With stations in so small an area as the British Isles the errors are not large. With stations farther afield the errors may easily be as much as 10°. The graticule of such a chart as Figure 2 might take as much as three or four months' solid work to calculate using, as it is found necessary, six-figure mathematical tables. With METEOR the co-ordinates for each graticule on a map such as Figure 2 can be calculated and printed by the machine in a matter of 15 minutes, including the direction-rose borders.

REFERENCE

1. Geneva, World Meteorological Organization; Technical Regulations, **1**, 1959, para. 7.2.1.1.

551.509.317:551.509.324.2

DEVELOPMENT OF RAIN AHEAD OF AN UPPER TROUGH

By T. A. M. BRADBURY

Introduction.—During the afternoon of 7 April 1961 there was a rapid development of rain over England ahead of an upper trough which moved eastwards across the country. The rear edge of the rain area coincided approximately with the upper trough line. It is suggested that the movement of this trough controlled the development and subsequent movement of the rain area. The 300 mb contour chart is advocated as a useful guide to the probability of this kind of development.

Descriptive account of the outbreak of rain.—The surface chart for 1200 GMT on 7 April 1961 is shown in Figure 1. The main features are the

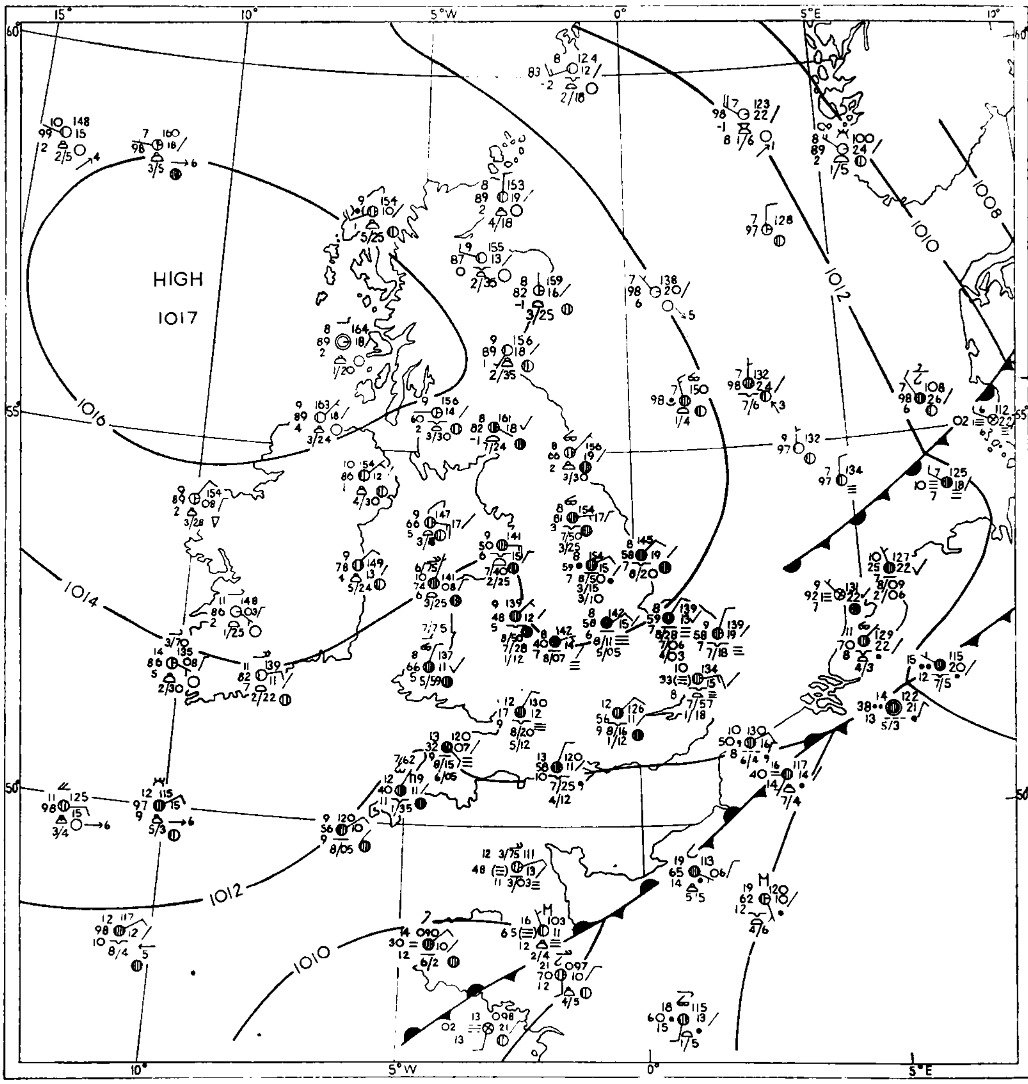

FIGURE 1—SURFACE CHART FOR 1200 GMT, 7 APRIL 1961

developing anticyclone approaching Scotland from the west, and a quasi-stationary front near the north coast of France. This front marked the southern boundary of a broad diffuse frontal zone which lay over the southern half of England. Earlier charts had shown a weak occlusion lying across England north of the quasi-stationary front and approximately parallel to it. However, the occlusion grew too weak to be located with confidence and was omitted from the official analysis.

At 1200 GMT the only rain reported over Great Britain was the small area of light rain near Finningley, and the rain there died out soon afterwards. The chart for 1500 GMT showed two new outbreaks of rain, one near Shawbury

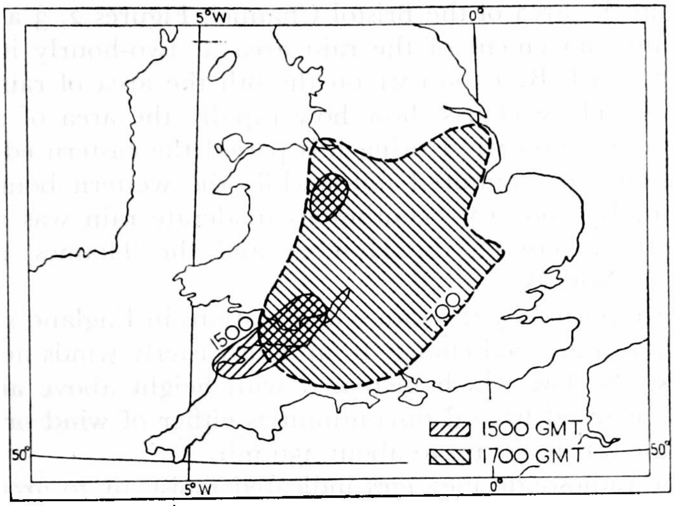

FIGURE 2—RAIN AREA FOR 1500 AND 1700 GMT, 7 APRIL 1961

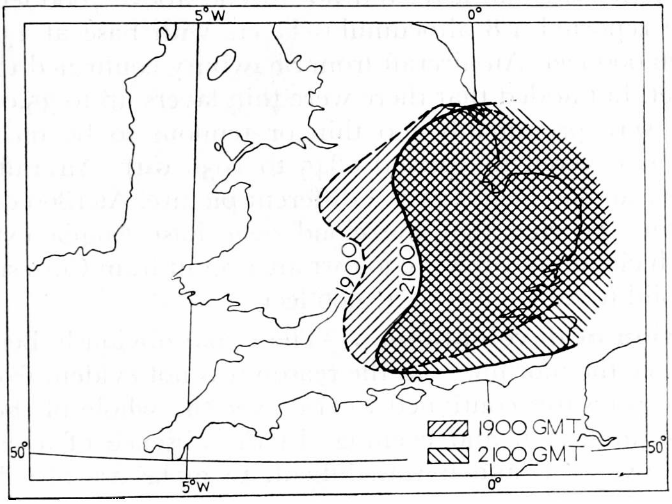

FIGURE 3—RAIN AREA FOR 1900 AND 2100 GMT, 7 APRIL 1961

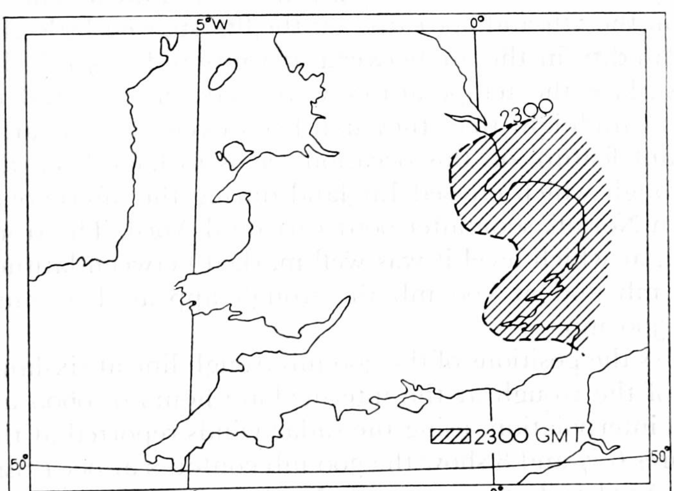

FIGURE 4—RAIN AREA FOR 2300 GMT, 7 APRIL 1961

By 0100 GMT, 8 April, rain had ceased over England.

and the other in the area of the Bristol Channel. Figures 2, 3 and 4 show the development and movement of the rain area at two-hourly intervals up to 2300 GMT on 7 April. By 0100 GMT on the 8th the area of rain was clear of eastern England. These charts show how rapidly the area of rain increased between 1500 and 1700 GMT. During this period the eastern edge of the rain area advanced about a hundred miles while the western boundary showed little movement. By 1900 GMT continuous moderate rain was reported by a number of stations between the Humber and the Thames, and from the Welsh border to Norfolk.

Upper winds reported by the radiosonde stations in England showed that at midday there was a gradual change from light easterly winds near the surface to a south-westerly flow which increased with height above about 850 mb. There were no marked frontal discontinuities either of wind or temperature. However, the air was moist up to about 350 mb.

Although the radiosonde messages indicated moist air to great heights the morning aircraft reports from Lincolnshire, East Anglia and also Ternhill showed that the main cloud layer did not extend above 7000 feet. An aircraft from Pershore reported 4/8 altocumulus layers with base at 13,000 feet and cirrus top at 26,000 feet. An aircraft from Shawbury confirmed the main cloud top at 7000 feet, but added that there were thin layers up to 35,000 feet. These higher layers were presumably too thin or tenuous to be measured. These morning reports covered the period 0845 to 1030 GMT. Aircraft observations made after the rain had begun gave a different picture. At 1800 GMT an aircraft from Honington reported that the cloud over East Anglia extended up to 27,000 feet with cirrus above. At 1930 GMT an aircraft from Cottesmore reported the cloud as solid from 500 feet to 27,000 feet.

Consideration of developments.—There had obviously been a considerable change since the morning, but the reason was not evident from the surface charts. Surface pressures continued to rise over the whole of the British Isles throughout the afternoon and evening. In the absence of a clearly defined frontal surface over England it was difficult to make use of a hodograph to establish up-slope motion, nor was there any clear sign of cold air "over-running" at high levels. In fact a comparison between the ascents from Hemsby for 1200 GMT on the 7th and 0001 GMT on the 8th showed little change in temperature or humidity in the air between 250 mb and 415 mb. From 415 mb down to the surface the temperatures were between two and three degrees Celsius colder at midnight than they had been twelve hours earlier.

The important feature on this occasion seems to have been the movement of an upper trough which crossed England during the afternoon and evening to reach eastern Norfolk soon after 0001 GMT on 8 April. The trough shows up best at 300 mb, at which level it was well marked between latitudes 49°N and 54°N. At 400 mb and at 500 mb the trough appeared at much the same position as at 300 mb.

Figure 5 shows the positions of the 300 mb trough line at six-hourly intervals. The positions of the trough at the intermediate hours of 0600 and 1800 GMT were drawn by interpolation, using the radar winds reported at these hours for guidance. Figures 6, 7 and 8 show the 300 mb contours at 0001 GMT on 7 April, 1200 GMT on 7 April and 0001 GMT on 8 April.

Comparison between the chart showing the movement of the upper trough and the charts showing the positions of the rain area demonstrates that the

[*To face p.* 74

PRESENTATION OF L. G. GROVES MEMORIAL PRIZES AND AWARDS
(see p. 80)

Left to right: Mrs. K. J. Groves, Major K. J. Groves and Mr. E. Knighting.

Crown copyright

PRESENTATION OF L. G. GROVES MEMORIAL PRIZES AND AWARDS

(see p. 80)

Left to right: Senior Technician L. Hodgkinson, Squadron Leader J. M. Robertson, Mr. E. Knighting, Major K. J. Groves, Mrs. K. J. Groves, Air Marshal Sir Ronald Lees, Sergeant H. S. Carden and Flight Lieutenant R. J. K. Nicholas.

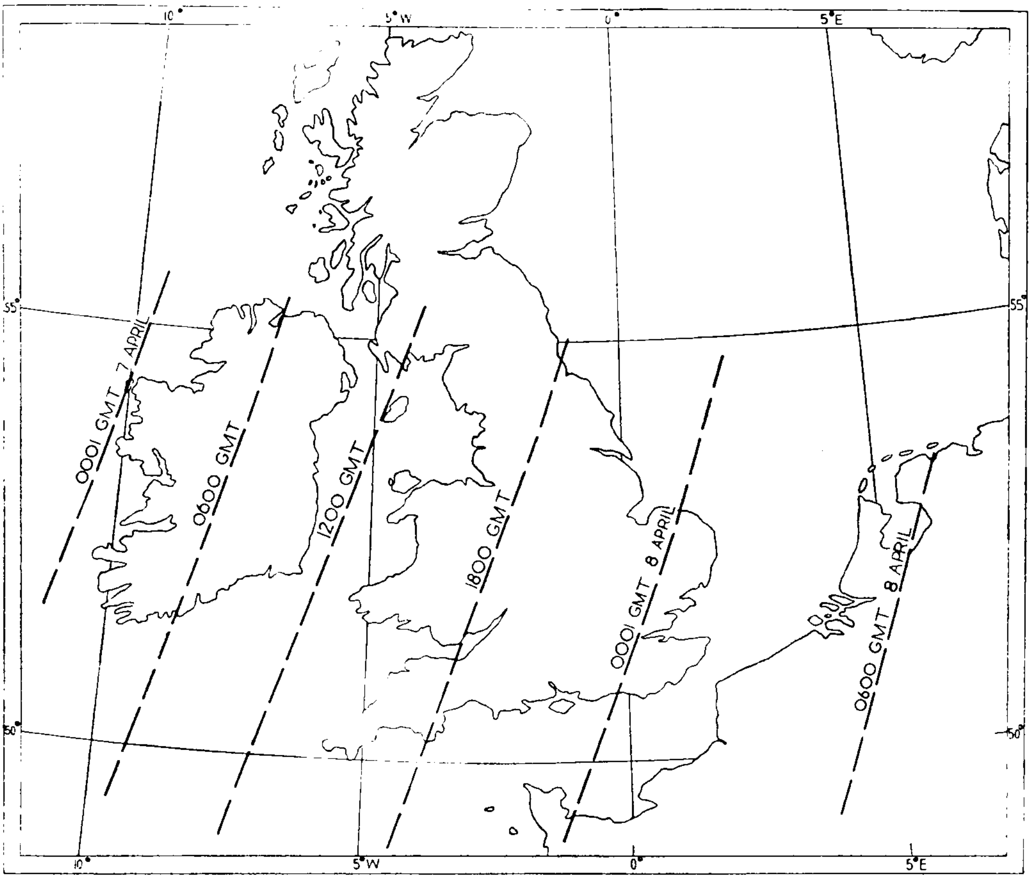

FIGURE 5—MOVEMENT OF 300 MB TROUGH LINE FROM 0001 GMT, 7 APRIL TO 0600 GMT, 8 APRIL 1961

first outbreak of rain in the west occurred just ahead of the trough line and later extended more than a hundred miles in advance of the line. Within broad limits the rear edge of the rain was more or less coincident with the trough line.

It appears that in the region east of the trough line there was ascent of the already moist air mass. The Camborne upper air sounding for 1200 GMT on the 7th showed the air would have reached saturation at levels above about 750 mb after an ascent of 1000 to 1500 feet. West of the trough line the 1200 GMT upper air soundings from Aldergrove and Valentia both indicated regions of subsided air above the 850 mb level.

Cloud observations plotted on the 1200 GMT chart also showed a difference between the air on either side of the upper trough line. Over Ireland, then west of the trough line, there was no medium-level cloud and practically no cirrus. In contrast just east of the trough line there was an almost complete cover of medium or high cloud at Carlisle, Valley, Aberporth and St. Mawgan. The western edge of the medium and high cloud sheet was in this case nearly coincident with the line of the upper trough.

Three points suggest that the line of the upper trough was also the approximate boundary between regions of ascending and descending air in the middle troposphere.

(i) The rain developed exclusively ahead of the trough line.

(ii) The edge of the upper cloud observed at midday corresponded fairly

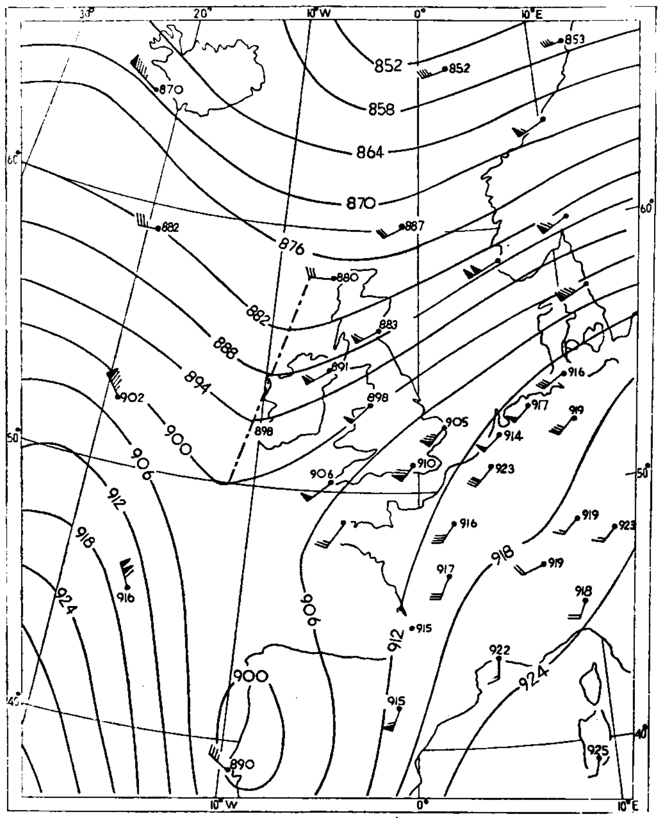

FIGURE 6—300 MB CONTOURS FOR 0001 GMT, 7 APRIL 1961

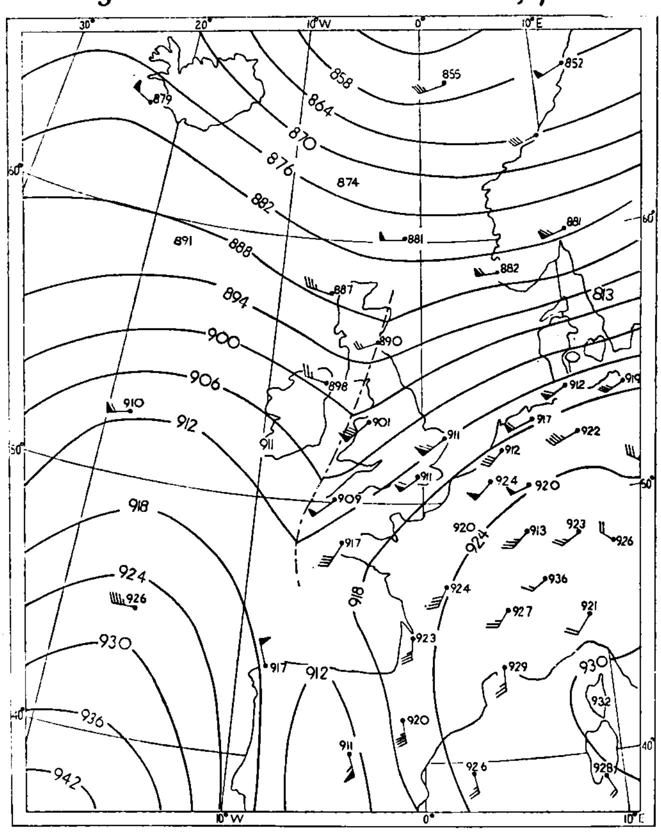

FIGURE 7—300 MB CONTOURS FOR 1200 GMT, 7 APRIL 1961

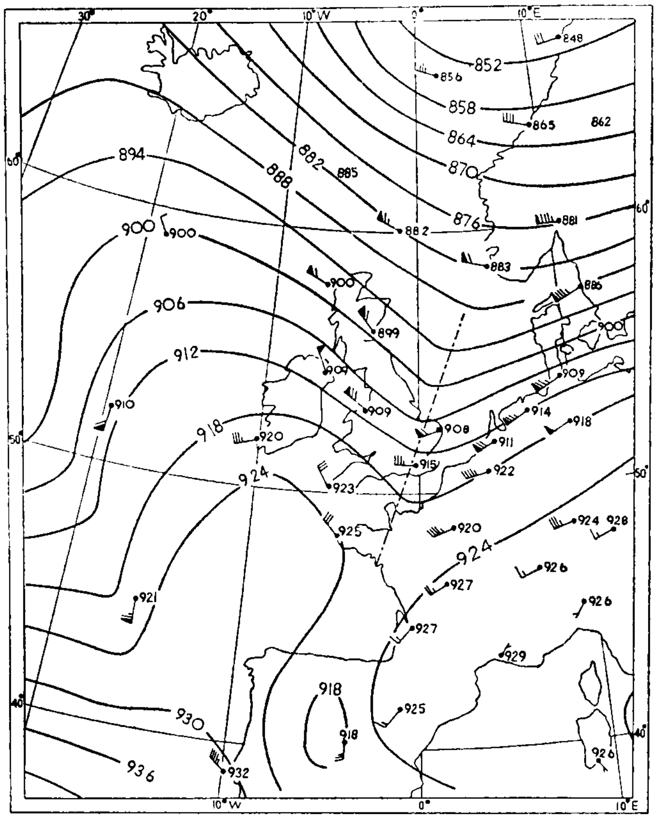

FIGURE 8—300 MB CONTOURS FOR 0001 GMT, 8 APRIL 1961

closely to the line of the upper trough, but not to the orientation of the surface frontal system.

(iii) The midday Irish radiosonde ascents showed subsidence had taken place in the air west of the trough line.

Several writers have shown that the upper trough line may at times be a dividing line between areas of ascending and descending air in the middle troposphere. Oliver[1], describing the use of 700 mb charts, stated that elongated vee-shaped troughs have cloudiness and precipitation in the southerly current in advance of the trough with clearing at the trough line and behind it. Fleagle[2] produced an idealized vertical cross-section showing the trough line marking a boundary between a region of ascending air ahead of the trough and descending air behind it.

Petterssen[3], dealing with the distribution of vorticity in the upper troposphere, gave examples of the advection of positive vorticity ahead of a 300 mb trough. This occurs when the upper wind is blowing through the trough, and is associated with high-level divergence ahead of the trough. Such upper troughs have been observed to travel faster than the surface frontal systems and overtake them. This overtaking by an upper trough (with positive vorticity advection in advance of it) of a frontal system in the lower troposphere is considered by Petterssen to be one of the most reliable indications of cyclonic development at sea level. It was found that as the upper trough neared the surface front the divergence at high level was compensated by convergence at low levels resulting in ascent of air through the level of non-divergence which was generally found near the 600 mb level.

This process could account for the development which took place ahead of the upper trough over England on 7 April. With an upper trough of this type ascent of air from the lower levels can occur in advance of the trough, while descent takes place to the rear of the line. It is not certain that the existence of a front is vital to the process, but undoubtedly the presence of a considerable depth of moist air over England was necessary for the rapid development of rain. Had the air been dry the upper trough would probably have passed unnoticed.

Value of the 300 mb chart.—It is considered that in general the development and movement of upper troughs can be seen more clearly from a sequence of 300 mb charts than other standard levels. Examination of the 1000–500 mb thickness lines on 7 April 1961 showed that this chart gave little indication of the sharpness of the 300 mb trough. The trough in the thickness lines was of small amplitude and very broad, and the speed could not readily be worked out by simple methods of advection or extrapolation. At 300 mb the axis of the trough was sufficiently well marked for the approximate speed to be found from a sequence of observations.

The movement of upper troughs is not always in phase with features shown on the surface chart, and on the occasion described above the upper trough was largely independent of the systems shown on the surface chart of the area near the British Isles. It is thought that a study of the development and movement of the 300 mb pattern can be of help in forecasting surface developments, particularly when the commonly used contours of the 1000–500 mb thickness fail to show any well defined features.

Summary.—The movement of upper troughs over frontal systems in the lower troposphere can result in ascent of air in the region ahead of the trough. This process is considered to have caused the rapid development of rain over England on 7 April 1961. A sequence of 300 mb charts can help in forecasting similar occasions when inactive fronts may develop a fresh rain area on account of the low-level convergence and high-level divergence ahead of the upper trough.

REFERENCES

1. OLIVER, V. J. and OLIVER, M. B.; Forecasting the weather with the aid of upper-air data. Handbook of meteorology (ed. by F. A. Berry, E. Bollay and N. R. Beers), New York, 1945, p. 815.
2. FLEAGLE, R. G.; The fields of temperature, pressure and three-dimensional motion in selected weather situations. *J. Met., Lancaster, Pa.*, **4**, 1947, p. 165.
3. PETTERSSEN, S.; Weather analysis and forecasting. Vol. 1, New York, 1956, Ch. 14 and 16.

551.5:028:41

LEARNING TO READ RUSSIAN METEOROLOGICAL LITERATURE

By R. F. ZOBEL, O.B.E.

A vast amount of Russian scientific and technical literature is now reaching this country and amongst it are many papers on all the various branches of meteorology, hydrology, oceanography and other sections of geophysics. Most professional meteorologists in this country are able to read the French literature, whilst a good sprinkling are also able to read German. But the accession of Russian papers into the Meteorological Office Library is considerably greater than those in either French or German. Yet very few meteorologists are even able to read the Cyrillic alphabet. No doubt this situation is not peculiar to meteorologists, but applies to scientists in general.

The main publishers of meteorological papers in Russia are the Hydrometeorological Service, the Academy of Sciences and the Arctic and Antarctic Institute. These are all major scientific institutions. Indeed the first-named is probably the largest meteorological service in the world and many of its published works, and those of the other institutions, are major works which the progressive meteorologist cannot afford to ignore. There are only two ways of obtaining a full knowledge of the contents of these papers. One is to rely on somebody else's translations and the other, by far the better, is to read them oneself.

Both these ways are beset with quite serious difficulties. Professional translators almost always have adequate command of the language, but their command of meteorological terminology and parlance usually leaves a great deal to be desired. So much so, indeed, that sometimes the real meaning is quite obscure. For example, a linguist would almost certainly translate ВЕРТИКАЛЬНАЯ СТРАТИФИКАЦИЯ ("vertikal'naja stratifikacija"—international system of Cyrillic transliteration) as "vertical stratification", but a meteorologist with a knowledge of Russian would translate it as "lapse rate". Another very great problem confronting the professional translator concerns the names of non-Russian authors referred to in the text. The Russian practice with such names is to write them in Cyrillic characters so as to obtain, as nearly as possible, the correct pronunciation of the name in the original language. But this leads to untold difficulties for the translator in arriving at the English spelling of the name. For example, a translator might well be forgiven for not knowing that КОШИ (Kosi) is equivalent to Cauchy. A particular pitfall lies in the fact that there is no letter H in the Russian alphabet. That symbol does in fact appear but it is equivalent to N. Therefore the Russian renders foreign words in his own language by transliterating an H by a Cyrillic Г. But this means that the names Hill and Gill, for example, would appear in a Russian text as precisely the same. Only one quite familiar with the bibliography on the subject of the paper could tell the real name of the author. The professional translation always requires correction and editing by a meteorologist, but this is in itself a tall order, as he must have a good working knowledge of Russian and also be familiar with the branch of meteorology being discussed. Another disadvantage of the professional translation is the time-lapse before it becomes available, not to mention the cost which always far exceeds the cost of the original document. For a long text the difference in cost may be several hundred pounds.

There is no doubt at all that the best, cheapest and, in the long run, the quickest way of obtaining a knowledge of Russian scientific literature is to learn to read it oneself. But here again there are difficulties and they are more obvious. Firstly, one needs the determination and the time and, secondly, one preferably needs to find a competent instructor or an institution offering part-time classes in Russian. Most of these classes are not aimed specifically at teaching one to read Russian scientific literature and they may devote considerable time to the speaking of Russian, which to the scientist who is only wanting to read is rather a waste of time.

There is however no escaping the fact that one must acquire a thorough knowledge of the whole language, though the vocabulary required may be somewhat restricted. This point is made in the first paragraph of the Introduction to *An introduction to Russian science reading* by A. Dressler*, which as the name implies is intended specifically to assist scientists to become able to read Russian scientific texts. It is, however, possible to dispense with instructors and classes and to become proficient by self-study. Indeed it can be a fascinating hobby which provides useful dividends in one's work.

Truly the learning of any language is a big undertaking and Russian is no exception. Possibly the difficulties are greater than in learning, say, French or German. First of all there is, of course, the unfamiliar alphabet of 32 letters. But the scientist will actually be familiar with quite a few of them, because some are the same as in English and others have direct Greek equivalents as used in mathematics. Others he will need to learn but it is easy to learn the letters in an hour, though the correct order of them, so necessary to know when using a dictionary, will take a little longer. Then again, rather like Latin, Russian has three genders, nouns even names (with exceptions) are declined and verbs conjugated. The Russian verb presents difficulties, apart from the conjugations (some of which are irregular), as there are only three tenses as against twelve in English. But, of course, a Russian is perfectly able to express the finer shades of meaning and times of action of a verb, though he does it in a way which is unfamiliar, focussing attention on whether the action is in progress or is an habitual action (imperfective aspect), or whether the action is to be thought of as a completed whole (perfective aspect). As with other languages the thought processes and the syntax are not the same as in English, but there need be no great fear of the difficulties of the Russian language. Of course, some flair for languages is no disadvantage.

Another prerequisite to self-study is a thoroughly sound and reasonably comprehensive textbook. As any such book must do, Dressler's makes all the main points and he puts them clearly and concisely. It is not entirely clear, however, if the author really intends the book to be used as a text for self-study by a raw beginner, who by the time he has worked through to the last page will be able to tackle Russian literature on his own subject. There is some suggestion in the Introduction that this is the case, although the alternative use of the book under a tutor's guidance is certainly envisaged and its title includes the word "introduction". As a self-study text, however, one can but feel that it is scarcely sufficiently comprehensive alone. It is a slim volume of only 158 pages, the last 43 of which are entirely devoted to translating exercises. This leaves few more than 100 rather small pages for the grammar and the acquisition of a working vocabulary before setting out to translate passages from scientific texts. Incidentally there is no key to the translations which is unhelpful to a self-taught student, though in fairness a number of hints are given, but only in relation to the easier exercises. When one considers that a well known, often recommended textbook on scientific Russian provides over 600 pages on grammar, interspersed with reading exercises only here and there, it will be realized that Mr. Dressler has resorted to considerable condensation. This is also very apparent in the index which leaves a good deal to be desired.

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* *An introduction to Russian science reading*, by A. Dressler. 8 in. × 5½ in., pp. x + 161, English Universities Press Ltd., 102 Newgate Street, London, E.C.1, 1961. Price: 20*s*.

It is also a pity that there is no glossary of Russian words. This would avoid the student needing to refer to a dictionary in order to translate the passages in the book.

In view of the very considerable difficulties in deducing the real names of transliterated authors' names, referred to earlier, it is felt that the book should make some reference to it. One also needs to be put on one's guard against "faux amis". These are prolific in French, for example "ciment" is not "cement", and there are some too in Russian. ГРАДАЦИЯ (gradacija) is simply given in many dictionaries as meaning "gradation", but in meteorological texts it mostly means "range" as, for example, in the phrase "within the range 1000–1010 mb". The word ДИАПАЗОН (diapazon) is also used for "range" in contexts having no association with acoustics. The word КАМЕРА (kamera) does not mean camera unless qualified, but means a cell or chamber. The word БАЛЛ (ball) occurs with monotonous regularity, but it does not mean "ball", but indicates a reading, mark, or point on an arbitrary, usually ten-point, scale. A Russian regards ДЕКАДА (dekada) as a ten-day and not a ten-year period. There are other points of difficulty which might well have found greater prominence in Mr. Dressler's book. One of these, especially important in forecasting texts, relates to the manner in which the precise time of an action is expressed, for example, at, by, after, before three o'clock; three hours later; three-hourly, etc. These have been known to give real difficulty to quite experienced translators.

The book under review has however many commendable features as a supplementary text. The section on word-building is particularly well done and will be found most useful. The exercises have been chosen with care and lead naturally to the more difficult passages, which are introduced by admirable hints on how to get the most value out of dictionaries. These passages will appeal particularly to meteorologists, because although chemistry and other sciences are well represented, quite a number of them have meteorological associations. The latter indeed includes a passage on phosphorescence at sea which makes reference to a paper published in our contemporary, the *Marine Observer*.

Although the price of £1 cannot be regarded as cheap, any scientist learning Russian will be pleased to have this little book.

It is to be hoped that the knowledge that such books as Mr. Dressler's and others exist with the express aim of allowing scientists to read the information published by their Russian colleagues, will encourage many others to learn at least to read the language. The advantages in doing so, as against reading someone else's translation, are many, which is perhaps reward enough, but there is also a satisfaction in the achievement which adds pleasure to the more material rewards.

NOTES AND NEWS

Meteorological Office, Royal Air Force, Felixstowe, 1918–61

Felixstowe was a Royal Naval Air Station during the First World War (1914–1918) but early in 1918 the station was taken over by the Royal Air Force and it has been associated with the Royal Air Force up to the present day. Weather observations were made at the Coastguard Station, Felixstowe, as early as 1914 and continued up to 1928. Routine observations at the Royal Air Force Station (about half a mile distant) began in 1918 and at this time the Felixstowe Meteorological Office was one of a total of only a dozen meteorological offices in the whole country, compared with over a hundred today. Since 1924 weather observations at Felixstowe have been made at the "synoptic" hours (which have changed over the years) almost without interruption until 1936 when the office was temporarily closed. In recent years observations have been made at every hour of the day and night without interruption.

There have been three meteorological office buildings at Felixstowe since 1918. The first was a wooden building used until 1928 and the second was a brick building adjoining the first office and this was used from 1929 to 1937 (Plate I, facing p. 70). The present office was built in 1937; it is a self-contained brick building situated on the sea-front facing west across the estuary of the Rivers Stour and Orwell (Plate II). It is approximately 30 feet from high water mark and before the erection of a 5-foot sea wall was liable to be flooded as in 1947 and 1953. In the flooding from 31 January to 2 February 1953, the anemometer hut was under 6 feet of water and the Stevenson screen was submerged. In spite of the severe damage, the office was operational again within three days.

Felixstowe during most of its history was closely connected with Coastal Command of the Royal Air Force and therefore with flying boats, seaplanes and marine craft. The Marine Aircraft Experimental Establishment was based at Felixstowe since the early years of the station although it was originally based in 1921 at Royal Air Force, Isle of Grain, Kent, where there was also a meteorological office. The association of the Marine Aircraft Experimental Establishment with Felixstowe ended in 1956 when it moved to Bedford. The seaplanes which took part in the international Schneider Trophy air races carried out their trials at Felixstowe during the 'twenties and early 'thirties. The Trophy was won outright in 1931. Another notable project in the years just preceding the Second World War was the "Mayo" catapult combination of a seaplane lying on a flying boat. Various types of flying boats were stationed at Felixstowe, for example the Stranraers and the Lerwicks, but the most well known were the Sunderlands for their anti-submarine exploits during the war. Forecasting for these aircraft was not easy because of the large sea areas they covered over periods up to 24 hours. The Search and Rescue role of Felixstowe, in peace and war, must not be forgotten; Walrus aircraft were used for this purpose during the war and in recent years (1956–61) Westland Whirlwinds of 22 Squadron performed this vital role. Other units that have been dependent on the Felixstowe meteorological office for their forecasts have been the Balloon Barrage Unit during the war, the neighbouring Naval units, including H.M.S. *Ganges*, and many civilian organizations such as sailing clubs, local flying clubs and of course the information bureau of the Felixstowe Urban District Council.

The work of the Meteorological Office, Felixstowe, was well known to the local community and it is fitting to close this article with an extract from the very warm tribute paid to the Felixstowe staff in a letter from the Chairman of the Urban District Council:

> "With the closing of the Meteorological Office at the R.A.F. Station, Felixstowe, I desire on behalf of the Council to convey to you and your colleagues the appreciation and grateful thanks of the Council and the townspeople and visitors for the excellent service which you have so willingly

given over a long period of years in providing us with the daily weather records and forecasts.

"The information obtained has been most valuable to the Council and its Information Bureau from the record and publicity point of view, and at the same time it has provided the public with a most useful facility. Forty years is a long time for such a service to have operated continuously, and we are indeed extremely sorry that it was found necessary to discontinue the meteorological service here."

J. PEPPER

AWARDS

L. G. Groves Memorial Prizes and Awards

The presentation of the L. G. Groves Memorial Prizes and Awards for 1961 was made by Major K. J. Groves in the Air Historic Room at Air Ministry, Whitehall, on 24 November 1961. The winners are given below:

The Memorial Prize for Meteorology was awarded to *Mr. E. Knighting, B.Sc.*, with the following citation:

"Mr. E. Knighting joined the Meteorological Office in 1940. He was a member of the team which developed the techniques of upper air analysis and forecasting from the network of upper air temperature and wind observations which have contributed much to upper wind forecasting and aircraft safety. He has made a notable analysis of the structure of the lowest 100 metres of the atmosphere, has studied the application of electronic computers to weather forecasting and, since 1959, has headed the British team on numerical weather prediction. In 1960–61 he published several important papers contributing to the establishment of numerical methods as a practical basis for weather forecasting and to the fundamental understanding of large-scale atmospheric motions."

The Memorial Award for Air Meteorological Observers was awarded to *Flight Lieutenant R. J. K. Nicholas* with the following citation:

"As an aircraft captain engaged on meteorological reconnaissance duties at Royal Air Force Station, Aldergrove, Flight Lieutenant Nicholas has completed 180 reconnaissance flights of which 43, involving 388 flying hours, have been during the past twelve months. He has never been deterred from completing the task by weather conditions at his base or in the reconnaissance area. His perseverance in the course of these gruelling and demanding flights has made a valuable contribution to the weather forecasting service and he has been granted the Air Meteorological Observers' Award for 1961 in recognition of his meritorious service."

The Memorial Prize for Aircraft Safety was jointly awarded to *Senior Technician L. Hodgkinson* and *Sergeant H. S. Carden* for devising a test set for checking the operative parts of an aircraft fire extinguisher circuit.

The Second Memorial Award was made to *Squadron Leader J. M. Robertson* for his design of a computer which provides a fighter pilot with a quick, simple and effective means of calculating the magnetic track and distance from his base, or a diversion, airfield.

REVIEW

Where no birds fly, by Philip Wills. $8\frac{3}{4}$ in. $\times 5\frac{3}{4}$ in., pp. 141, *illus.*, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2, 1961. Price: 21*s*.

Philip Wills has accrued thirty years of gliding experience over countries ranging from Scotland to New Zealand and Poland to the United States of America. He has navigated across the inhospitable mountains of Yugoslavia, searched for landing areas amidst the vast lakes and forests of Sweden, ridden the turbulent mistral over the French Alps, circled across the mesquite of Texas, soared to 30,000 feet over Mt. Cook and has won the World Gliding Championship in Spain. Luckily for book lovers, he also has the gift of describing his experiences in an entertaining and informative style. In this, his second book on gliding, he tells with humour and modesty of many of his famous flights and records incidents in the growth of the British gliding movement from its early hesitant beginnings to its present position of international pre-eminence.

Naturally the weather has its place in all the aerial adventure stories told, sometimes as almost commonplace convection, sometimes in the form of hail, lightning, giant lee waves, violent rotor flow or sea-breezes. Almost any of Mr. Wills' exploits could well be the subject of a meteorological paper or article. Tacit suggestions range from a climatological study of the Mackenzie country of New Zealand to a local investigation of what was probably a "land-breeze front" which he explored off the east coast of Kent.

The flying tales are interspersed with accounts of gliding organization and the arduous toil required by ground crews during gliding operations. To the uninitiated these accounts may appear to be overdramatized but they are nonetheless true. Indeed, although Mr. Wills' enthusiasm for gliding is obvious, he presents his observations of the air and its ways factually without premature conjectures or wild theories, and thereby makes these facts all the more impressive and intriguing for the meteorological reader.

C. E. WALLINGTON

PUBLICATION RECEIVED

Proceedings of the Iraqi Scientific Societies, Vol. 4, 1960–61. $9\frac{1}{2}$ in. $\times 6\frac{3}{4}$ in., pp. 44, *illus.*, Ar-Rabita Press, Baghdad, Iraq. Subscription: £1 per annum.

OBITUARY

Mr. H. Garnett.—The news of the death of "Joe" Garnett on 27 December 1961 at the early age of 57 came as a great shock to his many friends inside and outside the Meteorological Office. His cheerful and happy nature had endeared him to all those with whom he came in contact over a varied Office career lasting more than 35 years.

"Joe" Garnett joined the Meteorological Office in 1927. From his earliest days he was known as "Joe" although this was not his real name. The origin of this title is lost in the mists of time. For about eighteen months after taking up his first appointment, Mr. Garnett was employed on forecasting duties both at Meteorological Office Headquarters in London, and for a short time at that famous place, now alas gone from the Royal Air Force, Calshot. In those days a short time spent at Calshot was an almost inevitable part of the earlier experience of the young Junior Professional assistant gaining his first knowledge of aviation forecasting for the Royal Air Force.

However, in 1929 Mr. Garnett moved over to chemical defence research work at Porton, and for the next 17 years he was associated with this type of meteorological work both at Porton, and in India where he served two tours, one between 1934 and 1937, and another shorter tour at the end of the war and just after.

In 1946 Mr. Garnett returned again to forecasting duties and served with the Royal Air Force at H.Q. 47 Group (Transport Command); also at Dunstable and London Airport, before becoming, in 1948, Senior Meteorological Officer at H.Q. 38 Group (Upavon), again one of the Transport Command groups. In 1951, during a Transport Command reorganization, H.Q. Transport Command moved to Upavon and absorbed H.Q. 38 Group. Mr. Garnett remained at Upavon until 1960 as Chief Meteorological Officer of Transport Command. During this period he had many problems to deal with as the Command gradually became equipped with the modern and more advanced types of aircraft.

Mr. Garnett took up his last appointment in the Meteorological Office in September 1960, when he joined the Headquarters Branch specializing in the meteorological problems connected with agriculture. This Branch was then at Harrow, but Mr. Garnett moved with it to the new Meteorological Office Headquarters at Bracknell only a few months before his death.

"Joe" Garnett will be sorely missed by a wide circle of friends in the Meteorological Office, and also by many outside the Office with whom he came into contact during his varied official career. The deepest sympathy is extended to his widow and family.

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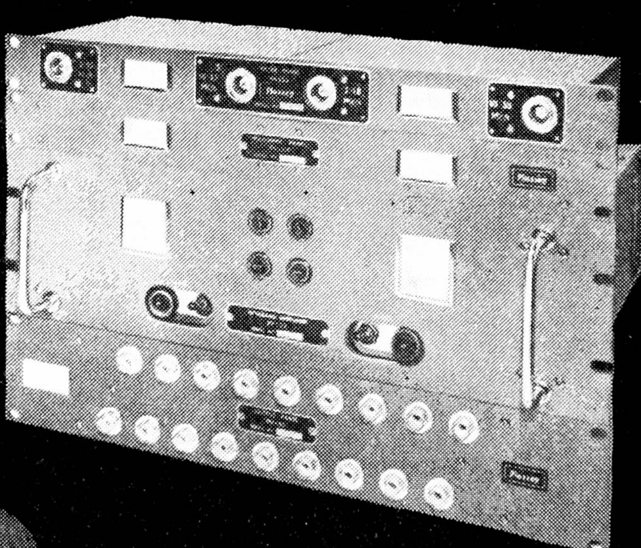

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