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SNOW SURVEY OF GREAT BRITAIN

Season 1954–55

As in previous years the basic material for this report has been derived from the returns made by voluntary observers who have provided, month by month, daily records of snowfall and of any snow-cover within their range of vision. These records, from a network of stations distributed over the country, are augmented by data extracted from the regular monthly returns from official weather stations and also from voluntary climatological stations reporting to the Meteorological Office. Without the co-operation of all those responsible for these voluntary observations it would have been impossible to have prepared this report in anything like its present detail.

Measurements of depth of snow in the following pages refer, in general, to 0900 G.M.T. or thereabouts.

Summary of 1954–55 season.—The season may be classed as one of more than average snowfall. Data for ten representative stations* in Great Britain at altitudes between 400 and 1,200 ft., which have been used for seasonal comparison since the survey of 1946–47, give a mean of 51 days with snow lying at the hour of morning observation. This compares with an average of 36 such days over the past eight seasons; the great variability of snowfall in the British Isles is shown by the fact that during these seasons the mean number of days ranged from 13 in 1948–49 and 1949–50, to 66 in the severe winter 1946–47. The snowfall during the season under review may be compared generally with that of 1946–47, although the worst conditions were largely confined to northern districts, whereas during the 1946–47 season they were more evenly distributed over the country. In February 1955 undrifted snow accumulated to a depth of over 24 in. over a wide area in Scotland, and Drummuir, Banffshire, reported a depth of 36 in. on the 21st, whereas in the Pennines at Forest-in-Teesdale during February 1947 the depth of level snow increased from 44 in. on the 6th to 53 in. on the 18th. The number of days on which snow fell was also less this season than in 1946–47.

Notes on the months.—*September 1954.*—Temperature during the month was below normal for the time of the year, and sleet showers fell locally in Scotland on the 16th–18th and 24th–29th. Snow lay on the summit of Ben Nevis throughout the month, and on some other high peaks in Scotland, notably the Cairngorms on the 17th–20th and 26th–30th, and on some of the higher peaks in Cumberland and Westmorland on the 27th–28th.

* These stations are:—Dalwhinnie, Braemar, West Linton, Eskdalemuir, Huddersfield (Oakes), Buxton, Whipsnade, Little Rissington, Princetown and Rhayader.

October 1954 was a very mild month, particularly in England and Wales where the average temperature was 3°F. above the seasonal normal. Snow or sleet showers were reported locally on the 17th, 21st–25th, 27th, and 30th. Snow lay on some of the Scottish hills, mainly at 2,500 ft. and above, from the 10th onward, and on the higher hills in Cumberland and Westmorland, including Cross Fell on the 24th–29th.

November 1954.—Mean temperature during the month was about the seasonal normal. Snow or sleet fell locally on most days, but there were no really heavy falls, though snow lay several inches deep on high ground in Scotland on the 24th; for example, 2½ in. at Glenlivet in the Cairngorms and at Glengavel in the northern foothills of the Southern Uplands, Lanarkshire, 4 in. at Dalwhinnie in the Grampians and 5 in. at Leadhills in the Southern Uplands. Snow also lay on the higher ground of north-west England on the 5th–9th, 12th and 23rd–27th including Moorland Cottage and Cross Fell in the Pennines and on Helvellyn and Scafell in the Lake District.

December 1954 was exceptionally mild in England and Wales, where the mean temperature for the month was nearly 4°F. above normal in spite of a rather cold period from the 5th to the 12th and again from the 23rd to the 24th. Snow fell fairly frequently north-west of a line, Bristol Channel to the Wash, particularly in parts of Scotland where heavy falls blocked roads for several days. At 2,400 ft. near Leadhills, Lanarkshire, there were drifts 12 ft. deep. Snow was widespread on the 8th, 12th, 23rd and 24th; it lay to a depth of 22 in. at Braemar and 18 in. at Balmoral, both in Aberdeenshire, on the 8th, and 14 in. at Achnagoichan and Glenmore Lodge, both in Invernessshire, on the 9th. Further south at Moor House, Westmorland, there was 6 in. of level snow with drifts 3 ft. deep on the 9th–12th; 4 in. at Buxton, Derbyshire, on the 8th–10th and 5 in. at Cae Llwyd, Denbighshire, on the 8th.

January 1955, in marked contrast with December, was very cold except for the last week. In Scotland local falls of snow or sleet occurred throughout the month, and there was snow in most areas from the 10th to the 18th, the main falls occurring from the 11th to the 14th and from the 16th to the 18th. At Glenrossal, Sutherland, level snow lay to a depth of more than 12 in. from the 14th to the 21st and was 18–20 in. deep on the 18th; on the same day it was also 18 in. deep at Achnagoichan near the Cairngorms and at Adit 3 near Loch Lochy on the Caledonian Canal. Gales piled the snow into deep drifts—30-ft. drifts were reported at some places—and many farms and villages, thus isolated, were supplied with food by aircraft. In England and Wales snow or sleet fell fairly frequently up to the 19th, and was widespread on the 4th, 5th, 15th and 18th. It was lying to a depth of 6–9 in. on the 17th in Northumberland, Durham, the North and West Ridings of Yorkshire, south Lancashire and north Wales.

February 1955 was an exceedingly cold month, the coldest in the British Isles since February 1947 with average temperatures 5–6°F. below normal. In Scotland, snow or sleet fell daily with moderate or heavy falls on most days from the 9th to the 22nd. As in January, the north and north-east were severely affected with undrifted snow in places more than 24 in. deep; Drummuir, Banffshire, reported a level depth of snow of 36 in. on the 21st. In England the north-east was badly affected; in parts of Northumberland level snow lay over a foot deep from the 22nd till the end of the month, while at Buxton, Derbyshire, undrifted snow was 20 in. deep from the 25th to the 28th. Further details of the snowfall of January and February are given in an earlier article[1].

March 1955.—This was another cold month with mean temperature everywhere below the average. In Scotland, snow and sleet fell chiefly during the first week and from the 16th to the 24th though there were local snow showers until the 29th; at Reay Forest, Sutherland, snow lay 16 in. deep on the 20th and 21st. In England and Wales snow fell to a depth of 6 in. in parts of East Anglia and Kent on the 6th, and to a similar depth in places in northern England on the 20th; there were also scattered snow showers, particularly in eastern England, throughout the major part of the month.

April 1955 was dry, sunny and mild with very little snow. Snow fell locally in Scotland, however, on the 20th and 24th, and in parts of Bedfordshire and Buckinghamshire on the 17th–19th.

May 1955.—The mean temperature was again considerably below the normal. Snow and sleet fell almost daily for the first three weeks of the month in Scotland and on the 10th and 14th–21st in England and Wales. Snow fell on 8 days at Malham Tarn, West Riding of Yorkshire, where it lay to a depth of 4 in. on the 17th. On this day snow was fairly widespread; 3–4 in. lay extensively in the Merthyr, Brecon and Neath districts of south Wales; 3 in. were measured in parts of Wiltshire and Dorset after an unusually heavy snowstorm for mid May, and many parts of east Yorkshire and the east midlands had a cover of 1 in. Further details of snowfall in May are given in an earlier article[2].

Duration of snow-cover on British mountains.—The mean number of days of snow-cover at 2,500 ft. on four mountain groups used as indices was 93 compared with an average of 81 for the past eight seasons. The stations used were Glenbrittle (Cuillin Hills 3,300 ft.), Meggernie Castle (mountains round Glen Lyon 3,400 ft.), Capel Curig (Snowdonia 3,500 ft.), and Tairbull (Brecon Beacons 2,800 ft.). Diagrams showing the distribution of snow-cover relative to height for eleven stations are given in Fig. 1.

Harris, in the Outer Hebrides, reported snow-cover on 1 day in October and 8 days in November; in December it was covered from the 7th to the 13th and from the 22nd to the 24th. Snow-cover was also observed during January 9–23 and from February 4 to the end of the month, most of which time the snow-line was down to sea level. There was snow-cover for 3 days at the beginning of March and during the whole of the second half of the month, extending to April 1, and for 6 days during the middle of May.

The Cuillins of Skye were occasionally covered during the last week of October and the first 3 weeks of November. The summits were also covered during December 4–19, January 10–24 and during the whole of February and March, most of which time the snow extended down to 2,000 ft. The snow-line came down to sea level during the middle of January, the last half of February and for 3 days towards the end of March.

The peaks around Glen Lyon had snow-cover for a few days during October, most of November and December and continuously from January 1 to March 8, except for 5 days at the end of January. There was also snow-cover during mid May. Snow came down to station level (760 ft.) frequently from December to March, and on November 12 and May 14.

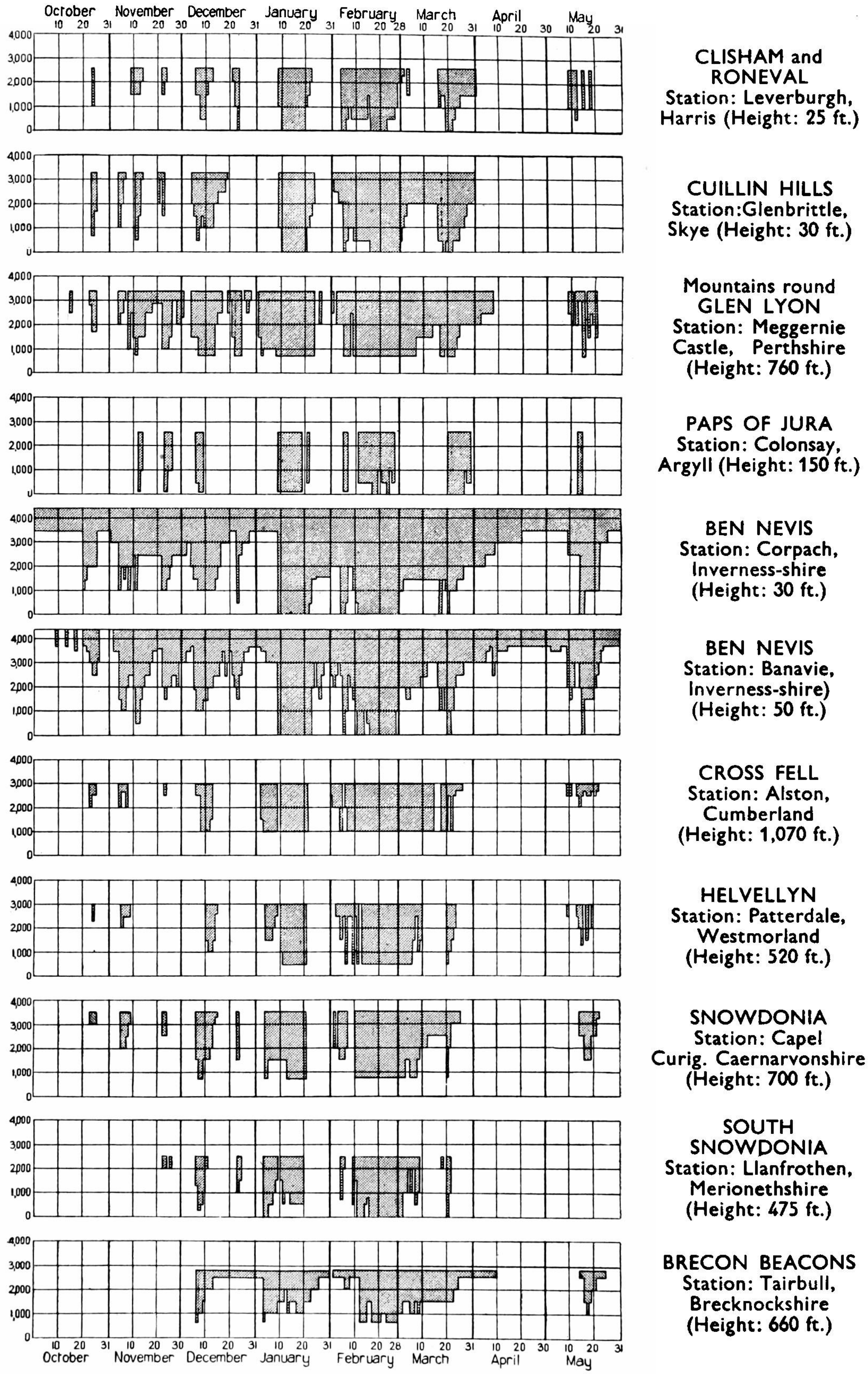

FIG. 1—DISTRIBUTION OF SNOW-COVER IN RELATION TO HEIGHT

The Paps of Jura were covered for 5 days in November, three days at the beginning of December, January 10–19, January 22, February 6–7, February 12–27, March 22–30 and May 17–18, most of which time the snow-line was down to station level (150 ft.) except for a week in mid February.

The summit of Ben Nevis was observed to be covered continuously from the beginning of September to the end of June and snow was seen in gullies down to 3,200 ft. even as late as August 8. Snow-cover came down to 1,000 ft. during each month from September to May, except April, and down to sea level January 10–22, most of February, 2 days in March and 2 days in April.

Cross Fell was snow-capped for 3 days in October, 5 days in November, and 7 consecutive days in December, during which time the snow-line came down to station level (1,070 ft.) on December 9, 10 and 12. The summit was covered on January 2–7 and 9–21, the whole of February, March 1–4, 6–14, and 18–26; during most of this period snow extended down to station level. Snow was also observed on 12 days during mid May.

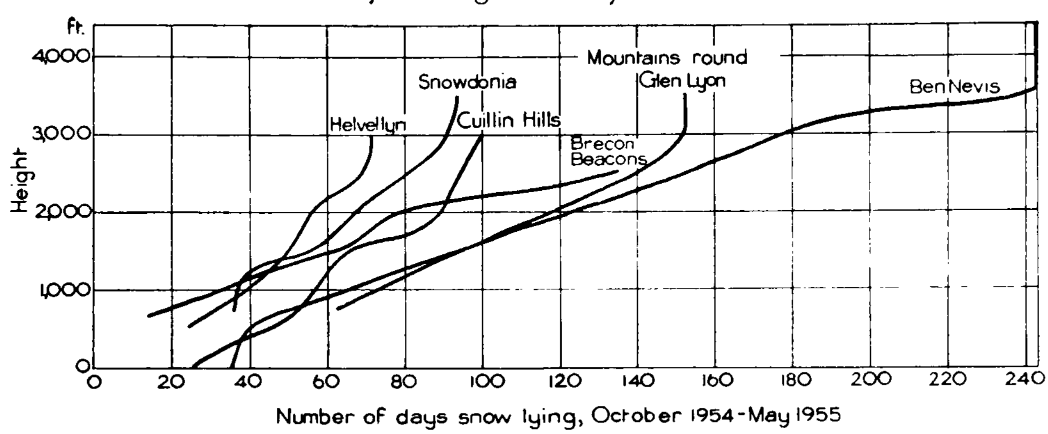

FIG. 2—SEASONAL DURATION OF SNOW-COVER

Helvellyn was snow-covered for 1 day in October, 4 days in November and 5 consecutive days in December when the snow came down to 1,000 ft. on December 11 and 12. Snow-cover was also observed on January 3–9, 11–21, February 3–12, February 14–March 10 and March 21–24; snow was down to station level (520 ft.) on January 12–21, February 7, 10, February 14–March 6 and March 21. Snow was also observed on 6 days during mid May.

The peaks near Capel Curig had snow-cover above 3,000 ft. on 3 days during the last week of October and were occasionally covered above 2,000 ft. in November. Snow-cover was observed on December 6–16, about half of January and from February 2 to March 26 except for February 3 and February 8–10, most of which time snow extended down to 2,000 ft. Snow was also observed on 8 consecutive days during mid May.

In south Snowdonia there was snow-cover at 2,500 ft. on November 23–25, December 6–11, 24 and 25, January 3–20 (except 10), February 5 and 6, from February 10 to March 9 and March 19, 21 and 22; most of this time snow was down to station level at 475 ft.

The Brecon Beacons were under continuous cover above 2,500 ft. from December 7 to April 10 except for one day, February 1, and during May 14–25. Snow came down to station level (660 ft.) on December 7, January 4 and February 13–15, 18–21, and 24–28.

Curves showing total seasonal duration for six stations are drawn in Fig. 2; 200 days' snow-cover was exceeded on Ben Nevis above 3,500 ft., and 100 days' cover was exceeded on the mountains about Glen Lyon above 1,600 ft., on the Brecon Beacons above 2,500 ft. and at the summit of the Cuillin Hills.

REFERENCES

1. BOOTH, R. E.; The snow of January and February 1955. *Met. Mag., London*, **84**, 1955, p. 129.
2. BOOTH, R. E.; An exceptionally cold day in May. *Met. Mag., London*, **84**, 1955, p. 293.

THE OCCURRENCE OF SPELLS IN LONDON RAINFALL AND TEMPERATURE

By D. H. McINTOSH, M.A., B.Sc.

Introduction.—In a spell of disappointing weather, such as that experienced in the British Isles in the summer of 1954, there is a tendency for the expression of the lay opinion—or perhaps it is merely the hope—that the future weather is likely to atone to some extent for the past by being better than average for the period in question, the "law of averages" usually being invoked in vague support of this belief. The corresponding belief, that the chance that the future weather will be as good as average is somewhat decreased if the weather in the immediate past has been exceptionally favourable, is also fairly generally held though less widely expressed. Professional meteorological opinion does not appear to be unanimous on these points which have apparently lacked systematic investigation in the past; no doubt the view most widely held is that, following a rather indefinite period of persistence of the existing tendency, the most probable course of events, in any particular case, is a return to average without any "compensating" period. This is the conclusion that would reasonably be drawn from what various investigations have shown concerning the general character of the meteorological elements. But such a conclusion can hardly be reached with certainty without a special investigation, which appears the more necessary because Glasspoole[1] has recently reported a type of result which accords with the more popular belief; namely that if in a run of four very dry months there has been only about a third of the average rainfall, then the next four months are likely to redress the deficit to some extent.

Attention is confined in this investigation to the monthly values of rainfall and temperature published[2] for Greenwich for the period 1841–70, and for Kew from 1871 to 1949; to these were added the Kew observations for 1950 to 1953. The data thus covered a period of 113 yr. The two elements were considered separately.

Rainfall.—The rainfall of each of the 12 × 113 months was expressed as a departure from the appropriate monthly mean for the whole period; the annual variation of rainfall amount was thus eliminated. The data were then examined for evidence of secular change or changes during the period. This was done by averaging the monthly departures in successive groups of 10 yr. (13 yr. in the last group), and then examining the progression of these averages and also their magnitude, in terms of the standard deviation. As a result it was concluded that there was no clear evidence of any secular change in rainfall over the period, and that the data could safely be regarded as comprising a homogeneous set.

Wet and dry spells were then defined as follows:

Wet spell.—Any three successive months, each with a positive rainfall departure and having an aggregate rainfall more than 150 per cent. of the average taken over the whole period for the corresponding three months.

Dry spell.—Any three successive months each with a negative rainfall departure and having an aggregate rainfall less than 50 per cent. of the average taken over the whole period for the corresponding three months.

With these definitions it was found that there were 53 wet and 61 dry spells. The rainfall departure was noted for each month from 6 months before to 12 months after the middle month of each selected wet or dry spell and the average departures were calculated for the months: $-6, -5 \ldots . +12$ (month "0" being the middle month of the spell) for the two contrasting groups separately. Since it was considered possible that there might be a seasonal variation in the effect found, such that the effect might diminish or cancel out over the year as a whole, the results were first subdivided according to the middle one of each three months comprising a spell. The number of cases for each month was however too small for adequate discussion, and the results were therefore paired successively—middle month January or February, March or April, etc.—and are shown graphically in Fig. 1. Finally, the figures were combined for the six summer months April to September, the six winter months October to March, and for the year as a whole; these results are also shown in Fig. 1.

Standard errors of various plotted means are shown in each graph. These were calculated from the close approximation to the "population" standard deviation of monthly rainfall amount obtained from the whole series. There is in London monthly rainfall an annual variation of the variability of amount, which runs approximately parallel to the annual variation of rainfall amount itself. This results in small differences in the standard errors of the various plotted means; maximum and minimum values are shown for each curve where this is warranted by the scale of the plotted differences between these values. In each graph the number of cases comprising the mean is shown.

In the absence of the association of any effect, in subsequent or preceding months, with the occurrence of the selected spell, the departures at months other than 0, $+1$, $+2$ will be merely random fluctuations about the zero line. The method of analysis therefore consists simply in examining whether any of these plotted means differ from zero by an amount which is significant in relation to the general variability, as defined by the standard error of the mean values. For months $+11$, $+12$ (also $+13$ as used later with the temperature data), the mean value appropriate to "no effect" differs slightly from zero, which is the appropriate value for all the other months considered. This arises because, with months $+11$, $+12$, $+13$ the same months of the previous year were specially selected for their large departures ($+D$ say) from the whole period means, but are naturally excluded from making a contribution to the means found for months $+11$ and $+12$. Where the long period mean is M, and the number of cases comprising it N, the appropriate mean for "no effect" at months $+11$ and $+12$ is $(NM-D)/(N-1)$ which is approximately $M-D/N$ for large N, i.e. the mean is moved by an amount D/N in the sense opposite to that of the selected feature. In the present case $D=50$ mm. and $N=113$; the

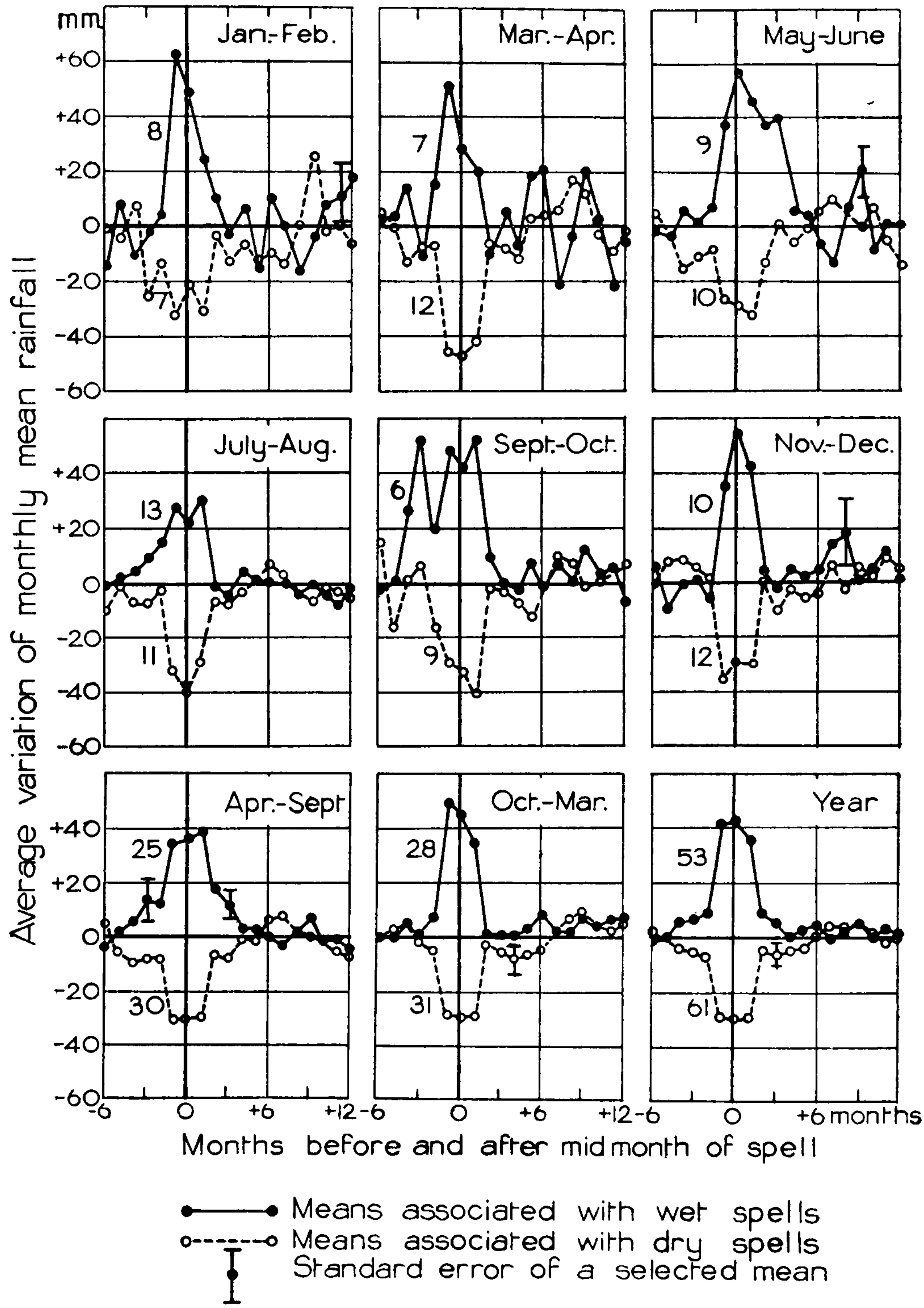

FIG. 1—AVERAGE VARIATION OF MONTHLY MEAN RAINFALL IN LONDON ASSOCIATED WITH WET AND DRY SPELLS LASTING 3 MONTHS

Month "0" is the middle month of spell and the number of spells in each average is given against each curve.

[To face p. 368

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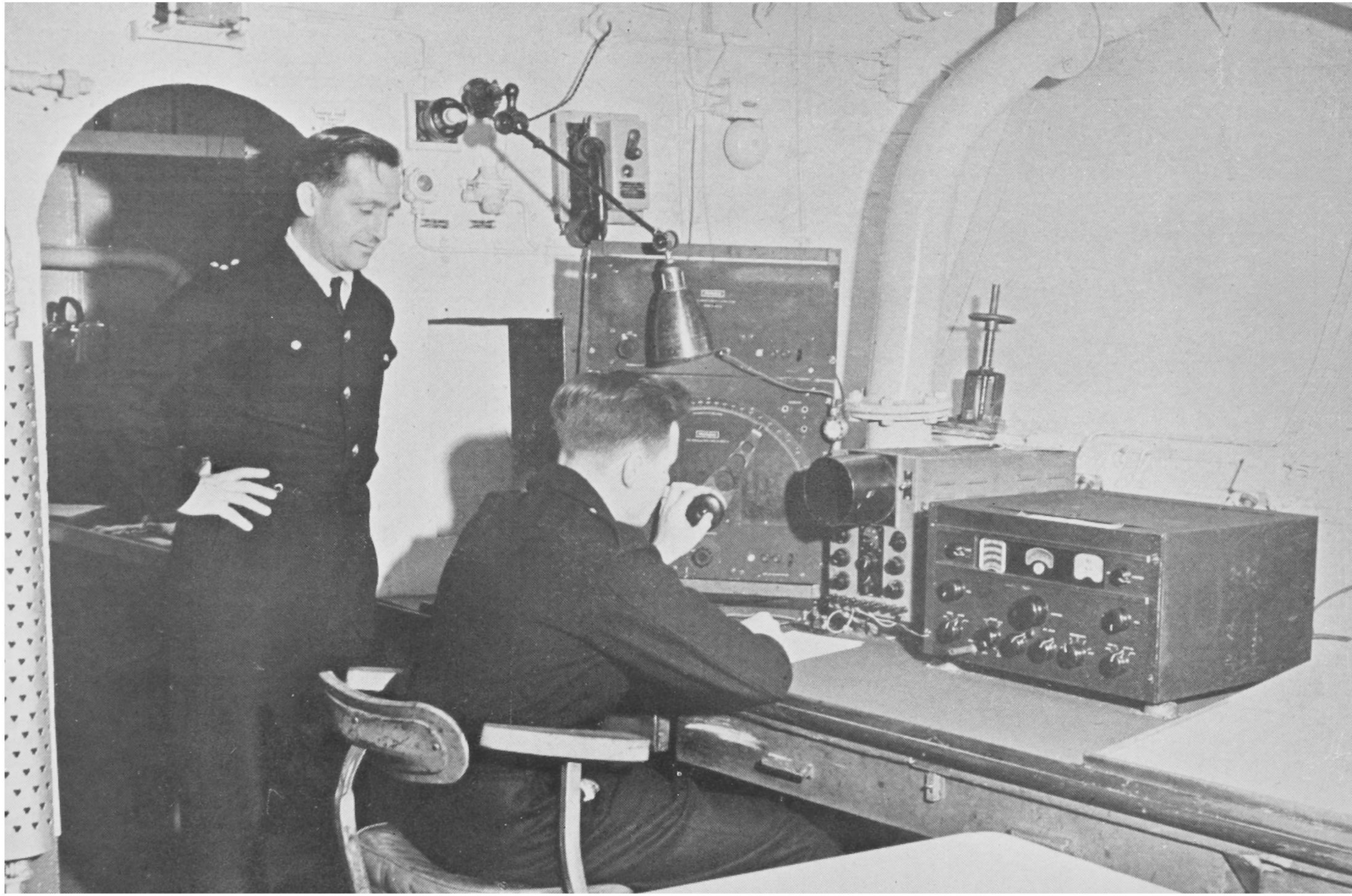
THE METEOROLOGICAL OFFICE ABOARD O.W.S. *Weather Explorer*

The instruments along the far wall are, from left to right, three marine barometers, each with a Gold slide (two are check barometers), indicating dials for the relative wind speed and direction, sea-temperature recorder (from the engine-room intake), wet-bulb and dry-bulb distant-reading thermograph, and an oil-damped barograph on an anti-vibration mounting. The dial almost directly above the wind-direction indicator gives the ship's speed. The meteorologist is working out an ascent using a pilot-balloon slide-rule; above him, on a folding arm is the microphone for communication with the ship's radar room.



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FOLLOWING A RADIO-SONDE ABOARD O.W.S. *Weather Explorer*

In this corner of the meteorological office are the standard surface instruments for a Meteorological Office radio-sonde, consisting of oscillator, cathode-ray oscillograph and radio receiver.

appropriate mean is thus changed by about 0·5 mm. which may be seen to be quite negligible. The effect is also negligible in the temperature data considered later.

The following interpretation is made of the results shown in Fig. 1; some weight is given in this interpretation to the general progression of the mean departures and to the results obtained with the two contrasting groups as well as to the absolute size of the departures.

(*a*) In the average of the six "summer" months wet and dry spells, as defined above, follow, and are followed by, months of the same average rainfall characteristic as the type of spell concerned. The effect lasts for two to four months on either side of the spell. The data are insufficient for determining the precise months during which the persistence tendency is at a maximum.

(*b*) In the six "winter" months there is no significant persistence tendency associated with wet spells; the long-period average becomes at once the most probable value. Following a dry spell in these months, the rainfall probably tends to remain below average for some four months.

(*c*) There is no evidence of any compensation effect, either immediately following a wet or dry spell or after a time lag. In particular the effect reported by Glasspoole is absent from these London data. In the 61 dry spells distributed throughout the year the succession of three dry months had an aggregate rainfall about 40 per cent. of normal; the four following months were all dry on the average, and aggregated 90 per cent. of normal. The calculated probability that this persistence of a dry tendency is other than a real feature is only 0·007.

Temperature.—As with the rainfall data, the effect of the annual variation of temperature was eliminated by expressing the temperature of each month as a departure from the whole-period average for the corresponding month. When this was done it was very soon apparent that there was a secular change or changes in the data. Thus it was found that in the first thirty years (1841–70) the "summer" months April to September comprised 65 positive and 115 negative departures; while in the last 23 years (1931–53) they comprised 96 positive and 42 negative departures. These particular periods were not specially selected, the data being worked in three batches each of 30 yr. and a final one of 23 yr. The over-all value of the autocorrelation coefficient r_1 was found to be $+0{\cdot}24$; 6 consecutive terms (April to September) were thus calculated as being equivalent to 4·1 random terms so that the early period comprised $30\times4{\cdot}1$ or 123 independent months, divided between 44 positive and 79 negative (retaining the percentage frequency of positive and negative actually found); and the later period comprised 94 independent months, divided between 66 positive and 28 negative. Application of the χ^2 test to these figures left no doubt that from April to September the temperatures in the later period were significantly higher than in the earlier period. In connexion with this secular change it may be noted that the data for the early years were for Greenwich and those for the later years were for Kew. Comparison over a common period gives the result for April to September, Greenwich minus Kew = $+0{\cdot}4$°F. Elimination of the site difference would therefore magnify still further the summer warming of more recent years.

In this particular investigation it was necessary to eliminate or minimize the effect of secular changes in the data. Thus, for instance, in a selection of

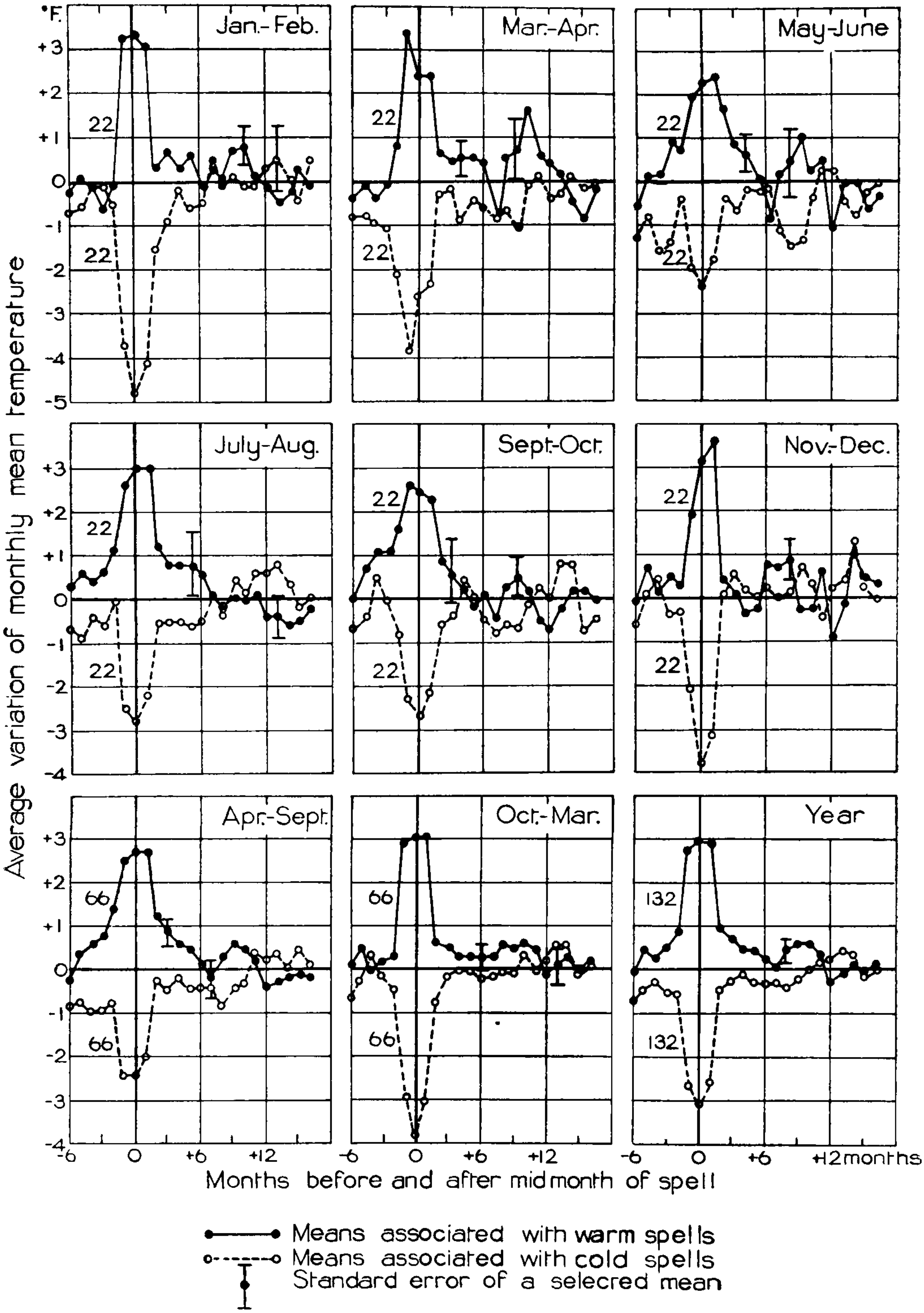


FIG. 2—AVERAGE VARIATION OF MONTHLY MEAN TEMPERATURE IN LONDON ASSOCIATED WITH WARM AND COLD SPELLS LASTING 3 MONTHS

Month "0" is the middle month of spell and the number of spells in each average is given against each curve.

warm summer months made from the data considered as a whole, the later years would be over represented as compared with the earlier years and the average progression of temperatures round the selected months would be biased in a certain way. Elimination of this effect could be achieved by using departures from some form of running means. This method was rejected as too laborious and approximate elimination of the effect of secular changes was achieved as follows. For the purpose of selection the temperature data were divided into three consecutive groups of 30 years and a final one of 23 years. For each group of consecutive three months, January–February–March, February–March–April, etc., the three highest and three lowest temperature aggregate months in each 30-yr. period (two highest and lowest in the final shorter period) were selected. The work thereafter progressed as already described for the rainfall data, except that it was subsequently considered advisable to extend the investigation beyond month +12 to month +16; subdivision into the four periods was not maintained beyond the initial selection. The plotted results are shown in Fig. 2 for the same groupings of months as before. The application of criteria of "suitable" stringency yielded more temperature than rainfall cases, mainly because, as may be seen from the plotted results, monthly temperature characteristics are rather more persistent than those of rainfall.

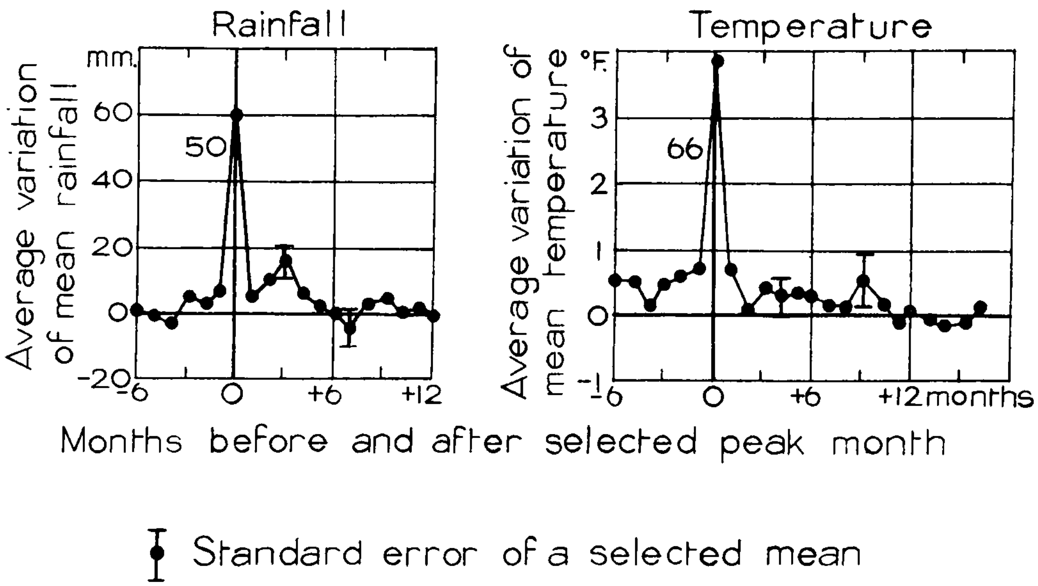


FIG. 3—AVERAGE VARIATION OF MONTHLY MEAN RAINFALL AND TEMPERATURE IN LONDON ASSOCIATED WITH WET MONTHS AND WARM MONTHS, APRIL–SEPTEMBER

Month "0" is the wet or warm month, and the number of wet or warm months in each average is given against each curve.

The conclusions drawn from Fig. 2 are as follows:

(*a*) Warm and cold spells, as here defined, have a definite tendency to follow months of the same temperature characteristic as the type of spell concerned, and the occurrence of such spells has a systematic average effect of the same sense in subsequent months. The magnitude of the effect is larger with "summer" than with "winter" spells. The indications—hardly amounting to proof—are that the after-effect lasts as long as 8 or 9 months. This period is so surprisingly long, and the apparent rate of decrease of the effect so slow, that it can hardly be accepted without clearer proof than available data are yet able to provide.

(*b*) Following the after-effect mentioned above, the long-period average remains in all months the most probable value; the data were extended to month +16 to confirm this.

General.—Attention has so far been confined to the effects associated with spells lasting at least three months, mainly because it is the longer-lived spells that give rise to the type of general comment referred to earlier. There is, however, no reason to doubt that the types of effect found have a more general application. This is confirmed by the results shown in Fig. 3 which refer to one-month spells of warmth and of wetness, obtained from a selection of the most conspicuous cases evenly distributed over the six months April to September; it is clear that the types of effect found with these one-month spells are similar to the corresponding effects found with the three-month spells.

REFERENCES

1. MILES, M. K.; Report of meeting, November 17, 1954. *Weather, London*, **9**, 1954, p. 383.
2. MARSHALL, W. A. L.; A century of London weather. London, 1952.

UPPER WINDS IN THE SOUTH-EAST ASIA–WEST AUSTRALIA REGION

By B. RAMSEY

Summary.—A survey of upper winds centred along the meridian of 110°E. was carried out for the months of April, July and October 1953 and January 1954. This shows a well defined seasonal movement and change in the broad west and east flowing air streams in the area in the height range from 10,000 to 50,000 ft.

The strongest easterly flow was in summer, but, although winter westerlies were strong, the strongest westerlies coincided with the spring in each hemisphere. During the summer of each hemisphere the broad belt of easterlies was interrupted by a deep monsoon flow the SW. monsoon of India which extends over the South China Sea and occasionally the Philippines, and the westerly monsoon of Java and other Indonesian islands.

It is emphasized that this summary was derived from the single months only and was not averaged over a period of years.

Period of investigation and data used.—Upper winds were plotted as routine at the meteorological office, R.A.F. station, Changi, Singapore, twice daily up to 50,000 ft. During 1952–53 increased upper wind data became available from south-east Asian territories, and vertical cross-sections could be constructed showing zonal flow over the area from China to south-west Australia. On general grounds it was considered January and July could be regarded as typical monsoon months, and April and October as transitional months. Cross-sections of interzonal flow were therefore prepared for April, July and October 1953 and January 1954.

Radar winds were available during that period from Hong Kong, Hanoï, Saigon, Chiengmai (Thailand), Bangkok, Songkla (Malay–Thai border) and Singapore on most days. Winds were available up to 80,000 ft. at times, but the frequency was rather low above 50,000 ft. However, in extracting the data, days with poor representation at high levels were ignored, and although figures of the number of occasions per month are not available, there were about 20 days per month when there was good coverage to 50,000 ft.

Pilot-balloon reports were frequent from Western Australia and in good weather heights up to 60,000 ft. were attained. Ascents from Kuching (Sarawak), Christmas Island and Indonesia unfortunately rarely exceeded 20,000 ft. and, being pilot-balloon ascents, they tended to give a bias toward

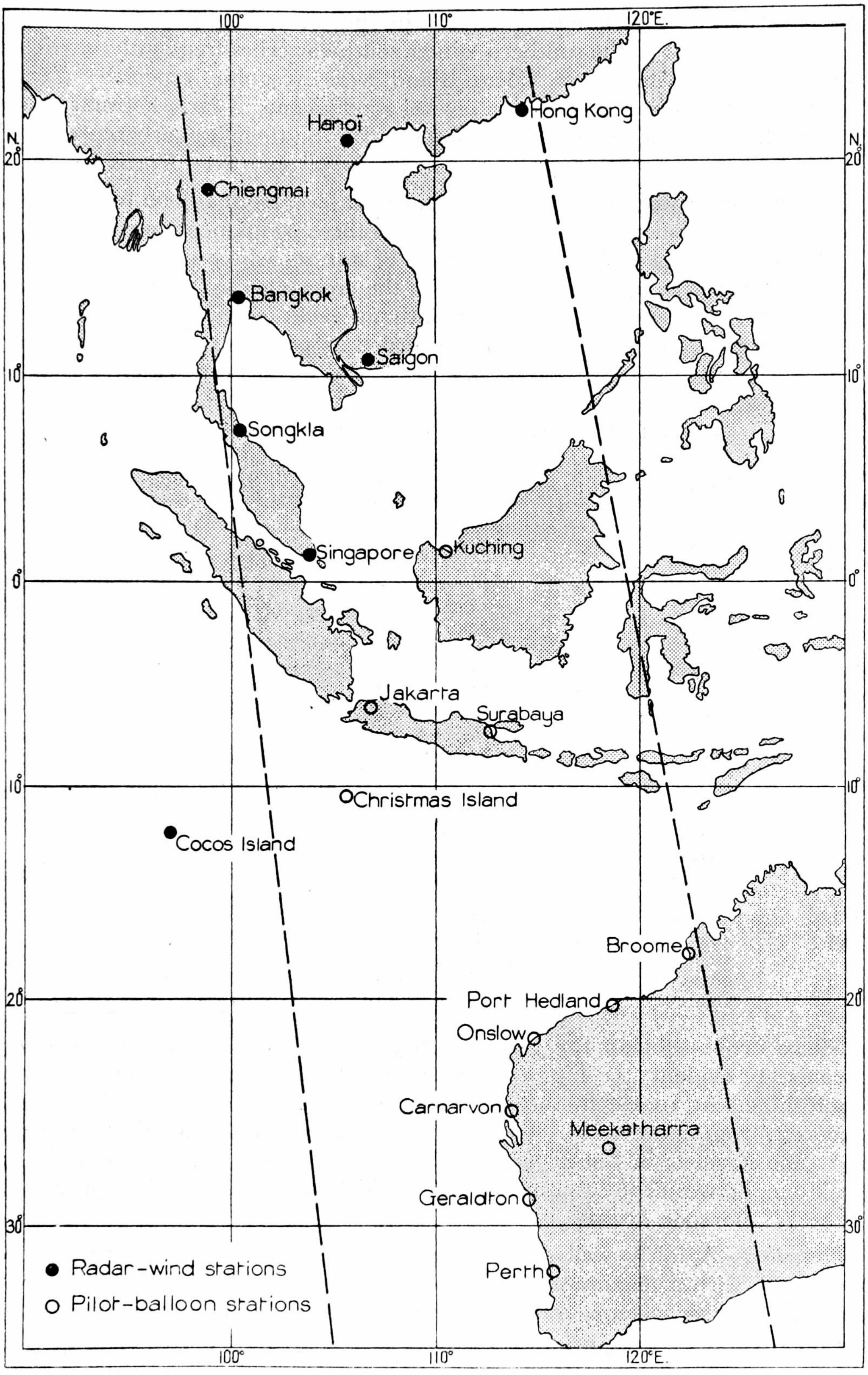


FIG. 1—SOUTH-EAST ASIA AND WEST AUSTRALIA

The approximate limits of the cross-sections are given by broken lines good weather. This was especially true in Indonesia where cloud in the W. monsoon and haze in the southern winter south-easterlies frequently restricted ascents. Radar winds from Cocos Island were irregular, especially during January 1954, but in compensation several good ascents in early February 1954 were used. The area between the equator and 15°S., then, is poorly represented throughout, with winds above 20,000 ft. available only from Cocos Island.

For each observation, and at each 10,000-ft. level from 10,000 to 50,000 ft. the east–west component was computed and these components were averaged for the month. Fig. 1 shows the positions of stations whose data were used in the survey with the approximate limits of the cross-sections. Table I gives the average W. components for each month at each height and at each 10° latitude, westerly components being regarded as positive, in conformity with other investigations[1,2]. The table was derived directly from the cross-sections of Figs. 2–5.

TABLE I—MEAN WESTERLY COMPONENT ALONG 110°E.

	Height	Latitude 20°N.	10°N.	0°	10°S.	20°S.	30°S.
	ft.	knots					
January 1954	50,000	40	−8	−42	−30	8	25
	40,000	55	−10	−20	−20	12	34
	30,000	55	−10	−15	−5	12	30
	20,000	40	−12	−9	0	0	20
	10,000	20	−12	0	8	−3	5
April 1953	50,000	55	−5	−10	12	33	35
	40,000	60	−11	−18	6	33	40
	30,000	52	−9	−12	−1	22	35
	20,000	35	−8	−9	0	11	28
	10,000	20	−12	−3	6	−3	12
July 1953	50,000	−50	−55	−38	−10	35	55
	40,000	−35	−30	−38	−10	40	82
	30,000	−20	−15	−25	−2	40	56
	20,000	−5	−5	−15	0	28	44
	10,000	6	10	−2	−12	9	25
October 1953	50,000	0	−35	−30	10	50	75
	40,000	6	−18	−25	10	55	88
	30,000	10	−10	−18	5	50	56
	20,000	5	−8	−12	−5	25	34
	10,000	5	−8	−3	−12	15	18

Mean cross-section for January 1954.—*Westerlies.*—Two main westerly streams are evident (see Fig. 2), the stronger being in the northern (winter) hemisphere. At 10,000 ft. the latter is continuous from about 17°N. and at 50,000 ft. from about 12°N. The westerlies in the southern hemisphere begin at 10,000 ft. at 24°S. but at 30,000 ft. at 12°S. There is another westerly, a weak one, between the equator and 14°S. which appears to be the upper limit of the W. monsoon of Java.

Easterlies.—A fairly well defined equatorial easterly stream is centred at about 2°S. with a maximum about 50,000 ft. At this time of year the inter-tropical convergence zone varies between 6° and 12°S. at this meridian.

Mean cross-section for April 1953.—*Westerlies.*—Again two main streams are evident (see Fig. 3). That of the northern hemisphere is a little stronger than in January with about the same geographical limits. The southern westerlies have increased as autumn advances, and although at 10,000 ft. they

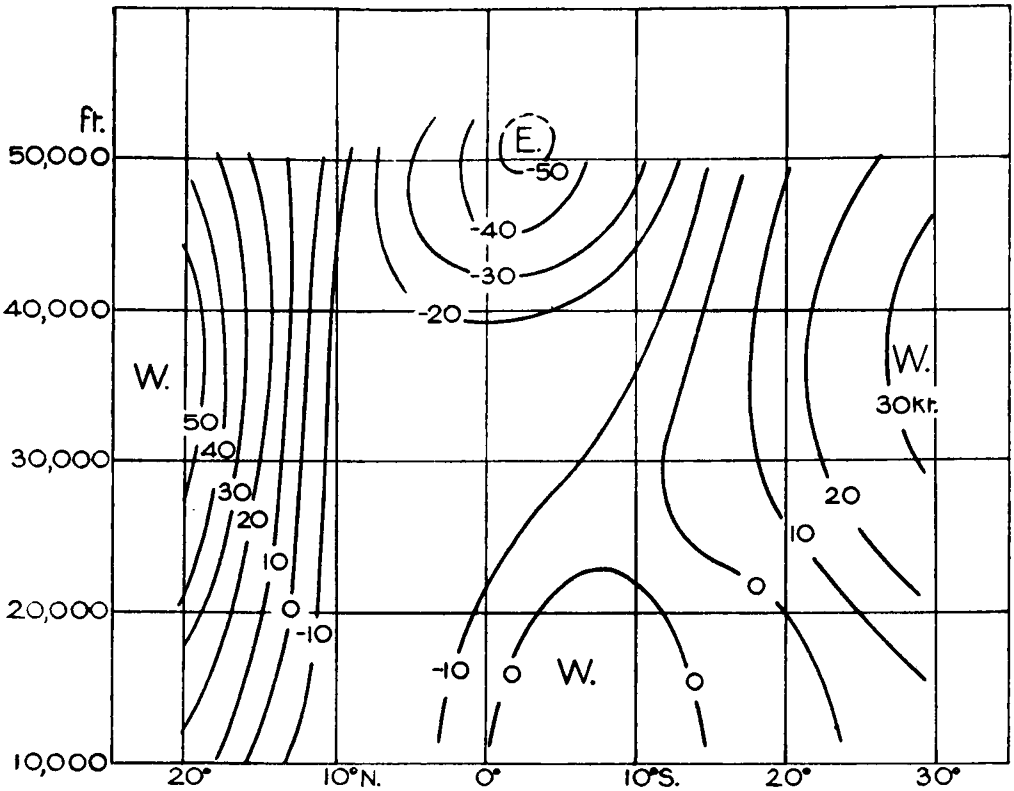


FIG. 2—MEAN CROSS-SECTION AT 110°E. FOR JANUARY 1954

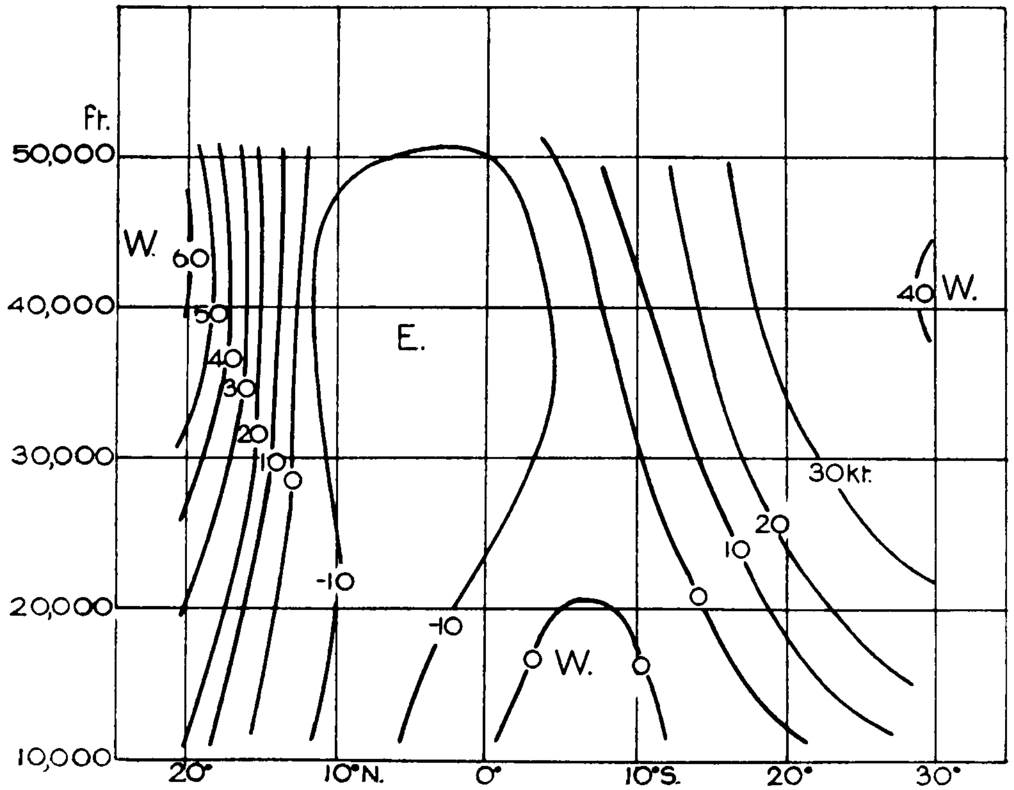


FIG. 3—MEAN CROSS-SECTION AT 110°E. FOR APRIL 1953

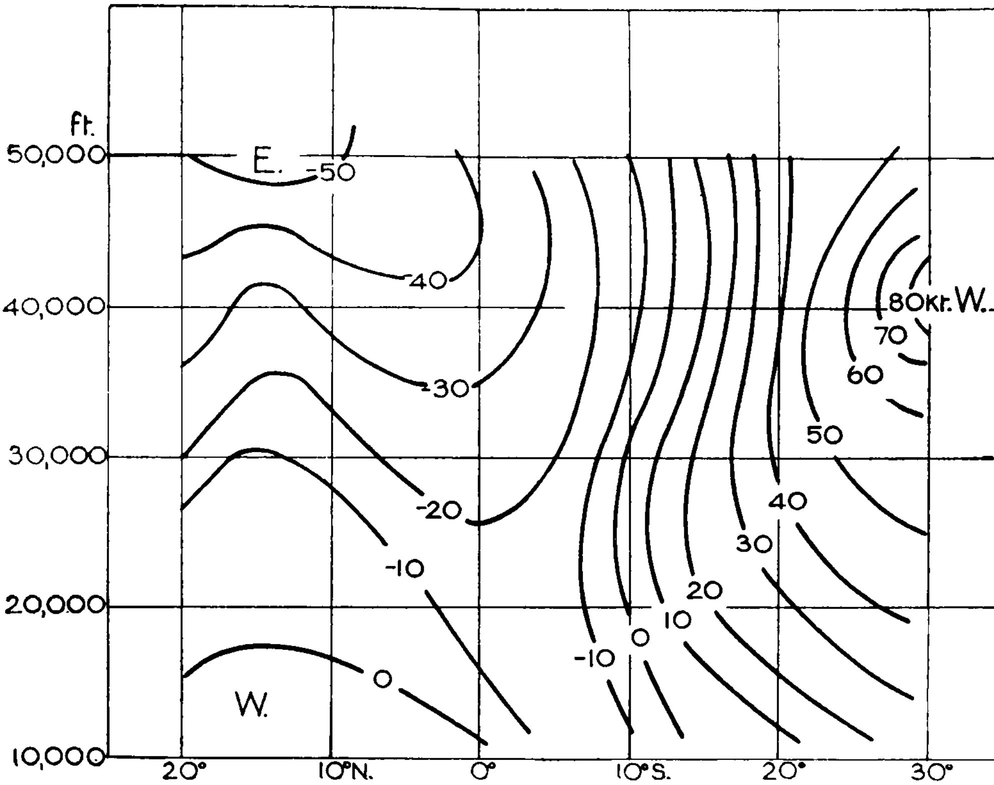


FIG. 4—MEAN CROSS-SECTION AT 110°E. FOR JULY 1953

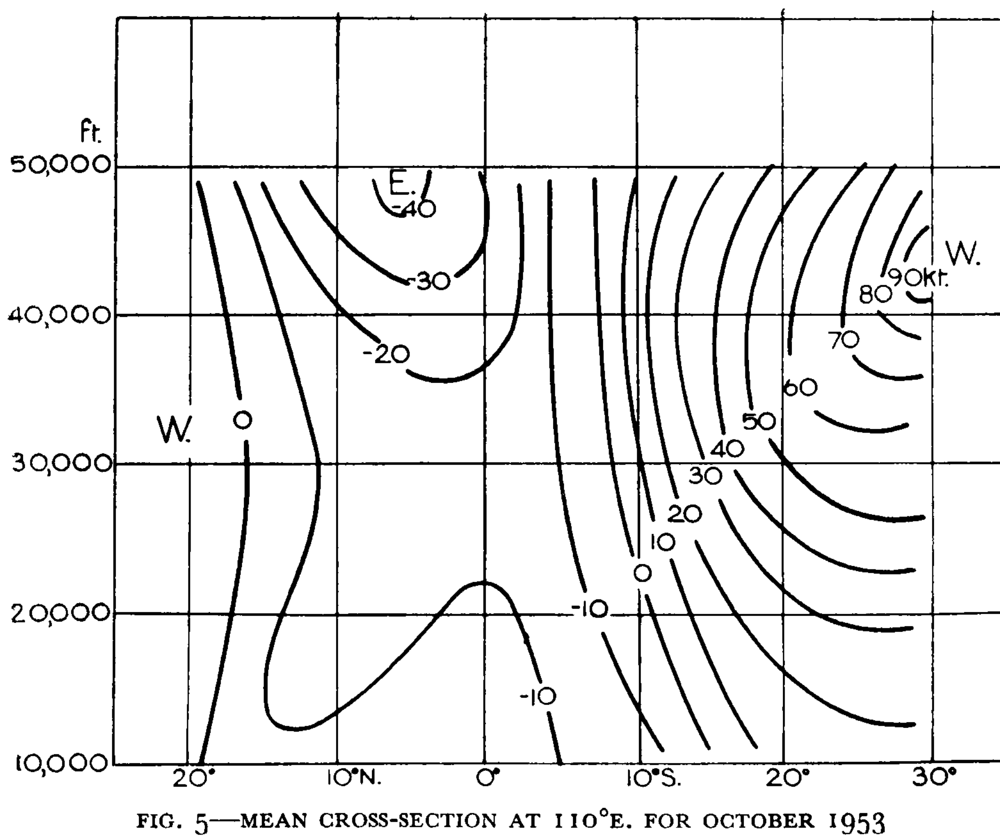


FIG. 5—MEAN CROSS-SECTION AT 110°E. FOR OCTOBER 1953

still appear at 22°S., their northward limit at 50,000 ft. appears to be in the region of 5°S. However, this is in the area of scarcity of data. The weak remnant of the W. monsoon still occupies the area from 1°S. to 12°S. at 10,000 ft.

Easterlies.—The strong easterly flow of January has faded into a broad weak flow between the great westerlies of either hemisphere. The intertropical convergence zone still south of the equator at the beginning of April, begins to penetrate into Malaya from about the middle of the month.

Mean cross-section for July 1953.—*Westerlies.*—A great change has taken place since April. The only westerlies now in the northern hemisphere are below 17,000 ft. (see Fig. 4). These are the upper limit of the SW. monsoon which now occupies the whole northern hemisphere from the equator to 20°N. at the surface. The winter westerlies of the southern hemisphere have strengthened considerably. Their northern limit has retreated a little southward to 12°S. at 50,000 ft., but at 10,000 ft. they extend to 15°S.

Easterlies.—There is now a very broad deep easterly flow from about 10°S. to beyond 20°N. above the monsoon, and the maximum is in the region of 15°N. The intertropical convergence zone at this season has moved north into China.

Mean cross-section for October 1953.—*Westerlies.*—During the month the northern-hemisphere westerlies re-appear south of 20°N. and the upper limit of the SW. monsoon is no longer evident (see Fig. 5). The southern hemisphere "jet stream" shows a slight increase, with the advance of spring, as happened in the north in April. Again, as the cross-section applies to a single month only, no conclusions as to the significance of this increase can be drawn.

Easterlies.—A more restricted but still fairly strong flow, especially at high levels, has moved south from the July position to about 5°N. The intertropical convergence zone is now at about 5°N. at this time of year.

Comparison with other meridional cross-sections.—Gilchrist[1] and Gibbs[2] have produced similar cross-sections for other meridians, two of them being 45°E. and 150°E.

Comparing the above cross-sections with those of Gibbs for 150°E., there is good general agreement. However, there is at 150°E. no parallel to the monsoon flow above 10,000 ft., and no well marked broad easterly flow in July. No increase in the southern westerlies is apparent in the spring, nor in April in the north. However, this apparent discrepancy may be removed with investigation into other years.

Gilchrist's cross-sections for 45°E., which unfortunately extend to 2°S. (Nairobi) only, show similar trends, and they, too, are for single months only. In January 1954 at 110°E. westerlies and easterlies are both stronger than in 1951 at 45°E. In April the westerlies at 110°E. are much stronger, and there is little or no component from the east at 45°E. In July there is great similarity, with an even stronger easterly at 45°E. The westerly monsoon flow is evident at both meridians, but it is deeper at 110°E. Similar agreement is shown in October with ligher easterlies at 45°E. and westerlies re-appearing down to 15°N.

REFERENCES

1. GILCHRIST, A.; Winds between 300 and 100 mb. in the tropics and subtropics. *Met. Rep., London*, **2**, No. 16 (in the press).

2. GIBBS, W. J.; A comparison of hemispheric circulations with particular reference to the western Pacific. *Quart. J. R. met. Soc., London*, **79**, 1953, p. 121.

OFFICIAL PUBLICATIONS

The following publications have recently been issued:—

The Annual Report of the Director of the Meteorological Office, presented by the Meteorological Committee to the Secretary of State for Air, for the year April 1, 1954, to March 31, 1955.

The Report describes the activities of the Meteorological Office as the State Meteorological Service and includes a full account of the vigorous research programme which has been maintained.

Meteorological services have been provided for civil and military aviation, for shipping and directly for the general public by telephone, television, radio, and through the Press, and indirectly by special forecasts for electricity and gas undertakings, farmers, and River Board and road engineers.

Considerable progress in the study of numerical forecasting—the process whereby forecast pressure maps are produced by the use of an electronic computer—has been achieved, and a long series of carefully controlled trials of the possibility of increasing rainfall by cloud seeding has been undertaken. The Meteorological Research Flight has continued its high-altitude research and much effort has been directed at the problems which result from the increasing heights at which aircraft now operate.

The Report includes financial and staff details, and indicates the continued shortage of scientific staff and difficulties produced by the continuing high rate of turnover of assistants.

GEOPHYSICAL MEMOIRS

No. 96—The free atmosphere in the vicinity of fronts. By J. S. Sawyer, M.A.

During the period 1950 to 1952 some 20 flights were made by aircraft of the Meteorological Research Flight from Farnborough in order to explore the structure of fronts. The results indicate the great complexity of the atmosphere in frontal regions. Although the observations confirm that a sloping baroclinic zone exists it is clear that no idealized frontal model can adequately represent an individual front. Small-scale irregularities of temperature are sufficient to prevent any clear delimitation of the frontal zone.

Some very dry air was often found in frontal regions in close juxtaposition to cloud and rain. Its presence can be adequately explained by large-scale air movements which are primarily horizontal. Cloud structure and turbulence in frontal regions were also observed.

ROYAL METEOROLOGICAL SOCIETY

At the meeting of the Society held on October 19, 1955, the President, Dr. R. C. Sutcliffe, in the Chair, the papers read were all on the subject of rainfall.

*Lewis, W. A. and Watkins, L. H.—Investigation into the accuracy of four types of rainfall recorder**

Messrs. W. A. Lewis and L. H. Watkins (Road Research Laboratory) described an investigation into the accuracy of four types of rainfall recorder. They required a rate-of-rainfall recorder for measuring high rates of rainfall in connexion with drainage design. The Meteorological Office standard total rainfall recorder was found unsuitable because the variations in rate did not stand out sufficiently clearly on the curve of total fall, and the periods, 1 min. or more, over which the Meteorological Office standard rate-of-rainfall recorder averaged its records were too long for their purposes. Two new recorders were designed by the

* *Quart. J. R. met. Soc., London*, **81**, 1955, p. 449.

speakers. One, the channel-flow recorder, was not successful. The other, now in use, records both total fall and rate of rainfall. The principle of the rate-of-rainfall part is the weighing of a cylinder through which the rain passes. A variable orifice at the foot opposes the flow so that a column of water builds up in the cylinder. The length of this column is steady so long as the rate of fall is steady, but if the rate changes the length of water column changes and the weighing mechanism moves to operate a pen in the usual way. Variations in rate lasting for only a few seconds can be measured. A number of records obtained from the instrument were shown. Queries raised in the discussion related to the difficulties of filtering solid matter without interfering with the flow of rain and the accuracy in very light rain. The authors described the filtering mechanism and said they were interested in the heavier rates of rainfall; small rates could be read from the gradient of the total-fall curve.

*Turner, J. S.—The salinity of rainfall as a function of drop size**

The next paper was read by J. S. Turner of Sydney, Australia. He found that raindrops falling at Sydney and at a station 45 miles inland 2,880 ft. above M.S.L. from clouds extending above the freezing level and so presumably from the melting of ice crystals formed by the Bergeron process had a salinity in drops in any one fall of rain independent of the radius when the cloud base was low but proportional to $(\text{radius})^{-n}$, where n might be as high as 2·6, when the cloud base was high. He showed that this distribution could be quantitively explained on the supposition that the salt content was collected below the cloud, collection of salt particles and evaporation of the drop both increasing the salinity, and inferred that the salt content played no essential part in the formation of the rain. On the other hand the salt content in raindrops falling at Hawaii from clouds with tops well below freezing level in which the primary condensation is believed to occur on salt nuclei had a minimum salinity in drops in the middle of the size range with appreciable increases in smaller and larger drops. The large drops were the first to fall, and he believed the large salinity was due to them having been formed on giant salt nuclei. The salinity of the small drops had values intermediate between those which would be obtained by supposing the raindrops were formed by coalescence of equally saline cloud particles and by supposing them formed on salt particles falling through a mass of pure water droplets or droplets formed on nuclei other than sea salt. The results suggest that if the primary process is condensation on salt nuclei the later growth of the drop takes place by collection of smaller droplets which are not pure water but have a mean salinity about equal to that in the final rain. The general result suggests that salt nuclei play an essential part in the formation of rain in "warm" clouds, but are not essential in the formation of rain from clouds extending above the freezing level. Observations of the salt content of cloud particles are needed for further progress.

Questions raised in the discussion related to whether the distribution in "warm" rain could be due to differential sweeping up of the drops, doubt whether measurement of sodium content alone, as was done in this work, to measure salt content was satisfactory in view of the known variations in the sodium: chlorine ratio in raindrops, and whether the method gave any indication of the mass of the nucleus.

D'Albe, E. M. Fournier, Lateef, A. M. A., Rasool, S. I. and Zaidi, I. H.—The cloud-seeding trials in the central Punjab, July–September 1954†.

Finally Mr. Ludlam read a paper on the cloud-seeding trials in the central Punjab in July–September 1954. These trials were made by spraying fine salt particles into the air from two places, it being believed that showers in the monsoon period in this area fell mainly from clouds whose tops did not reach freezing level and so were entirely produced by condensation on hygroscopic particles. Samples showed the surface air in the Punjab contained 5–10 hygroscopic particles per cubic metre of a mass exceeding the critical one of 10^{-9} gm., and it was hoped by dispersal of salt particles to at least double this; 5×10^9 particles ground to the right size were dispersed per second. It was found that the rainfall in a down-wind sector of 100 Km. radius comprising 72 per cent. of the wind directions was significantly higher than in other areas round the seeding points, various combinations of the logarithms of the ratios of area rainfalls being used to establish this. Rainfall in the sector mentioned was about normal for the season and in the others below normal. In the course of the discussion it was asked if the clouds were deep enough for a chain reaction to be set in motion to which the reply was "no"; it was stated there were no orographic effects. It was pointed out that it would have been advisable to deal separately with each day, and state rainfalls along the trajectory from the point of seeding in relation to other areas to eliminate possible natural fluctuation in rainfall over the sector believed to have been seeded; and that it would be desirable to measure the nucleus content of the air in the cloud.

ERRATA

October 1955, PAGE 300, line 34; *after* "h the height" *insert* "and d the diameter".
November 1955, PAGE 345; *interchange* the diagrams without altering the captions or figure numbers

* *Quart. J. R. met. Soc., London,* **81**, 1955, p. 418.
† *Quart. J. R. met. Soc., London,* **81**, 1955, p. 574.

LETTERS TO THE EDITOR

Effect of a wind-break on the speed and direction of wind

One or two statements in Mr. Lawrence's interesting re-analysis of the Manby wind-screen data in the August *Meteorological Magazine* invite further comment.

In the first place, his consideration of the effects of thermal stability on the efficiency of protection involves a procedure which is surely unsound. The velocity-profile formulae apply to flow over surfaces with small roughness elements and in conditions when a "steady state" in respect of the interchange of momentum, appropriate to the surface roughness and the thermal stability of the air stream, has been achieved. Nor can the formulae be applied through, what are effectively, two distinct fields of flow—that above the surface of separation, and that below, i.e. in the turbulent wake. In any event field evidence suggests that the protective efficiency of a barrier is less with an unstable turbulent stream than with a stable one—although the differences are usually of "second-order" in magnitude. Physically it is reasonable to suppose that the more rapid vertical interchange of "eddies" in unstable conditions compared with that in stable conditions results in the incident flow being re-established nearer the barrier. This argument is frequently used to reconcile results obtained from models subjected to the steady flow in the wind tunnel and those for the actual barriers placed in the naturally turbulent wind. Again the re-establishment of a velocity profile can be used as a means of defining the extent of the "zone of influence" of a barrier.

Secondly, presumably, we are to assume from the lowest diagram in Fig. 2 that the flow is symmetrical about the centre line—implying an equal net mass flow from each of the ends converging towards the centre (but below $0 \cdot 7H$ according to the statement on p. 248). This, it appears, can very easily be disturbed since if the incident direction deviates by 5° from the normal (strictly apparently $2\frac{1}{2}$–$7\frac{1}{2}^{\circ}$) the direction of mass flow is parallel to the barrier and in one sense only. In view of the range of variation in direction of the natural wind, it would seem that in practice there would be a series of pulses or surges alternately from either end, and that over an extended period (say 30 min.) the net mass flow parallel to the barrier would tend to zero when the mean incident direction over the same period was normal to the barrier. This is not the place to raise the difficult problem of the measurement of air flow in the open, but Mr. Lawrence may care to comment on the specific point suggested by his diagrams.

R. W. GLOYNE

Edinburgh, September 1, 1955

[Regarding the first point in the above letter, Mr. Gloyne appears to have misunderstood the procedure. Sutton's formulae have been applied only to the free atmosphere and not to the disturbed air around the wind-break. Also, the "shelter" isopleths are not intended to represent any "efficiency of protection" under each type of lapse rate as it occurs naturally in the atmosphere. Unfortunately, the data available did not permit this, as no temperature ascents were made.

As far as his second point is concerned, the large area of "variable wind direction" when the wind is normal or nearly normal to the barrier, is sufficient testimony to the occurrence of "pulses and surges". The convergence immediately behind the barrier is presumably associated with a "suction effect" which balances the "down-draught" further down stream behind the barrier.—E. N. LAWRENCE].

Lunar rainbow

A lunar rainbow was seen by Mr. W. Duncan, auxiliary observer at Glenlivet at 2040 G.M.T. on October 3. The bow, which was complete, was faintly coloured, yellow and green being predominant. At the time the visibility was six miles in slight rain. There were seven oktas of cumulus and cumulonimbus cloud, patches of nimbostratus at 1,800 ft. being the lowest clouds.

P. E. PHILLIPS

Pitreavie, Fife, October 6, 1955

NOTES AND NEWS

The sunny weather of July 1955

Except for the first three days high pressure persisted throughout July extending from the Azores across the British Isles to the region of Scandinavia. For much of the month the weather over England and Wales followed the same pattern day after day; easterly or north-easterly winds brought cloud inland at night, but this cleared from most areas during the morning to give fine sunny days. As this cloud did not cross the Pennines and rarely penetrated far into the Midlands, sunshine totals were usually larger in the west of the country than in the east. Fairly frequent thunderstorms reduced the total amount of sunshine recorded during the month in the south Midlands and south and south-east England, and sunshine in the north of Scotland was reduced by weak frontal systems associated with small disturbances which, from time to time, passed north-eastward between Iceland and Scandinavia. Elsewhere the sunshine of July 1955 was outstanding. In south and east Scotland, north-west England, north and west Wales, Northern Ireland, the Republic of Ireland, and in parts of the Midlands there was more sunshine than during any previous July since records became available.

Much of southern Scotland had 100–150 hr. of sunshine in excess of the average. Renfrew, with sunshine records dating back to 1921, registered 291 hr. during the month, 56 hr. more than the previous highest July total in 1952. Eskdalemuir, with records since 1910, registered 40 hr. more than its previous best July total of 217 hr. in 1935. Glasgow's total of 292 hr. exceeded that of any July since their records began in 1880. Aberdeen, with a similar long period of sunshine records, enjoyed 263 hr., the most ever registered in July and 24 hr. more than during the July of the brilliantly fine summer of 1911. Leuchars, with observations since 1922, recorded 262 hr., 18 hr. more than their previous July record of 244 hr. in 1935.

At Southport, in north-west England, July 1955 was the sunniest of any month since observations began in 1896. The total of 329 hr. was approximately 65 per cent. of the total possible sunshine for the latitude, 135 hr. more than the average and 14 hr. above the previous monthly record set up in June 1940. An even higher total of 336 hr. was registered at Squires Gate, Blackpool, and this too was higher than all previous monthly sunshine totals available for Squires Gate since records were first taken there in 1942. Keswick with 294 hr.—more than twice the average amount—and Stonyhurst with

285 hr. each had more sunshine than in any other July since observations were first made in 1919 and 1881 respectively.

In Wales, the total of 295 hr. at Hawarden was the best for July since records began in 1923 and 50 hr. better than the previous highest in 1934. At Llandudno, with 332 hr., it was the sunniest month in their records which date back to 1909; the previous best monthly total was 304 hr. in June 1940. Holyhead with observations dating back to 1914 recorded 341 hr., 67 per cent. of the possible duration and an average of 11 hr. sunshine a day compared with the usual daily average of just under 6 hr. The total was 156 hr. above their July average and 86 hr. more than their previous best July total in 1934. There were 14 days during the month with more than 13 hr. sunshine.

In Northern Ireland, Aldergrove, with 274 hr., registered more sunshine than in any other July since their records began in 1923; this was 54 hr. above their previous highest July total in 1954 and 138 hr. more than their monthly average.

In the Republic of Ireland records at Birr Castle and Valentia date back to 1881. The total of 266 hr. at Birr Castle was 46 hr. better than their next best total for July in 1911. In spite of there being five days during the month with 3 hr. sunshine or less, Valentia registered 311 hr., 154 hr. above the average and 76 hr. more than the previous sunniest July in 1918.

Among the places in the west Midlands which had the sunniest July on record, Ross-on-Wye enjoyed 275 hr., 4 hr. more than their previous highest total for July in 1942; sunshine records were started there in 1880.

Of all these stations Southport and Holyhead are usually the most sunny with an average of nearly 6 hr. sunshine daily in July—1955 totals were 184 and 178 per cent. of their averages; the least sunny are Eskdalemuir and Keswick with a daily average of sunshine of just below and just above 4½ hr.—the totals for July 1955 were 187 and 204 per cent. of the average respectively. Most of the stations quoted recorded more than 180 per cent. of their July average.

At Southport, Squires Gate and Llandudno, July 1955 was the sunniest month ever recorded and no station mentioned above had ever before recorded so much sunshine in July though in some cases observations cover a period of more than 70 years.

R. E. BOOTH

Bibliography on the history of terrestrial magnetism

The late Dr. A. Crichton Mitchell published in *Terrestrial Magnetism and Atmospheric Electricity* a series of articles entitled "Chapters in the history of terrestrial magnetism"*. His daughter has now presented to the Edinburgh Meteorological Office, papers which show that Dr. Mitchell had planned a more extensive work on this subject. The papers consist of a card index bibliography of almost 10,000 cards and a considerable volume of Dr. Mitchell's notes. These notes are not in a state which permits easy editing for publication, but they would undoubtedly be valuable to a research worker on the history of terrestrial magnetism. They can be consulted by arrangement with the Superintendent of the Meteorological Office, 26 Palmerston Place, Edinburgh.

* *Terr. Magn. atmos. Elect., Baltimore*, **37**, 1932, p. 105, **42**, 1937, p. 241, **44**, 1939, p. 77 and **51**, 1946, p. 323.

New units for upper air observations

With effect from January 1, 1956, the Meteorological Office will use the degree Celsius for measuring temperature and geopotential metres for measuring height in all upper air observations. The new units will be used in the daily international exchange of upper air observations, in the *Daily aerological record* and in *Climatological summaries of upper air data.*

Contour lines and thickness lines on charts in the *Daily aerological record* and in broadcasts from the Central Forecasting Office will be given at 60 m. intervals. The interval for the tropopause will be 1,000 m.

Whenever, for special purposes, it is necessary to provide upper air observations with temperatures expressed in degrees Fahrenheit and heights in feet, this will be done.

The height of base of low cloud will continue to be measured and expressed in feet.

Fog patches at Tilbury

The photographs facing p. 384 and p. 385 illustrate the nature of the fog of November 15–16, 1949. A deep depression passed eastwards across Scotland on November 12 reaching Denmark at 0000 on the 14th. The cold winds behind the depression swept over the whole country on the 14th and, as the depression entered the Baltic and began to fill up, first a ridge of high pressure and then a small anticyclone developed over the British Isles. The wind dropped rapidly to calm over south-east England and, with clear skies, fog formed over the London area during the evening, the visibility falling to 100 yd. at London Airport at midnight. There were local and temporary clearances during the late morning and afternoon of the 15th, and when these pictures were taken over Tilbury about 1000 the sky could be seen through the fog in many parts. The fog formed again during the late afternoon and finally dispersed on the afternoon of the 16th. By this time a large anticyclone had developed over Scandinavia and the Baltic Sea.

REVIEWS

Lake Eyre, South Australia: The great flooding of 1949–50. Report of the Lake Eyre Committee. 9½ in. × 7 in., *Illus.*, pp. xii + 75. Royal Geographical Society of Australasia, South Australian Branch, Adelaide. Price: £A1 1*s*.

Several articles have already appeared dealing with various aspects of the filling of Lake Eyre in 1949–50 and of the subsequent drying up which lasted until the end of 1952. Here is a comprehensive report which, with the aid of references to previous articles and to earlier literature, provides a compact guide to all that is known about the "lake".

Beginning with the explorations of E. J. Eyre in 1840, investigations spread over more than a century, including the use of aircraft since 1922, had led to opinions that Lake Eyre rarely contained much water and would probably never fill again. It was known that in recent decades the lower reaches of one of the main potential feeders, the Cooper, had become blocked by wind-formed sand ridges, and there were strong suspicions that sporadic flood flows down the creeks were inadequate to counteract continuing dessication in the lake area. But flood waters began to pour into Lake Eyre North during the first half of 1949, the sand hills across the Cooper were reported to be breached in June, and at the beginning of November observation from the air established that the mouth of the Cooper was discharging, with water from it already joining the then main body which had entered the lake from the Warburton. The Cooper was flowing at its strongest in August 1950, and by the end of September Lake Eyre North, covering an estimated area of rather more than 3,000 square miles, was completely full. Lake Eyre South, with an estimated area of little more than 500 square miles, is joined to the main lake by a slightly raised channel and did not fill.

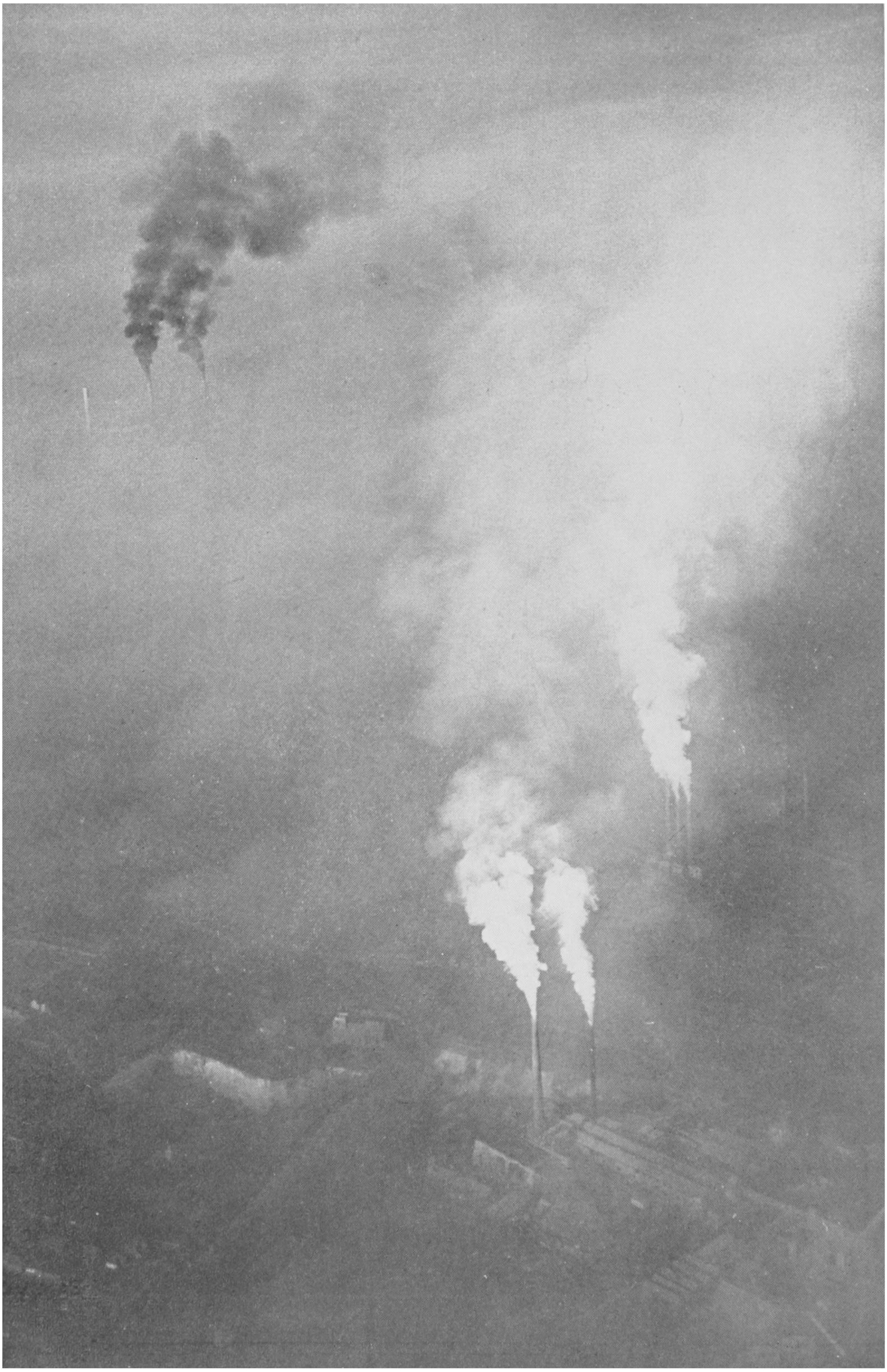
The occurrence aroused much interest, not least one suspects, because of a persistent reluctance to accept conclusions that the region is all but useless and incapable of economic development beyond the maintenance of a sparse pastoral population. The scientific activities of the specially formed Lake Eyre Committee were accompanied by the less scientific resurrection of schemes for irrigation, or for joining the lake to Spencer Gulf by means of a canal 250 miles long, which would keep an enlarged lake of about 5,000 square miles permanently full, and perhaps transform the climate of the area. No such scheme receives any encouragement from the Committee's report. As for possible modifications of the climate, the discussion of the drying up of 1951–52 includes the remark, "It is interesting to note that the high evaporation had virtually no effect on the climate of the surrounding country, for this was to suffer a drought even while the lake evaporated fast into the dry continental air." A land expedition to the shores of the drying lake in the summer of 1951–52 found the humid heat almost intolerable: "to everyone's relief the next day, December 7, dawned cloudy and it proved rather cooler. (The maximum measured at the lake was 100·5°F.)". On some days any form of activity was out of the question during the period 10.30 a.m. to 6.30 p.m. and "the enervated party could do little work even after the sun had set". It is impossible to escape the conclusion that even if there was a modification of some of the elements of climate, due to the presence of the large area of water, there was no appreciable improvement in terms of human comfort.

The main appeal of the report is to the hydrologist. For instance, the description of the "Channel Country" of Cooper's Creek, south of Windorah, Queensland, presents a picture of a river system in reverse. The main creek in flood does not spread laterally as the flood rises, but breaks up into several smaller channels, which in turn branch out into a multiplicity of distributaries, until eventually (with only moderate flood) the final streamlets disappear into the dry ground. The analysis of the rainfall of 1949–50 shows the sequence of events, with heavy rainfall in one part of the drainage system, followed after an interval by heavy rainfall in another part, which so modified ground moisture conditions that very high floods reached Lake Eyre without losing themselves, or suffering great reduction, in the Channel Country. It is apparent, without giving further details, that this was a very special case in the hydrology of flood discharges.

A short account is given of a partial filling and subsequent drying of Lake Eyre North in 1953, and a brief mention of yet another filling, as the report was going to press, in March 1955, in which it appears that Lake Eyre South filled independently and probably contributed to the flood in Lake Eyre North. There seem to be interesting new features in this latest flood, and perhaps we shall hear more of Lake Eyre in the near future.

Photograph by Mirrorpic

FOG PATCHES AT TILBURY, NOVEMBER 15, 1949
(see p. 383)



Photograph by Mirrorpic

FOG PATCHES AT TILBURY, NOVEMBER 15, 1949
(see p. 383)

Meanwhile the sections of the report which are potentially of the greatest general values are those dealing with evaporation, and it is a great pity that the observations were severely restricted by the difficulties which the land expeditions had to face. The data could have been of very wide application because of their value as a check, for extreme conditions, on theoretical estimates, and it is to be hoped, if the 1955 filling has proved to be as complete as the early reports suggested, that further expeditions will be organized and attempts made to obtain fuller data. In the circumstances the close agreement between observed and estimated values obtained by Penman, who took part in the December 1951 expedition, must be regarded as surprising rather than gratifying. In his own contribution to this report he says that "the agreement . . . cannot be regarded as a confirmation of the theoretical basis". Nevertheless the results are worth quoting. Three estimates of the total evaporation for the year 1951 were obtained:—

By C. Warren Bonython ...	77 in.
By H. L. Penman	86 in.
From lake-level observations ...	94 in.

The first two estimates were made by extrapolating from two brief periods of observation at the lake—the first by reconstructing monthly mean values of the elements used in the computation for the lake area by reference to the data obtained at the nearest climatological stations (50–100 miles away); the second by calculating evaporation at the lake for the two periods of observation, and then fitting to these two values the seasonal cycle observed at the nearest station with a standard evaporation pan (200 miles away). Optimistic as these methods may appear to be, it does not follow that the third estimate is necessarily the most accurate (it is given elsewhere in the report as 7·5 ft.). This "measured" value neglects the possibility of seepage from or into the lake, and though this was carefully judged to be negligible it was not proved beyond doubt to be small. Also the measurements of lake level were subject to some error because of seiches which caused fluctuations from day to day. An overnight fall of 15 in. was observed in February 1951 on the cessation of a strong northerly wind; a rapid rise of at least 2 ft. (maximum not observed) occurred with a north-westerly squall in December 1951; and in the same month, a few days later, there was a "spectacular fall" of 20 in. produced by a strong S. wind. Although the relatively calm periods were used to estimate the mean static level, there is some doubt, in particular, about the December 1951 value. Perhaps the best that can be said is that open-water evaporation at Lake Eyre is now known to the nearest foot, and, making a small deduction from the 1951 value to correct to the normal year, it is probably nearer to 7 ft. than to 8 ft. which was roughly the value previously assumed.

A. BLEASDALE

Klima und Bioklima von Wien. I Teil. Ergebnisse der langjährigen Messreihen an der Zentralanstalt für Meteorologie und Geodynamik in Wien, Hohe Warte. By Prof. Dr. F. Steinhauser, Dr. O. Eckel and Dr. F. Sauberer. 9½ in. × 6½ in., pp. 120, *Illus.*, Verlag: Österr. Gesellschaft für Meteorologie, Wien XIX, 1955.

This is the first part to be published of a climatology of Vienna for use in town planning, building design and industry.

The observations summarized were made at three sites, two in the built-up city between 1775 and 1872 and since 1872 at one in a park area to the north-west. The elements covered are radiation (direct solar, sky, global, and long-wave radiation and daylight illumination), temperature, earth temperature, humidity and evaporation, total amount of cloud, fog, sunshine, precipitation, thunderstorms, wind, and air pressure. The temperature observations summarized are for the period 1775–1950, the radiation data are for 1938 to 1944, and the others for intermediate periods, precipitation being for 1851–1950.

The publication gives a great amount of information on means, extremes, diurnal and annual variations, frequencies of special periods, such as ice days, dates of earliest and last occurrence of snow in the year, highest gusts, and on combinations, such as frequencies of wind strength, and direction at low temperatures, of importance in building. Interesting combinations, frequencies of which were new to the reviewer, are those of sunless days with precipitation and the amount of sunshine on days of precipitation. The probability in winter that the sun will not shine on a day with precipitation is about ½ but in late summer it is only 1/20.

While much information on rainfall is given there is none on frequencies of high rates of rainfall which are of great importance in drainage design; no other omissions were obvious to the reviewer. Tables of the individual monthly means of temperature, cloud amount, of amounts of rain and extremes of temperature are given in appendices. In view of the purpose of the work no application of the data to study of secular change was to be expected.

G. A. BULL

Climates in miniature. By T. Bedford Franklin. 8½ in. × 5½ in., pp. 138, *Illus.*, Faber and Faber Ltd., London, 1955. Price: 15*s.*

This is an attractive and useful addition to the relatively small number of books devoted to exploring and explaining the complicated interaction between plants and animals and their climatological environment. The author presupposes some familiarity on the part of the reader with physical concepts and techniques, and obviously brings to his task considerable scientific knowledge, and, equally welcome, a wealth of results from personal observation and experiment.

The first four chapters, respectively entitled "What a microclimate is" "Warmth and hibernation", "Cranberry marshes", and "Soils", are mainly introductory. In Chapter III some of the problems encountered in the subject are illustrated from the classical work of H. J. Cox on methods of reducing frost damage on plantations of cranberries in Wisconsin, whilst in Chapter IV special attention is paid to soil temperature—a topic dealt with more formally in Chapter V "Taking earth temperatures". Chapter VI, "What happens to the rain", introduces the subject of evaporation, and in Chapter VII, "Nature's way", some interactions between soil temperature, soil moisture and soil cover are discussed with special reference to the freezing of soil.

Chapter VIII, "Frost", includes information on artificial methods of reducing damage and some empirical forecasting rules. The following chapter, "Air temperatures", covers considerable ground and contains interesting remarks on temperatures in walled gardens.

Chapter X, "Humidity and dew", includes some of the author's instrumental measurements of dew deposit, and first-hand observations are also quoted in Chaper XI, "Wind and shelter", although the experimental set-up used by the author needs careful noting before the result illustrated in Fig. 9 (p. 99) can be assessed. Chapter XII, "Light and shade", deals satisfactorily with a subject notoriously difficult to explain in simple terms.

The last three chapters, "Cloches and frames", "Microclimates on the farm", "Microclimates in the home", illustrate the application of principles and results mentioned earlier.

The author dismisses the Rothamsted work on evaporation rather too hastily in Chapter VI, and in the course of estimating "transpiration ratios" (i.e. mass of water needed to produce unit mass of dry matter) implies that the water loss from an area covered with vegetation can be separated into two easily computed components: that lost from the soil and the surface of the vegetation and that transpired by the vegetation; the consistently low values he finds for the above ratio may arise from these assumptions. Regarding frost risk—does it follow (p. 29) that if one soil plot experiences a greater diurnal temperature range than a neighbouring one then the frost risk in the former case is the smaller? Snow does not "disobey the law that a good reflector is a poor radiator" (p. 62), and, contrary to the statement on p. 78, " air frost" as well as "ground frost" are recorded officially (although only the latter is published in the *Monthly Weather Report*). The statement on p. 84 that 92 per cent. of bright sunshine is used in transpiring water is incorrect—the correct estimate is given on p. 103. It might also have been wise to mention explicitly the distinctions between photosynthesis and photoperiodism (pp. 107–109).

There are other points one could criticize, but none of these make the book less worth reading and purchasing—one feels impelled to try and emulate the author's enthusiasm and ingenuity; for a start some of the empirical rules on, for example, pp. 48–49, 61–62, 70–72, 76 might be tried out.

R. W. GLOYNE

Sun, sea and sky: Weather in our world and in our lives. By Irving P. Krick and Roscoe Fleming. 8½ in. × 5½ in., pp. 248, *Illus.*, Victor Gollancz Ltd., London, 1955. Price: 16*s*.

This is a most unusual book, in which, according to the "blurb", "a distinguished meteorologist and a skilled writer combine . . . to present the drama of the weather". The meteorologist in the combination is well known to many as possessing unusual enthusiasms, and these combined with the literary style of an American journalist give the book its character.

The book is crammed full of similies and metaphors which are used to such an overbearing extent as to be a real burden to the reader, proving how wise is the use of the ordinary, formal style of writing used in scientific papers. Whole paragraphs of entirely unnecessary similies are to be found everywhere; sometimes even a whole page can be consumed without advancing the argument any further, while on a smaller scale even the better, simpler, paragraphs are marred by the use of pictorial but scientifically unnecessary adjectives. If all this is the work of a skilled writer then we must rejoice that so many scientists are unskilled.

From a scientific point of view the book is of very mixed quality, bearing too heavily the signs of meteorological eccentricity, but at the same time often showing real wisdom and learning. It begins with an account of the conversion of the earth's atmosphere from one of carbon dioxide into its present composition, and then there is a good account of the working of the earth's atmosphere, and how it transports heat and water, using the energy of the sun. Most of this is very good but there is a serious lapse on p. 47 where a very woolly and loose account is given of a theory that the heat absorbed in the ozone layer of the atmosphere drives the general circulation of the atmosphere. This is a theory that would require careful presentation to be acceptable, and it is doubtful whether even those most interested in ozone would accept it easily. From this we proceed to an account of the structure of clouds and depressions. This is followed by an account of the history of forecasting and of the latest developments, with special reference to the analogue technique in which Dr. Krick is very interested. Having regard to the limited acceptance of this method it would seem to be greatly over-emphasized.

Next, in Chapter V, the book gives an account of the ordinary weather systems of the atmosphere, and in Chapter VI the changes of the climate of the globe are reviewed. From this point, except for parts of the last chapter, the book degenerates into what is almost entirely an account of the activities of analogue forecasters and of modern rain-makers and their claimed successes; and in the reviewer's opinion the accounts are usually biased and misleading. There are some good parts, but these are few. There is a lot of politics.

The last chapter is devoted mainly to mankind's pollution of the air, rivers and sea and his consumption of the world's resources of clean water and fertile land. Perhaps because the reviewer agrees with the views expressed, these are rated very high, and although there is nothing very new it is always well to have it said.

The book by its style invites actual quotation, but two are specially selected. The first, from the chapter on atmosphere pollution (p. 227), because it ought to be read by many English people: "Most of the pollution is unnecessary and wasteful. Better ways of burning, more complete combustion, would for example give Britain an ample supply of coal in the amount she now digs from the ground, rather than the chronic shortage which she must supplement from abroad though she can hardly afford it. But her inertia, more than her poverty prevents reform." The second from p. 92—because many readers of the *Meteorological Magazine* will like it—"The ablest forecasters are humble men. . . ."

A. W. BREWER

The observer's book of weather. By R. M. Lester. $5\frac{3}{4}$ in. × $3\frac{3}{4}$ in., pp. viii + 152, *Illus.*, Frederick Warne & Co. Ltd., 1955. Price: 5*s.*

This neat little volume is presumably intended to give the amateur weather observer some knowledge of the physical processes of the atmosphere and the problems confronting a forecaster. It is not possible to recommend it because the author has a most awkward style, the sequence of his thought is confused, and the uninformed reader may easily be misled at many points by implication if not by positive mis-statement. For example, referring to oxygen in the composition of the atmosphere, the author states: "This is a variable gas that decreases with altitude. . . ." and follows this immediately by: "The other variable gas in the atmosphere is water vapour. . . ." Again, the description of fronts and of the formation of a frontal depression makes difficult reading, and the definition of a cold front, given in the glossary, is more than misleading. In fact, several of the definitions in the glossary are inaccurate. It is difficult at times to decide whether the author intends his statements to apply to the British Isles only or more generally. Indeed, in his chapter on "Weather lore" he appears to treat certain Biblical quotations on weather as if they applied to the British Isles. The book is well illustrated by numerous plates, some in colour. The cloud photographs are good and their captions in most cases accurate.

H. HEASTIE

BOOKS RECEIVED

Natural water and its use in S. Rhodesia. Minister of Agriculture and Lands, Rhodesia. *Rhod. agric. J., Salisbury,* **49,** 1952, pp. 203–211, 272–279, 384–391, **50,** 1953, pp. 54–67, 255–262, 486–490, **51,** 1954, pp. 193–196, 478–488. 9½ in. × 6 in., *Illus.*

Resumen de Labores, Año 1954. No. 3, 10 in. × 7½ in., pp. 44, *Illus.* Universidad Mayor de San Andres, Laboratorio de Física Cósmica, La Paz, Bolivia, 1955.

AWARDS

The L. G. Groves Memorial Prize for Meteorology has been awarded this year to Dr. F. J. Scrase, O.B.E., M.A., Sc.D., Senior Principal Scientific Officer, Meteorological Office. Dr. Scrase is a world authority on meteorological instrumentation and an inspiring leader of the Instrument Development Division of the Meteorological Office. As President of a Sub-Commission of the World Meteorological Organization Dr. Scrase has been in very large measure responsible for the new "Guide to International Meteorological Instrument Practice", a comprehensive work of reference. His recent personal research work includes further studies of turbulence in the upper atmosphere and an important theoretical investigation of the errors, due to radiation and lag, of radio-sondes. These studies are also closely related with practical problems of aviation and air navigation.

The L. G. Groves Memorial Award for Meteorological Air Observers has been awarded to Flight Lieutenant J. Formby, R.A.F.R.O. Since September 1952 Flt-Lt Formby has been engaged in carrying out the meteorological ascents which are performed daily from the R.A.F. station at Woodvale. He has made over 450 such flights and during one period he was called upon to make the ascent every day for five weeks. Throughout his period of service he has shown marked enthusiasm for this task and exceptional ability both as a pilot and as a meteorological observer. Flt-Lt Formby's keenness and devotion to duty have contributed much to the remarkable regularity with which these flights have been carried out at Woodvale.

METEOROLOGICAL OFFICE NEWS

Ocean weather ships.—The following extracts are taken from reports of Masters of ocean weather ships:

O.W.S. *Weather Explorer.*—At station K in the Bay of Biscay, August 31–September 24, 1955:

"Weather on station was mainly very good, almost subtropical; the air temperature averaging 68°F. and sea temperature about 69°F. led to a considerable amount of sea bathing. Two small turtles which swam round the ship caused considerable excitement to those of the ship's company who had never seen such a thing before."

The Meteorologist-in-Charge aboard o.w.s. *Weather Explorer* says, "The mean temperature was some twenty degrees higher than on our previous voyage and we were able to indulge in such recreations as swimming, sailing, sun-bathing and the indigenous form of cricket."

o.w.s. *Weather Observer*.—At station J, August 25–September 18, 1955:

The number of transatlantic aircraft to which navigational aids and meteorological information was given reached the very high total of 911.

The increasing use which is being made of weather ships by transatlantic aircraft at ocean station J, which is very near the great-circle track from London Airport to Gander, is indicated in the following table which shows the average per voyage of the number of aircraft to which assistance was given:—

1947 ...	30	1952 ...	321
1948 ...	185	1953 ...	348
1949 ...	237	1954 ...	417
1950 ...	235	1955 (to date)...	605
1951 ...	228		

Social activities.—In celebration of the Meteorological Office Centenary, the staff of the Central Forecasting Office held a very successful dinner and dance at the Leicester Arms Hotel, Luton, on October 25. Attendance, including wives and friends, was over 100, all branches and grades at the Central Forecasting Office being represented. Mr. S. P. Peters presided and introduced Dr. and Mrs. Sutcliffe as the guests of the evening. Dr. Sutcliffe gave a short historical survey of the Meteorological Office with special light-hearted references to what had been achieved since he joined the staff in 1927. The evening undoubtedly justified the faith of the organizers, and a desire that a similar function should be held before the next centenary was strong and unanimous.

Sports activities.—*Lawn Tennis.*—In the Air Ministry annual lawn tennis competition for 1955, Miss U. J. Murray won the Ladies' Singles Championship and Miss B. M. Edwards and Miss N. M. Edwards won the Ladies' Doubles Championship.

Swimming.—In the Air Ministry Swimming Championships held at the Chelsea Baths on November 2, the Meteorological Office gained first place in the Ladies' Relay and second place in the Men's Relay. In the Ladies' Championship Miss L. Carter and Miss G. A. Morgan were second and third respectively. Mr. J. V. Evling gained second place in both the Men's Free Style and Backstroke Championships and Mr. I. Ridgway was third in the Breaststroke Championship.

WEATHER OF OCTOBER 1955

Pressure anomaly features over the northern hemisphere were remarkably nearly inverse to those in September 1955. In October there were negative departures all over northern North America culminating in a maximum anomaly of −11 mb. over north-west Canada. This was associated with noteworthy deepening of the North Pacific depressions which spread in over Alaska and travelled across northern Canada. Pressure was also far below normal over Finland and Scandinavia, and eastern and central Europe, with anomalies of −9 mb. near the White Sea. The monthly mean pressures were up to 6 mb. above normal between Iceland and South Greenland and the Azores anticyclone appeared weak, though these anomalies reflect an unsteady régime with considerable variability in the positions of the main centres of action in the Atlantic sector, especially in the second half of the month. The Siberian anticyclone was intensely above normal along an axis in 50°N., whilst depressions travelled east near the Arctic coast.

Temperature was below normal over the Arctic Ocean and in Alaska. There were also smaller negative anomalies over the North Sea and western half of Europe and over north-easternmost Siberia. Eastern Europe, central and western Siberia, nearly all North America and Greenland were 1·4°C. warmer than normal.

The complex pattern of rainfall anomalies was chiefly remarkable for large areas of deficiencies over Alaska, north-west Canada and also the southern Rockies, moderate excesses of rain around the Baltic and North Sea and some great excesses in south-east Europe. There were again great excesses in northern and central India but deficiencies in East and West Pakistan.

In the British Isles the first week ended with widespread rain; during the second week, mainly anticyclonic conditions prevailed while the third was unusually wet in the south. Sunny weather with cold northerly winds predominated during the last week of the month.

There were outbreaks of thundery rain with sunny periods during the first few days as troughs slowly crossed the country, but on the 5th the first major depression of autumn developed off north-west Ireland; winds reached gale force on western coasts and rain was widespread, and in many places heavy, as the depression crossed southern Scotland to reach the North Sea on the 6th. Behind the depression, squally showers with strong north-westerly winds, which reached gale force at times, became general—a gust of 74 kt. was registered at Bidston Observatory. An anticyclone from the Azores moved to the Bay of Biscay on the 8th and later to southern Russia; warm Atlantic air spread over the British Isles accompanied by widespread rain and a general rise in temperature. Weather was fine and warm from the 9th to the 12th with light south-easterly winds and temperature often in the upper sixties, although widespread fog night and morning persisted all day in many places. An anticyclone became established over southern England from the 13th to the 15th; winds veered to a south-westerly direction with temperature generally somewhat lower than of late although it reached 70°F. at many places in eastern England on the 15th. An influx of polar air on the 16th caused a sharp and general fall of temperature of about 15°F.; at Rotherham, Yorkshire, the minimum temperature, which was 53°F. on the 15th, fell to 26°F. on the 16th, while London, with a maximum temperature of only 48°F. on the 16th, had its coldest day since March. On the 18th a depression deepened considerably as it moved southward from Iceland; it was centred over Ireland by midday the following day, afterwards turning north-east and 24 hr. later was over the northern North Sea. Rain was widespread over the British Isles for two days with exceptionally heavy falls in places; in 24 hr. Poole recorded more than 4 in. and Swanage and Bournemouth each had over 3 in., while Southampton registered 1½ in. on both the 18th and 19th. A cold front associated with the main depression moved slowly across the country with occasional rain on the 20th, but a wave on this front developed into an active depression which remained quasi-stationary over the southern North Sea during the 20th and 21st; northerly gales developed along the east coast with heavy and prolonged rainfall in south-east England; several stations again registered more than 2 in. in 24 hr. while at Hastings rain fell continuously for more than 30 hr. The last week of the month was mainly anticyclonic and became progressively colder as arctic air spread southwards. On the night of the 28th, 30th and 31st air frost occurred over much of the country.

It was one of the coldest Octobers of recent years with temperature more than 2°F. below normal on the East Anglian coast. The average night minimum temperature at Croydon was the lowest during October since 1926. The sudden and severe frosts on the night of the 15th-16th caught many growers by surprise and had quite an appreciable effect on the cut-flower trade. Sunshine was about the average, but rainfall was very variable; over much of the country, rainfall was well below the average but parts of south-east England had twice the normal amount. The dry conditions, especially in the north and west, made ploughing extremely difficult with the result that the acreage of winter sown corn to date is very small in places. Harvesting generally has been satisfactory although root crops have been lighter than usual owing to the dry summer.

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

	AIR TEMPERATURE			RAINFALL		SUNSHINE
	Highest	Lowest	Difference from average daily mean	Percentage of average	No. of days difference from average	Percentage of average
	°F.	°F.	°F.	%		%
England and Wales ...	73	17	−1·3	77	−5	121
Scotland	71	18	−1·2	108	0	101
Northern Ireland ...	68	26	−1·0	86	−2	112

RAINFALL OF OCTOBER 1955

Great Britain and Northern Ireland

County	Station	In.	Per cent. of Av.	County	Station	In.
London	Camden Square ...	2·79	106	*Glam.*	Cardiff, Penylan ...	2·26
Kent	Dover	6·17	159	*Pemb.*	Tenby	2·23
,,	Edenbridge, Falconhurst	4·87	135	*Radnor*	Tyrmynydd	4·67
Sussex	Compton, Compton Ho.	3·93	86	*Mont.*	Lake Vyrnwy	3·62
,,	Worthing, Beach Ho. Pk.	2·37	65	*Mer.*	Blaenau Festiniog ...	7·53
Hants.	St. Catherine's L'thouse	2·03	54	,,	Aberdovey	2·98
,,	Southampton (East Pk.)	4·67	119	*Carn.*	Llandudno	2·14
,,	South Farnborough ...	4·17	130	*Angl.*	Llanerchymedd ...	1·83
Herts.	Harpenden, Rothamsted	3·05	97	*I. Man*	Douglas, Borough Cem.	3·25
Bucks.	Slough, Upton	3·90	139	*Wigtown*	Newton Stewart ...	2·30
Oxford	Oxford, Radcliffe ...	1·57	54	*Dumf.*	Dumfries, Crichton R.I.	3·47
N'hants.	Wellingboro' Swanspool	1·70	67	,,	Eskdalemuir Obsy. ...	3·11
Essex	Southend, W. W. ...	4·10	164	*Roxb.*	Crailing...	1·92
Suffolk	Felixstowe	4·31	188	*Peebles*	Stobo Castle	2·81
,,	Lowestoft Sec. School ...	4·41	158	*Berwick*	Marchmont House ...	2·15
,,	Bury St. Ed., Westley H.	4·47	165	*E. Loth.*	North Berwick Gas Wks.	1·39
Norfolk	Sandringham Ho. Gdns.	2·56	84	*Midl'n.*	Edinburgh, Blackf'd. H.	1·44
Wilts.	Aldbourne	2·20	62	*Lanark*	Hamilton W. W., T'nhill	2·34
Dorset	Creech Grange... ...	5·69	112	*Ayr*	Prestwick	1·72
,,	Beaminster, East St. ...	2·85	64	,,	Glen Afton, Ayr San. ...	4·38
Devon	Teignmouth, Den Gdns.	2·08	54	*Renfrew*	Greenock, Prospect Hill	5·04
,,	Ilfracombe	2·76	61	*Bute*	Rothesay, Ardencraig ...	4·37
,,	Princetown	4·85	58	*Argyll*	Morven, Drimnin ...	8·31
Cornwall	Bude, School House ...	2·48	61	,,	Poltalloch	5·68
,,	Penzance	5·46	117	,,	Inveraray Castle ...	8·73
,,	St. Austell	4·21	80	,,	Islay, Eallabus	6·59
,,	Scilly, Tresco Abbey ...	3·41	89	,,	Tiree	6·52
Somerset	Taunton	1·32	41	*Kinross*	Loch Leven Sluice ...	2·58
Glos.	Cirencester	1·63	48	*Fife*	Leuchars Airfield ...	1·69
Salop	Church Stretton ...	2·06	56	*Perth*	Loch Dhu	5·94
,,	Shrewsbury, Monkmore	1·24	44	,,	Crieff, Strathearn Hyd.	3·21
Worcs.	Malvern, Free Library...	1·32	44	,,	Pitlochry, Fincastle ...	2·78
Warwick	Birmingham, Edgbaston	1·66	54	*Angus*	Montrose, Sunnyside ...	2·33
Leics.	Thornton Reservoir ...	1·51	54	*Aberd.*	Braemar	3·25
Lincs.	Boston, Skirbeck ...	1·65	60	,,	Dyce, Craibstone ...	5·08
,,	Skegness, Marine Gdns.	1·49	54	,,	New Deer School House	6·35
Notts.	Mansfield, Carr Bank ...	1·67	55	*Moray*	Gordon Castle	5·07
Derby	Buxton, Terrace Slopes	4·03	82	*Nairn*	Nairn, Achareidh ...	3·62
Ches.	Bidston Observatory ...	2·01	61	*Inverness*	Loch Ness, Garthbeg ...	5·46
,,	Manchester, Ringway...	2·11	68	,,	Glenquoich	...
Lancs.	Stonyhurst College ...	3·65	81	,,	Fort William, Teviot ...	8·80
,,	Squires Gate	2·22	63	,,	Skye, Broadford ...	11·55
Yorks.	Wakefield, Clarence Pk.	1·64	57	,,	Skye, Duntuilm ...	7·64
,,	Hull, Pearson Park ...	2·07	69	*R. & C.*	Tain, Mayfield... ...	3·10
,,	Felixkirk, Mt. St. John...	1·64	57	,,	Inverbroom, Glackour...	7·00
,,	York Museum	1·45	54	,,	Achnashellach	12·81
,,	Scarborough	2·72	87	*Suth.*	Lochinver, Bank Ho. ...	8·33
,,	Middlesbrough... ...	1·49	50	*Caith.*	Wick Airfield	4·08
,,	Baldersdale, Hury Res.	2·29	62	*Shetland*	Lerwick Observatory ...	4·78
Norl'd.	Newcastle, Leazes Pk....	1·40	55	*Ferm.*	Crom Castle	2·76
,,	Bellingham, High Green	2·21	56	*Armagh*	Armagh Observatory ...	1·47
,,	Lilburn Tower Gdns. ...	2·47	67	*Down*	Seaforde	2·39
Cumb.	Geltsdale	2·32	62	*Antrim*	Aldergrove Airfield ...	2·67
,,	Keswick, High Hill ...	3·44	61	,,	Ballymena, Harryville...	3·54
,,	Ravenglass, The Grove	...	...	*L'derry*	Garvagh, Moneydig ...	3·89
Mon.	A'gavenny, Plâs Derwen	2·48	54	,,	Londonderry, Creggan	3·80
Glam.	Ystalyfera, Wern House	4·24	62	*Tyrone*	Omagh, Edenfel ...	2·92

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