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NEW CRITERIA CONCERNING FINE SPELLS IN SOUTH-EAST ENGLAND DURING THE PERIOD MAY TO OCTOBER

By R. A. S. RATCLIFFE, M.A.

Summary.—From a study of 500 mb flow patterns over the years 1957–64, new criteria are deduced for forecasting fine spells in south-east England during the period May to October. The new criteria are shown to be capable of forecasting at least half of all such fine spells occurring in south-east England. Taken in conjunction with other known methods, it should be possible to forecast about three-quarters of all fine spells in south-east England between May and October.

Introduction.—Lowndes[1] criteria for forecasting fine spells have been used with success at the Central Forecasting Office for a number of years, but as Lowndes well realized, fine spells can occur with synoptic models[2] other than the one he chose as a suitable forecasting model.

One of the other possible ways in which fine spells occur is with an upper blocking pattern close to the British Isles. Such an upper pattern is usually slow moving and associated with a blocking surface anticyclone well north of the usual Azores position.

Both the block situation and the Lowndes fine-spell model postulate a dominating anticyclone either near the British Isles or moving north-east from the Azores region towards the British Isles.

It was noticed in 1963, when 14 fine spells occurred, that considerably less than half of these fell into the Lowndes or block categories. Further study of the fine spells of that year suggested that a third model might be found based on a strong upper flow or jet stream in some position to the north-west of the British Isles.

The purpose of this article is to define a fine-spell model in a manner which can be used by a practising forecaster without the necessity for any special charts and in as short a time as possible. Originally the new model was defined in terms of the 500 mb flow pattern. Later it was found to cover many of the fine-spell cases occurring with a strong surface ridge to the south of the British Isles when weak fronts cross south-east England without giving measurable rain.

Data used.—All the 500 mb charts for midnight in the 8-year period 1957–64 inclusive (May to October only) were scrutinized with a view to discovering any relationship which might exist between the 500 mb flow to the north-west of the British Isles and the occurrence of fine spells in south-east England.

In this connexion, a fine spell during May to October was defined as 6 consecutive 12-hour periods in each of which both Kew and London (Heathrow) Airport were dry or had not more than a trace of rain. The 12-hour periods corresponded to the periods reported in the *Daily Weather Report*, i.e. 0900–2100 GMT and 2100–0900 GMT.

This differs from the definition of a fine spell as given by Lowndes[1] who initially used only Kew as the check station and allowed no rain to fall over the 3-day period.

Forecasting criteria.—The results of the investigation suggested the following fine-spell forecasting criteria:

The strongest 500 mb flow in the Atlantic area roughly from 40°N to 70°N, and 10°E to 50°W should be

(i) centred inside the area bounded by 55°N to 65°N and 20°W to 40°W,

(ii) between 180° and 270° in direction.

The strong flow may continue from approximately the same direction up or downstream outside the area of (i), the only requirement being that the core of the strong flow should be centred inside the area of (i) at some place along its length, with the following provisos:

(*a*) an equally strong flow from between 270° and 310° does not exist immediately upstream from the strong flow;

(*b*) a 500 mb trough or vortex is not in evidence near the British Isles from 5°E to 15°W including Biscay and France.

Normally the fine spell is about to begin when the criteria above are satisfied but exceptionally it may follow in one or two days.

A typical 500 mb chart illustrating the criteria is shown at Figure 1, whilst Figures 2 and 3 indicate less normal situations satisfying the criteria and followed by fine spells. Table I gives a summary of results obtained.

TABLE I—THE NUMBER OF FINE SPELLS IN SOUTH-EAST ENGLAND MAY TO OCTOBER 1957–64 AND THE NUMBER FORECAST BY THE NEW CRITERIA

Year	1957	1958	1959	1960	1961	1962	1963	1964	All years
Number of fine spells	11	10	12	10	13	13	14	14	97
Number forecast by the new criteria	7	4	7	5	8	7	6	8	52

Table I shows that over half of the fine spells occurring in 1957–64 could have been forecast using the new criteria. Lowndes[1] also states that almost half of the fine spells of 1951–58 could have been forecast by the methods given in his paper. A check on the years 1957–64 indicates that the new criteria and those of Lowndes overlap on about one third of all occasions but even so the two methods together are probably capable of forecasting about two thirds of all spells in south-east England. Some of the remaining spells occur in block-type situations and in view of the period of time for which these persist, most of them could probably be forecast. Taking the three methods as a whole it seems reasonable to state that about three quarters of fine spells in south-east England could be forecast by one or other of the three methods.

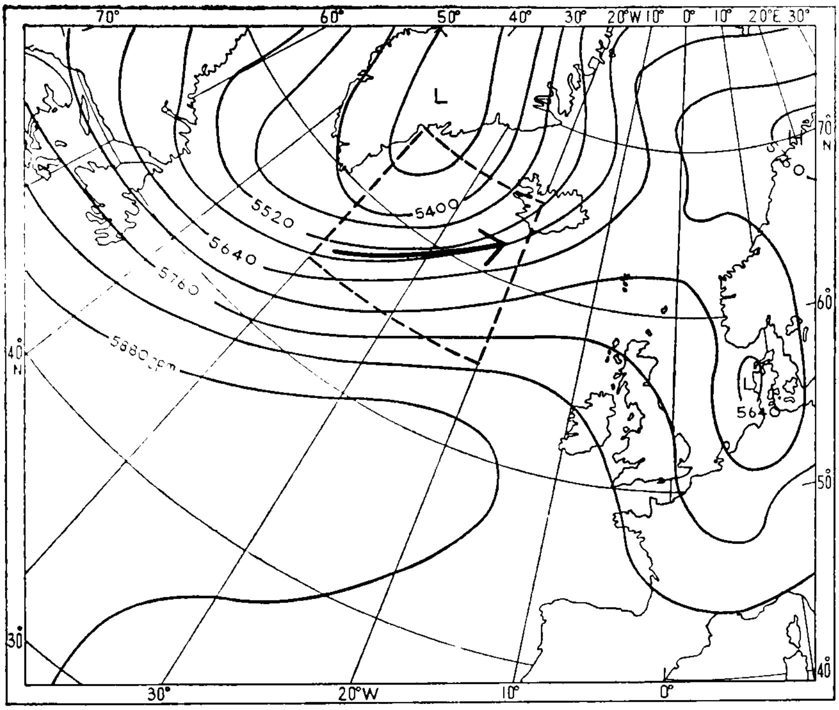

FIGURE 1—500 MB CONTOUR CHART ASSOCIATED WITH FINE SPELL, 0000 GMT, 23 JULY 1964

— — — — Boundary of defined area. Contours are in metres.
The strongest flow, indicated by an arrow, is across the centre of the defined area.

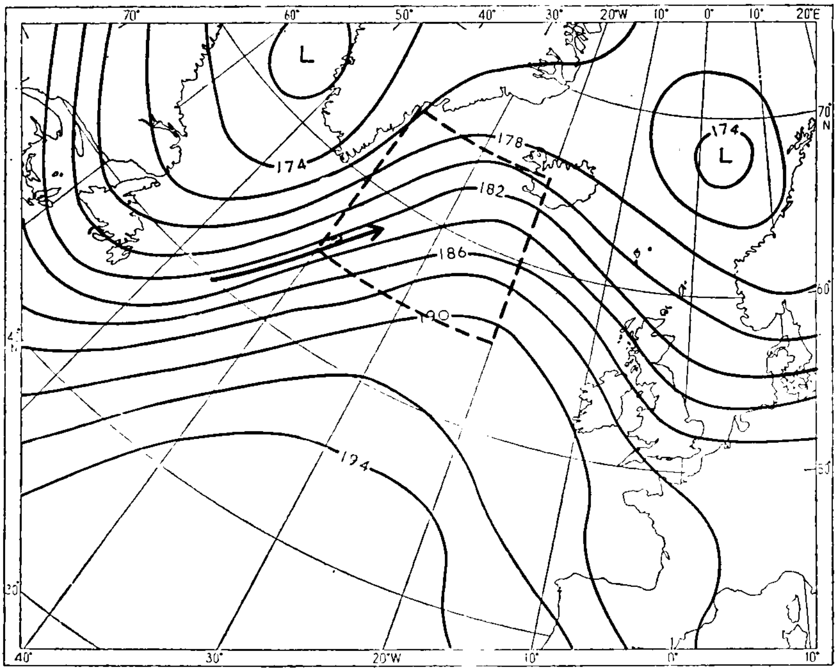

FIGURE 2—500 MB CONTOUR CHART ASSOCIATED WITH FINE SPELL, 0300 GMT, 27 SEPTEMBER 1955

— — — — Boundary of defined area. Contours are in hundreds of feet.
The strongest flow, indicated by an arrow, is near the western edge of the defined area. (Contrast with Figures 5 and 6.)

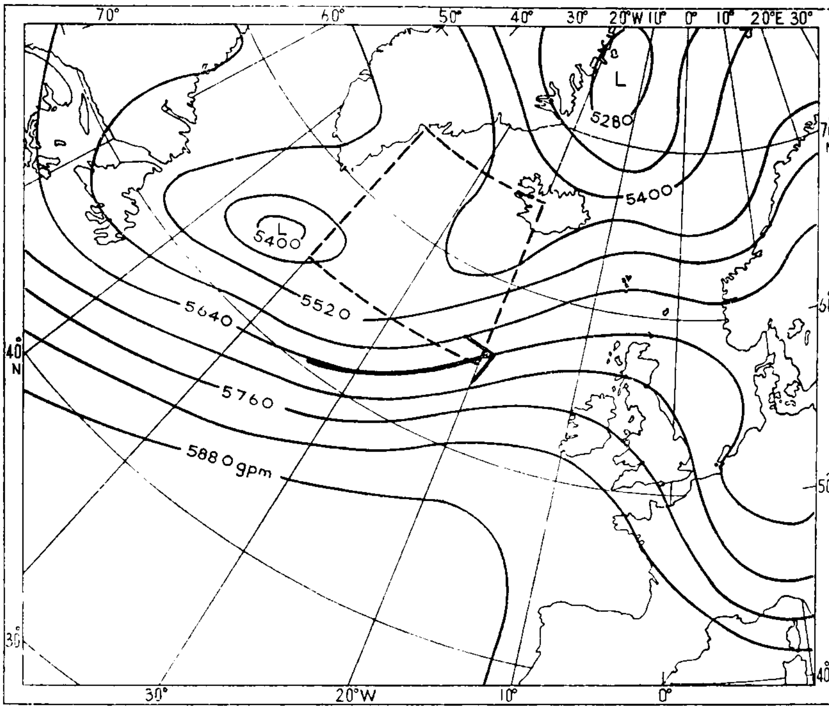

FIGURE 3—500 MB CONTOUR CHART ASSOCIATED WITH FINE SPELL, 0000 GMT, 7 SEPTEMBER 1964

— — — — — Boundary of defined area. Contours are in metres.
The strongest flow, indicated by an arrow, is near the south-east corner of the defined area.

Although the new criteria are purely empirical, it is clear that they have some dynamical basis. A strong upper flow in the position indicated normally goes with a building ridge to the east and south-east and is covered by the diffluent ridge pattern of development described by Sutcliffe and Forsdyke.[3] With a predominantly south-westerly flow some progression normally occurs, enabling the ridge to move towards the British Isles. But if an upper trough is between 0° and 15°W developments might spread into south-east England ahead of the ridge. On the other hand if retrogression occurs any trough between 0° and 5°E might bring rain into south-east England. Therefore in proviso (*b*) page 130 all cases with troughs between 5°E and 15°W are excluded (see example of retrogression in Figure 5).

Comments on the criteria.—A few more comments on the criteria seem appropriate.

(i) The exclusion of cases of strong north-westerly flow *upstream* from the south-westerly (proviso (*a*) page 130) is a safeguard against a north-westerly jet causing some development of the upper trough between the two strong flows. This is really covered by the initial statement that "The *strongest* 500 mb flow..." but cases of equally strong north-westerly flow *downstream* are not so important except in cases of retrogression which are discussed in paragraph (iii) page 133.

(ii) The limits of the area of the strong flow are very critical and should not be exceeded. For example a strong flow covering the whole area between 50°N and 60°N with its core at 55°N and from a direction near 270° is a very marginal case (see Figure 4). This type of flow results in weak fronts crossing south-east England but giving only a trace of rain. Any extension of the flow further south or east, however, results in measurable rain so the forecaster should not be tempted to include cases when the flow is centred, say, at 54°N 20°W or 55°N 19°W.

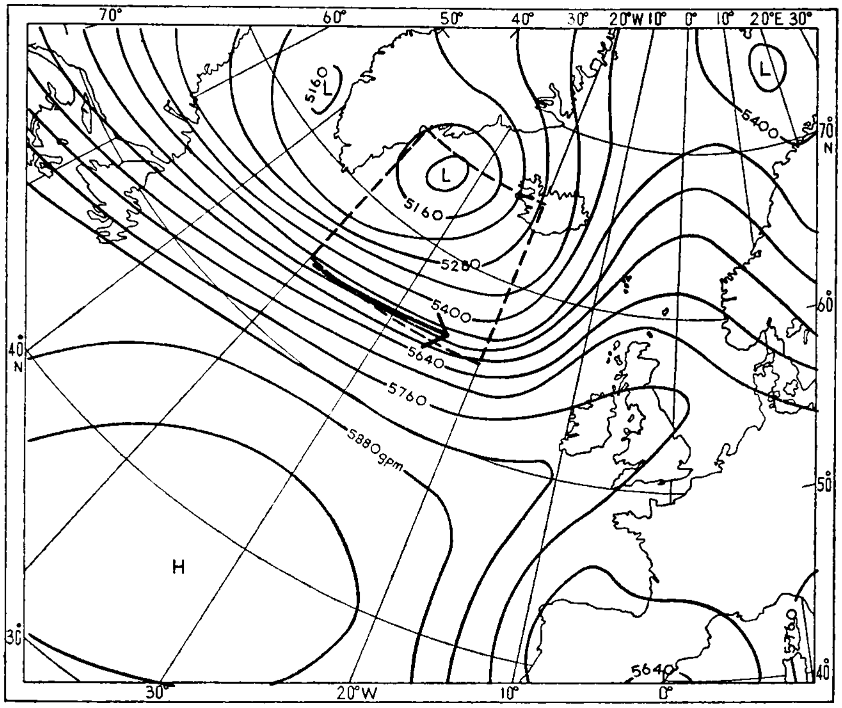

FIGURE 4—MARGINAL CASE FOR A FINE SPELL, 500 MB CONTOUR CHART, 0000 GMT, 13 SEPTEMBER 1963

— — — — — Boundary of defined area. Contours are in metres.
The strongest flow, indicated by an arrow, is along the southern edge of the defined area.

(iii) Discretion is needed in cases of flow near 40°W from a direction about 180°. In these cases the long-wave pattern is probably becoming more meridional and shortening: any north-westerly upper flow over the British Isles will probably veer northerly while troughs not far away from the east coast will tend to move westwards. Figure 5 shows an example of this type of situation. It was followed by retrogression of the trough near East Anglia and no fine spell. This type is the reason for excluding occasions with a trough between 0° and 5°E. If the 500 mb pattern is clearly progressive, examples with a trough between 0° and 5°E need not be excluded.

(iv) If there is a weak trough over the British Isles and the 500 mb pattern is progressive, it is necessary to wait for the trough to clear the country before issuing a fine-spell notification. One must also re-check the flow pattern to ensure the criteria are still met at this stage. This type is more often associated with an upper flow veered from 180° and a longer wavelength than the cases in paragraph (iii).

(v) Closed 500 mb vortices near the British Isles and over France and Biscay are extreme examples of short wavelength and are often the result of retrogressive or block processes. They must be excluded. There is, however, scope

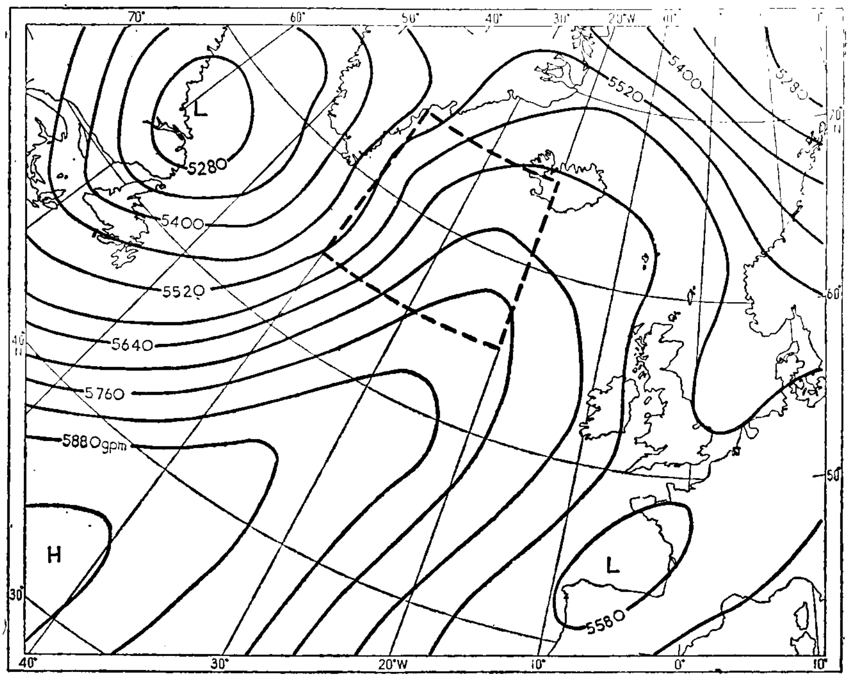

FIGURE 5—500 MB CONTOUR CHART NOT ASSOCIATED WITH A FINE SPELL, 0000 GMT, 19 MAY 1959

— — — — Boundary of defined area. Contours are in metres.
Later the trough moved further west into south-east England. (Contrast with Figure 2.)

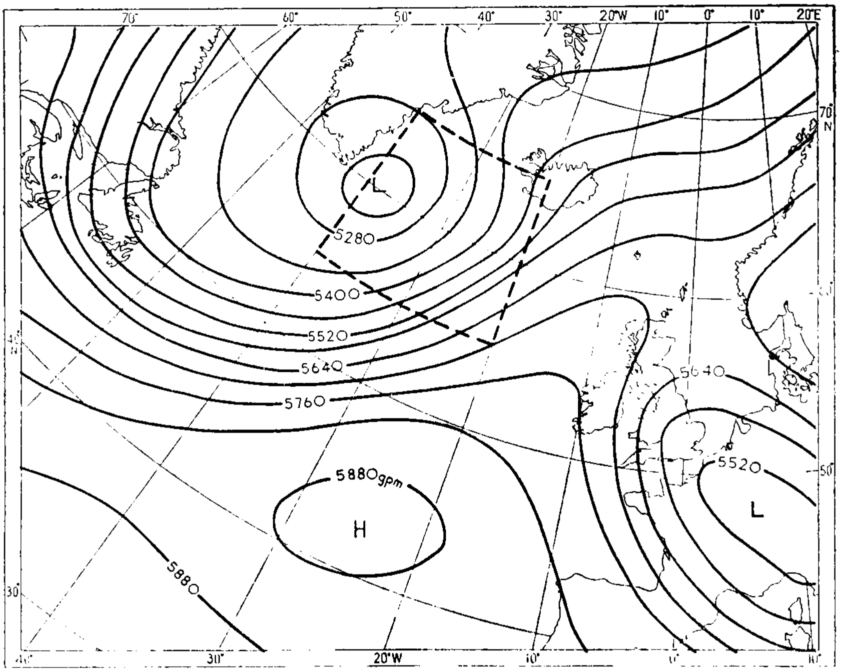

FIGURE 6—500 MB CONTOUR CHART NOT ASSOCIATED WITH A FINE SPELL, 0300 GMT, 9 JUNE 1956

— — — — Boundary of defined area. Contours are in metres.
Trough over south-east England with north-easterly winds.

for discretion in the exact limits in the positions of such vortices which merit exclusion. Cases with a 500 mb vortex over Switzerland, for example, with a trough extending back to south-east England giving north-easterly winds should be excluded (see Figure 6). On the other hand, with a weak vortex near Ocean Weather Station Kilo (45°N 16°W), issue of a fine-spell notification is justified provided the other conditions are met.

(vi) There is evidence that if there is a strong south-south-west flow near the south-west corner of the defined area (i.e. between 55°N and 65°N, and 20°W and 40°W), it is an advantage to have an equally strong or stronger flow upstream from about the same direction or only a little veered (see Figure 7). This pattern usually goes with an upper trough in approximately the Lowndes position and includes many of the cases when the two criteria overlap.

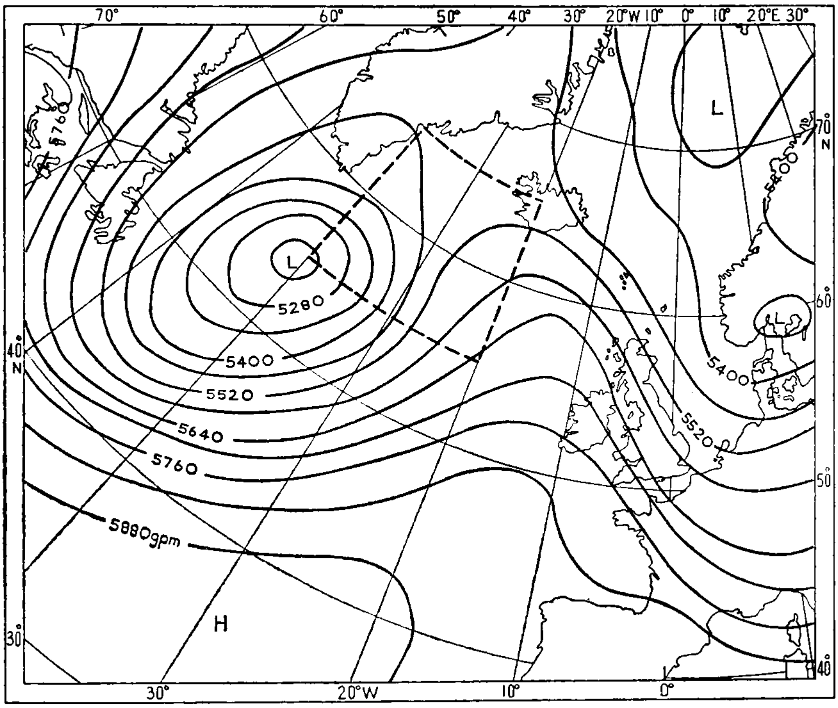

FIGURE 7—500 MB CONTOUR CHART ASSOCIATED WITH FINE SPELL, 0000 GMT, 21 SEPTEMBER 1964

— — — — Boundary of defined area. Contours are in metres.
A transition type between the 'Lowndes' model and the new model.

(vii) There are only a few occasions when the new criteria are satisfied and no fine spell occurs (see Table II on page 000). This suggests that when the criteria have occurred for several days during a fine spell *and then fail to appear*, the fine spell is likely to end within 3 days. This is only a tentative suggestion as there are cases during a spell when the criteria are not satisfied for a few days and then occur again without a break in the fine spell.

Additional tests of the criteria.—It has been shown that the new criteria can forecast a number of the fine spells which occur in south-east England. It is necessary also to show that the criteria do not occur on many occasions when there is not a fine spell. With this end in view all cases when the criteria were satisfied in the years 1957–64 inclusive were examined and tested to see whether or not they were associated with fine spells. Results are shown in Table II.

TABLE II—ANALYSIS OF FORECASTS OF FINE SPELLS 1957–64

Year	Number of days on which criteria are satisfied		Comments on failures
	with success*	with failure	
1957	26	3	26 Sept.—Followed by 2½ dry days 25 Oct.—Last day of spell, criteria barely satisfied 28 Oct.—Strong flow from 260° between 50°/60°N
1958	17	1	18 Oct.—Followed by 2 dry days
1959	46	3	24 Sept.—Fine spell followed after 3 days—criteria hardly satisfied 23 Oct.—Followed by 2 dry days 31 Oct.—Dry for 2½ days
1960	17	0	
1961	26	2	7 July—Dry except for 0.1 mm at Kew 20 Aug.—Criteria barely met (NW flow upstream equally strong)
1962	30	3	13 May—Last 2 days of a spell 14 May—Trough just east of 5°E 9 Aug.—Definite failure—strong diffluence in flow from 260° centred 55°N 40°W
1963	28	4	20 and 21 Sept.—Last 2 days of a spell 6 and 14 Oct.—Spell followed after 3 days—criteria barely satisfied
1964	24	2	1 July—0.1 mm at Kew on 3rd day 27 Oct.—Failure—trough and NE'ly flow over south-east England
Totals	214	18	Only 4 total failures

*Criteria were applied to the 0000 GMT chart (0300 GMT before 1 April 1957) for all days and were deemed to be satisfied with success if followed within 2 days by a spell as defined in the text.

There are very few cases of failure and some of these are not total failures. Six of the 18 cases of failure were followed by 2 or 2½ dry days while 8 others occurred either on the last 2 days of a spell or 3 days before a spell began.

As a further check the criteria were tested on the independent data of 1953–56 (4 years), with the results shown in Tables III and IV.

TABLE III—ANALYSIS OF FORECASTS OF FINE SPELLS IN TEST PERIOD 1953–56

Year	Number of days on which criteria are satisfied		Comments on failures
	with success*	with failure	
1953	16	2	28 May—2½ dry days 21 Oct.—Last day of spell
1954	14	3	3 June—2½ dry days 29 Sept.—2½ dry days 8 Oct.—2½ days before a spell began
1955	33	5	9 and 10 July—Rain on the 11th at Kew only 10 and 29 Sept.—Small amounts of rain on second and third days 28 Sept.—Small amounts on one day at Kew only
1956	17	7	27 May—2½ dry days 31 May—0.1 mm at Heathrow on the 3rd day 10 June—Criteria hardly satisfied—flow centred 60°N 20°W 20 and 21 June—Spell 20–27 June except 0.3 mm at Heathrow on the 22nd 26 and 27 Oct.—Dry on the 26th, 27th and 29th; some rain on the 28th
Totals	80	17	

*Criteria were applied to the 0000 GMT chart (0300 GMT before 1 April 1957) for all days and were deemed to be satisfied with success if followed within 2 days by a spell as defined in the text.

TABLE IV—RESULTS OF NEW CRITERIA OVER TEST PERIOD 1953–56

Year	1953	1954	1955	1956	All years
Number of fine spells observed	11	11	14	11	47
forecast	6	6	8	6	26

Conclusions.—It is shown that it is possible to forecast about half of the fine spells which occur in south-east England by considering the 500 mb flow in the area 55°N to 65°N and 20°W to 40°W.

If this flow is south-westerly and is the strongest in the Atlantic area, then, with certain restrictive conditions, a fine spell can be forecast with a fair amount of confidence for south-east England during the months May to October inclusive.

Taken in conjunction with cases of fine spells of the Lowndes type and also blocking patterns, the three types of synoptic situation together occur with about 75 per cent of all fine spells in south-east England.

Acknowledgement.—The author is grateful to Mr. V. R. Coles, Assistant Director (Central Forecasting), for his helpful advice and criticism during the preparation of this paper.

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IMPROVEMENT OF RAIN-GAUGE NETWORKS

By A. BLEASDALE

Introduction.—In terms of profusion and widespread distribution of stations, rain-gauge networks throughout the world provide outstanding examples of observational networks supplying data on a regular scheduled basis. Yet, on the whole, these networks have hitherto developed in a rather haphazard manner. There are great variations and irregularities in the densities of stations, and at one end of the scale these may locally, and even regionally, reach the proportions of gross deficiencies.

International planning.—In recent years attention has been directed increasingly towards the need for the planned development and improvement of meteorological and hydrological networks in general, and of rain-gauge networks in particular. Internationally, the design or strengthening of networks has been discussed under major agenda items at a number of important meetings. These include the first session of the World Meteorological Organization (WMO) Commission for Hydrological Meteorology, Washington, April 1961,[1] the second session of the same Commission, renamed the Commission for Hydrometeorology, Warsaw, September–October 1964,[2] and the series of meetings held at UNESCO House, Paris, in 1962, 1963 and 1964, to prepare the programme for the International Hydrological Decade, 1965 to 1974.[3] Guidance material on networks prepared by Working Groups established by the

WMO Commission, both in Washington and Warsaw, will be of great importance in connexion with some of the fundamental work to be carried out as part of the programme of the International Hydrological Decade, especially under the two headings of 'basic-data collection,' and 'representative and experimental basins.'

A further substantial contribution to the discussions at international level is being organized jointly by WMO and the International Association of Scientific Hydrology. This will be in the form of an International Symposium on the Design of Hydrometeorological Networks, to take place in Quebec City during June 1965. Preparations for the Symposium offer a suitable opportunity for reviewing the factors which are, in effect, enforcing a fresh appraisal of the problems of network design, and the requirements which must be met before general principles of design can in fact be put widely into practice.

Developments in the United Kingdom.—Nationally, in the United Kingdom, the most important recent developments which have helped to focus attention on networks, in particular rain-gauge networks, have been as follows:—

(i) *Basic data; countrywide networks.*—

(*a*) *For England and Wales,* the Water Resources Act of 1963, with some of the preparatory reports and other material leading up to it.

Before the Act came into force many aspects of drainage and river management, but not so much water conservation, had been the responsibility of the river boards, covering virtually the whole of England and Wales, which had been set up by the River Boards Act of 1948. From 1 April 1965, the river boards were replaced by river authorities. The functions of the new authorities relate fully to water conservation as well as river management and are not simply a transfer and continuation of the functions of the river boards but a significant extension and reinforcement of previous reponsibilities. A central authority has also been established in the form of the Water Resources Board, "charged with the duty of advising river authorities with respect to the performance of their new functions."[4] In the present context it is of particular interest to note the strengthening of the *statutory* obligations, taken over by the river authorities, to prepare and put into operation hydrometric schemes for the collection of basic data, including rainfall and now even evaporation among other elements.[5]

(*b*) *For Scotland,* special consideration, started by the Advisory Committee for Meteorology in Scotland, of the problem of improving rain-gauge networks in the more difficult parts of the country.

(*c*) *For Northern Ireland,* general improvement of climatological and rain-gauge networks, initiated several years ago, but furthered especially by the opening of Meteorological Office, Belfast, in 1960, and by the activities of the Committee on Water Resources in Northern Ireland, since it was set up in 1961.[6]

(ii) *Experimental areas.*—The establishment in 1961 of the Committee on Hydrological Research, and under this Committee, in 1962, of the Hydrological Research Unit, has stimulated experimental work, by the Unit and by other organizations, and has thereby provoked increased attention to the planning of networks for experimental areas. A particular aspect of very special interest is the problem of providing dense networks in difficult terrain within which, because of topography, afforestation or other causes, there are few, if any, conventionally satisfactory observational sites. The Water Resources Act is important for this item too. Under the heading "Financial Provisions," specific mention is made of contributions by the Water Resources Board towards the cost of experimental work carried out by river authorities.[7] To a limited extent some of the former river boards had already established experimental areas, even without this form of central support.

(iii) *Networks for special purposes, notably flood warning systems.*—In line with the generally increased interest in hydrological forecasting on the international scale, there has been an increase of activity in the United Kingdom with regard to flood warning systems, especially since the very wet autumn and winter of 1960–61. These schemes were developed for many areas in England and Wales by the engineers of the former river boards and will be continued and further developed under the new river authorities.

(iv) *The British Committee for the International Hydrological Decade.*—This Committee, set up in 1963, had prepared, by the end of 1964, a British programme for the Decade which to a large extent overlaps with, and is intended to stimulate, activities under items (i) and (ii) above.

Rain-gauge networks.—The haphazard development of rain-gauge networks in the past has been determined very largely by two factors:

(i) There is a need to find satisfactory sites where rainfall measurements will not be subject to systematic errors due, for instance, to over-exposure of the instruments to strong winds, over-shelter by nearby obstructions, or locally peculiar rainfall distributions caused by persistent eddies in the immediate neighbourhood. The conventionally good rain-gauge site is usually supposed to be representative for a fairly large area, and is not intended to provide information about local peculiarities. But in certain types of terrain strict observance of the conventions imposes a bias on rainfall sampling which can leave substantial gaps in the network and in knowledge of rainfall distributions.

(ii) There is also a need to find good observers, often voluntary, living or working within fairly easy reach of all selected sites. The existence of recording rain-gauges in a great variety of types, has not so far provided any widely practicable alternative to the need for local observers, though many investigators in the field, approaching rainfall work for the first time, assume that a suitable automatic recorder must have been devised long ago. In fact most if not all recording rain-gauges which have so far been produced require much more attention than the simple standard gauge used for daily readings. Recording rain-gauges at present available are not, in general, fully automatic gauges which can be left unattended for days, weeks or months at a time, to function satisfactorily without frequent servicing, and to record all the detailed information which may be needed.

Instruments and techniques for measurement.—The demands for improved rain-gauge networks, based on sound principles of network design and no longer overwhelmingly influenced by accidental circumstances, are becoming ever more insistent as a result of the recent developments outlined. In order that the demands may be met, in any full sense, there is a need to solve the two major problems implied in the above discussion of the limitations which have been imposed, up to now, by site and observer requirements; the two developments envisaged are:

(i) Techniques of rainfall measurement and instruments will need to be developed to the point where it will become possible to measure rainfall fairly accurately over a wide variety of sites other than conventionally acceptable sites which now predominate with relatively slight variations and departures from orthodox standards. In particular, there are investigations of undoubted importance requiring the measurement of rainfall in wind-swept localities, on steep slopes, including those which face the prevailing rain-bearing winds, and at points well removed from the immediate neighbourhood of the ground, especially above canopy level in forests.

(ii) Fully automatic rain-gauges will need to be developed, primarily with the object of obtaining instruments which can be left alone on remote sites for long periods, storing rainfall data with any degree of detail which may be required. Once such an instrument has been successfully produced it is likely to be used in fairly large numbers in sparsely populated areas. But it may also have an application in other areas as an alternative to earlier types of rain recorder. These usually record in ink on paper charts, producing a form of trace which is very tedious to analyse and tabulate with all the detail which may be of interest. The new instrument would therefore be doubly satisfactory if it could take the form of a fully automatic recorder, which would operate with the minimum of servicing and attention and record the data, probably most conveniently on magnetic tape, in such a way that the information could be either directly dealt with by a computer, or readily converted for computer input.

Problems of flood warning schemes.—The use of rainfall data in connexion with flood warning schemes raises problems of a rather different kind which merit special discussion. A meteorological service can offer information of two kinds to assist in such work:

(i) An assessment of the condition of a drainage area, which will indicate the degree to which a flood risk exists. One useful way of doing this is to estimate the areal soil moisture deficit at fairly regular intervals and keep account of the decrease of the deficit under the influence of autumnal and winter rain; or, when appropriate, to estimate the water equivalent of snow lying and the degree to which this represents a danger in the event of a rapid thaw.

(ii) An assessment of precipitation or, where appropriate, of the rate of melting snow (possibly, in some cases, both).

To meet the first of these requirements, the Meteorological Office has issued, for some time past, a series of maps of estimated soil moisture deficits or, in early 1963, of the water equivalent of snow lying. Although these maps are on a very small scale and capable of substantial improvement when resources permit, their value has been clearly demonstrated through a range of conditions, and the desire for a continuation of this service has been emphatically expressed by river authority engineers and others who make use of it.

To obtain the maximum benefit from the information, however, it must be complemented by information of the second kind. Ideally this should take the form of reliable quantitative forecasts, so that the effect of meteorological conditions on river flows could always be foreseen well in advance. Partly to this end, research on the quantitative forecasting of rainfall is now being intensified.

In the meantime, confining attention to rainfall and omitting, at present, occasions of melting snow, the next best method of providing the necessary information is to arrange for the very rapid transmission of actual rainfall observations to a suitable centre established for flood warning purposes. Various arrangements have been made to achieve this end, and even now the services of voluntary observers who are often willing to make readings for little or no reward at any time of day or night are by no means negligible. But a serious difficulty is that, as with rain-gauge networks in general, a significant proportion of the rainfall readings should come from as far upstream as possible, from the hills where the main stream and its tributaries rise. In such country it is often difficult to find observers suitably situated and therefore, for this purpose also, some form of automatic instrument is an urgent requirement.

In this case, however, the instrument should be designed primarily with the object, not of storing the rainfall information in considerable detail for all periods of rainfall, light, moderate or heavy, but of transmitting in some way, as soon as possible, the significant recent information during periods of heavy rain.

Necessary development work.—Underlying current discussion of rain-gauge networks, there are therefore at least three contributory topics concerned with fields of investigations in which satisfactory results must be obtained before general principles of network design can be widely applied in any realistic sense:

(i) Development of methods of measuring rainfall within acceptable limits of accuracy on a wide variety of sites which at present are usually regarded as unsuitable for conventional rain-gauges.

(ii) Development of a fully automatic rain-gauge which unattended will store rainfall data over long periods in a form which can later be analysed with any required degree of detail by computer.

(iii) Development of an automatic rain-gauge which will be capable of transmitting recent information, especially about heavy rain, to an appropriate centre established for the operation of a flood-warning scheme.

All three items are currently receiving attention in the Meteorological Office, and, in particular, promising stages have already been reached with automatic instruments.

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NEW METEOROLOGICAL OFFICE RAIN-GAUGES

By A. L. MAIDENS

Interest in the measurement of rainfall is of a very long standing and has led to the design of a great variety of rain-gauges. By far the larger number of these designs have not been followed by repetitive manufacture or accepted in recognized networks of rainfall observing stations, but even so the diversity of types in regular use is considerable. Variations in the rain-gauges employed are found not only between one meteorological service and another, but also within a single service, the Meteorological Office itself currently finding it necessary to employ eight differing types to meet its various requirements.

The meteorologically most significant features of any rain-gauge are the area over which the sample of rainfall is collected, the height above ground of the rim defining this area and the outside shape of those parts of the rain-gauge which may extend above ground level. Any variations in these features will affect the aerodynamics and hence the sampling qualities of the gauge and may lead to inconsistencies in the comparative accuracy of measurement between the differing gauges. A single universal design for at least the upper part of the rain-gauge has obvious merit, but this is not easy to achieve when other important factors are considerd. A major consideration is that while a gauge of large collecting area is essential when the recording of small increments of rainfall is desired, the larger the gauge the more expensive it is to construct. In consequence, the large gauge, although justified for certain applications, cannot be used as widely as may be desired and a smaller variant is thus unavoidable.

Whatever the dimensions chosen for the gauge, precautions must be taken against gains or losses of water by splashing, flooding or evaporation and against possible damage or loss of observations during periods of frost.

The standard forms of rain-gauges in universal use can be considered in three classes: (i) those which store the collected rainfall sample for short periods, (ii) those with specially enlarged storage capacity for operation over weekly or longer intervals, and (iii) those which record the rainfall at the time of occurrence.

The gauges of each class in current use by the Meteorological Office are constructed principally of sheet copper, the casings of each type being specifically designed to house one particular form of storage capacity or recording mechanism, with little or no tolerance for variations. The use of copper is itself far from ideal. It is a material of steadily increasing cost and its high thermal conductivity leads to increased internal temperatures by day, with consequential evaporation losses, and to the deposition of dew by night. Any internal heating is rapidly dissipated. During the life of the gauge the surface finish varies from a high polish, with low radiation absorption and rapid run-off of water over the internal surfaces, to a dull matt appearance of markedly deteriorating characteristics.

The conservation of water resources as a major problem on both national and world-wide scales has led to renewed and extended interest in assessing rainfall distribution in great detail. The vast volume of rainfall measurements necessary to provide the desired density of observations can be achieved only by the employment of all possible aid from modern methods of recording and data handling, in certain cases associated with the immediate transmission of information over considerable distances.

The variety of rain-gauges necessary to provide these facilities could well add considerably to the current diversity of design, should each new requirement be treated individually. It is therefore opportune to review the whole range of current and potential rainfall measurements, to ascertain whether these may be met by a very limited number of designs which, while conserving the essential meteorological and aerodynamic similarity as to outside profile, will allow the greatest possible flexibility as to the methods for measuring, recording and transmitting the measurements.

The Meteorological Office has now completed such a study and has designed a range of components from which a variety of differing assemblies can be made to meet all foreseen requirements. This rain-gauge 'system,' which has still to be manufactured in quantity and assessed in field trials, is believed to be unique.

The casing of the complete rain-gauge assembly is made up of two components, the upper of which forms the whole above-ground profile of the gauge and thus is the more critical in regard to comparative measurements. This component includes the rim, funnel and an outer skirt. Economic considerations have dictated that two sizes shall be available, the larger, providing a catchment area of 750 cm^2, being employed when the highest accuracy is justified, the smaller, of an area of 150 cm^2, being a considerably cheaper variant primarily for widespread use for 12-hour or daily totals. The corresponding diameters of the two gauges are 12.2 and 5.5 inches respectively. Both upper components have in common a rim height of 30 cm above ground level, and an identical diameter at the lower skirt. The material to be used for this part of the rain-gauge has not been finally decided, but could well be fibreglass or plastic-coated metal.

Either size of catchment may be used with a single form of tipping-bucket mechanism, which is attached direct to the outlet pipe of the rain-gauge funnel. When used with the larger of the two catchment areas, an electrical impulse is obtained for each rainfall increment of 0.2 mm. With the smaller, the increments are of 1 mm.

Two forms of the base for the rain-gauge will also be available, either base being usable with either upper component. The smaller base will be cylindrical and will provide a housing for a commercial 2-litre bottle. Used with the catchment area of 150 cm^2, this will provide storage for the equivalent of 133 mm of rainfall. Any excess up to about 4 litres (270 mm rainfall equivalent) will be retained for measurement in the base itself, which will be mounted for easy removal within a buried section of iron or earthenware pipe. This base may also be employed merely to position the rain-gauge when used with the tipping-bucket mechanism alone, without any storage bottle.

The larger base is in the form of a substantial rectangular box with removable lid. For one application this is intended to house a large inner tank, probably of plastic, the assembly being used with the smaller catchment area as a long-term collecting gauge. In this event the quantity of rainfall will be determined by weighing the tank complete. Alternatively, it may contain recording or telemetry equipment, applicable to unattended rain-gauges in remote locations. In this application the size of funnel employed is chosen in relation to the rainfall increments desired.

In both sizes of base, provision will be made for the drainage of water passing through the tipping-bucket mechanism and for the exit of the cables for distant reading. The choice of material for this part of the rain-gauge is not critical, providing it is sufficiently strong and free from corrosion.

To provide uniform conditions in regard to the splashing of rain from ground level, the gauge will be provided with a corrugated rubber mat which will cover the lid of the larger base and any ground which may have been disturbed. For use where long-term unattended recordings are required, a magnetic tape recorder is being developed. This is housed in the larger base and will provide records of up to three months' rainfall, the tape subsequently being processed centrally by a special translator unit. Various forms of telemetry, for interchangeable employment, are being developed.

A standard form of low-voltage operated heater and thermostat will be provided to avoid frost damage or freezing of the working mechanism. It should be understood, however, that the gauge is not intended for the measurement of melted snow, nor would the heat supplied be sufficient to melt it for this purpose, except in the event of light falls.

It cannot be emphasized too strongly that none of the components described above are as yet in regular production. One form of telemetry and a tipping-bucket mechanism has been manufactured in small quantities for trial use with standard Meteorological Office 5-inch rain-gauges and, if successful, can be applied to the new system with little or no change. These two components are described in greater detail in the following article.

551.508.77:621.398

TELEPHONE INTERROGATION OF RAIN-GAUGES

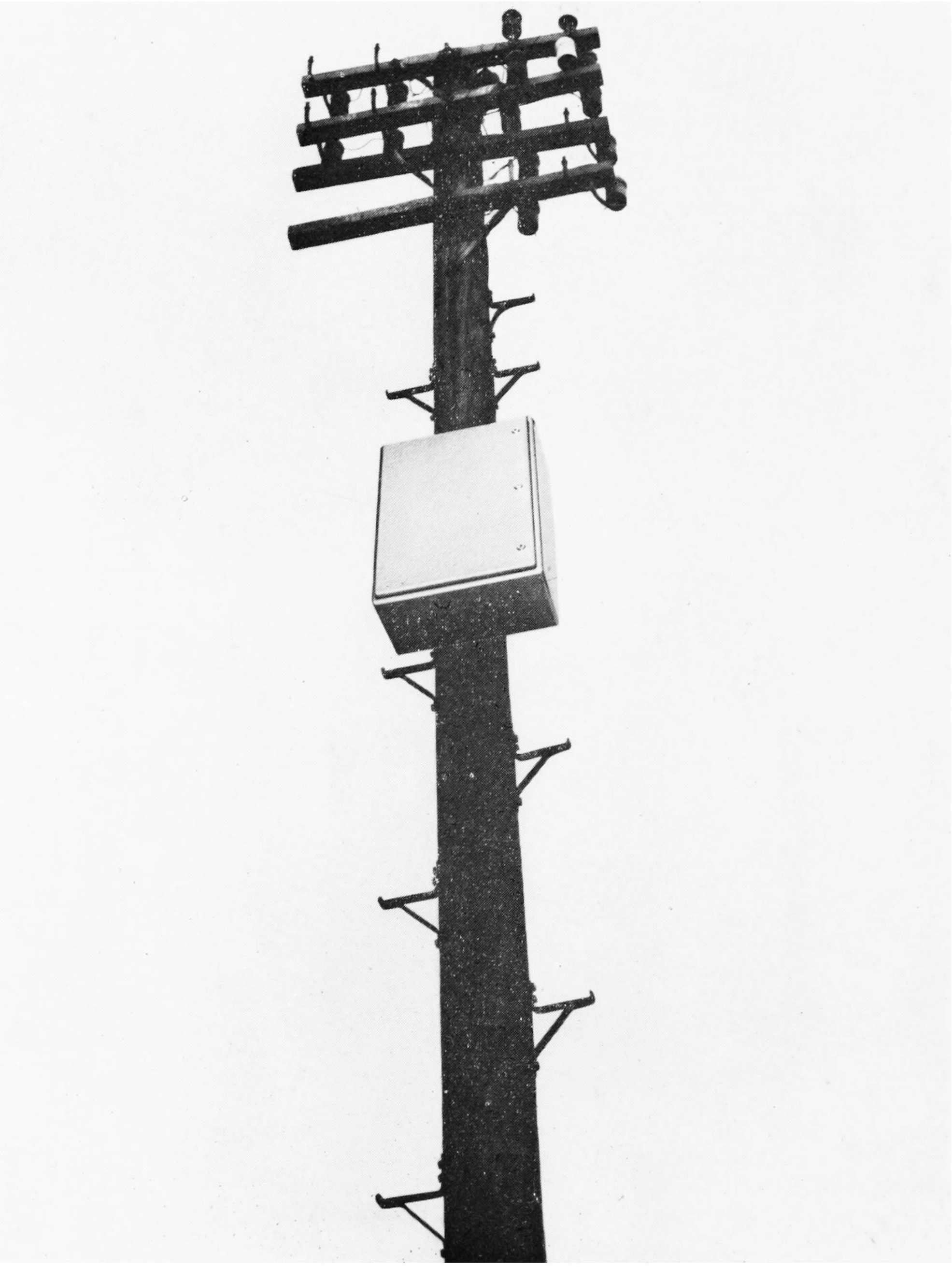
By C. E. GOODISON and L. G. BIRD

A comprehensive system for the measurement of rainfall requires that readings should be readily available from remote areas. Facilities are therefore required for telemetry over long distances using for instance a public telephone network. Such equipment has now been developed by the Meteorological Office and is in commercial production. At present the design is associated with a standard Meteorological Office 5-inch rain-gauge into which is built a tipping bucket which measures increments of 1 mm of rainfall. Only slight modifications would be necessary to adapt the design to other sizes of collecting funnels.

Crown copyright

PLATE I—PRE-PRODUCTION MODEL OF TELEMETER

See page 146.



Crown copyright

PLATE II—TYPICAL INSTALLATION OF RAIN-GAUGE TELEMETER
See page 147.

Crown copyright

PLATE III—HONG KONG'S ROYAL OBSERVATORY AS IT IS TODAY CONTRASTING AGAINST THE NEW BLOCK OF FLATS IN URBAN KOWLOON

(Official photograph issued by Government Information Services, Hong Kong.)

Crown copyright

PLATE IV—TYPHOON WARNING SIGNAL BEING HOISTED IN THE OBSERVATORY GROUNDS IN HONG KONG

Visual signals at 34 designated points around the Colony indicate the probable strength of a typhoon, the direction and proximity to Hong Kong. The particular signal being hoisted here is the Number Ten symbol, used to denote hurricane force winds. (Official photograph issued by Government Information Services, Hong Kong.)

The problem of measuring rainfall, as with any other accumulating quantity, is to decide whether the measurement should be made in terms of small increments (requiring a digital measuring system) or whether the sample should be stored and continuously measured as it is collected (requiring an analogue measuring system). The disadvantage of the continuous measurement method is that it must be interrupted when the storage capacity reaches its limit.

The tilting-siphon rain recorder is an example of the analogue measuring system and is inconvenient for telemetry applications because transmission of analogue information is more liable to errors than transmission of digital information. Rainfall measurement produced by the long-established tilting-siphon rain-recorder cannot conveniently be converted to electrical impulses. The Instrument Development Branch have therefore designed a tipping-bucket method, in which the quantity needed to tip the bucket is itself small and the measurement can be made in terms of the number of completely filled bucket units.

A dry-reed relay switch is used to sense each movement of the bucket. The dry-reed relay consists of two leaves of springy ferrous metal with plated contacts of precious metal. These leaves are sealed in a small glass tube filled with an inert gas. When the leaves are brought within the influence of a magnetic field, north and south poles are induced in the two separate leaves and they are brought smartly together. Removal of the magnetic field allows the contacts to open. The hermetic sealing of these relays ensures that the contact surfaces have almost unlimited life and a normal reed relay operated at its specified current load will have a life of 100 million closures.

The reliability of the magnetically-operated relay used in conjuction with the tipping-bucket gauge is much better than the reliability of the mercury switches which were previously used, and in addition the load on the tipping mechanism is much reduced.

With this tipping-bucket unit, the total rainfall is represented by the number of electrical impulses received. These may be translated by the use of a counter to provide a very simple distant-reading device as might be used between an instrument enclosure and a meteorological observing office.

The same type of rain-gauge may be used as the input to a telemetry equipment which may be interrogated by telephone as frequently as desired. The automatic gauge is provided with a telephone connexion which is allocated a 'private subscriber's' number. This number is dialled from an 'operations room' as if an ordinary telephone call were being made. The amount of rain collected since the counting mechanism of the gauge was set to zero is then transmitted in increments of 1 mm by three groups of audible tones, the groups representing hundreds, tens and units. The number of tones in the appropriate group gives the number of hundreds, tens or units. When the gauge is next interrogated, say after an interval of three hours, a simple subtraction gives the amount of rain that has fallen during the period.

Rates of rainfall may be deduced by careful choice of the frequency of interrogation and the duration of rainfall may be determined to within close limits. The gauge could be one of a network sited in the catchment area of a river.

Description of equipment.—The rain collector is a 5-inch rain-gauge in which the rain is made to operate a tipping bucket as shown in Figure 1. With the bucket in the position shown, rain falls from the funnel into compartment A until the bucket overbalances and takes up the position shown by the broken outline. As the bucket moves, the magnet B passes close to the reed switch C and causes the switch contacts to close briefly. The contacts are released as the magnet moves to D. Rain then falls in the compartment E until the bucket tips and returns to the initial position. The brief closure of the switch contacts is sufficient to operate the counting and storing relays described below, the bucket of the rain-gauge tipping once for every millimetre of rain collected.

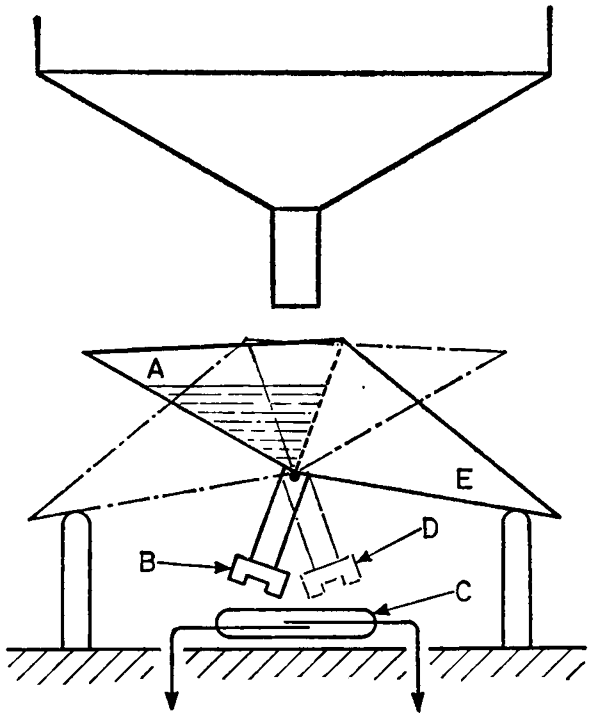


FIGURE 1—TIPPING-BUCKET RAIN-GAUGE

A and E are compartments of the bucket. The magnet B moves to position D when compartment A is full of rain and tips. C is the reed switch.

The first model of the telemeter was purely mechanical and was based on a design by E. Betz.[1] This design functioned well during initial trials but was considered unnecessarily complex for large-scale manufacture. An electro-mechanical version using standard components was developed by the Instrument Development Branch and tested over a period of six months. From this prototype six pre-production models were made under contract.

The telemeter consists of three parts; a unit for counting and storing the number of tips made by the rain-collecting bucket of the rain-gauge, a transmitter for converting the number of tips of the bucket into a number of tones in the three groups, and a station identifying and answering device (see Plate I). This last is a mandatory component whenever unattended equipment is attached to a British GPO subscriber telephone.

The counting unit consists of three relays of a special design, each counting in decades. The operation of these relays depends on the magnetic phenomenon known as remanence. With all types of magnetic materials a small amount of magnetism is left whenever they are taken through a magnetizing cycle. In these relays the remanent magnetism is enough to hold on the contact pieces when these are brought into contact with the relay core.

There are 10 contacts in each relay and, by an ingenious arrangement of springs whereby only one contact at a time is held on, the contacts are made and broken in successsion. This means that when four pulses are received, then the fourth contact only will be made. If three further pulses are then added to the first four then only the seventh contact is made. This type of relay is obviously, then, an adding and storing device. When the tenth contact is reached in the 'units' relay it is made to pass a pulse to the 'tens' relay, at the same time restoring the 'units' relay to zero. When the tenth contact is reached in the 'tens' relay a pulse is passed to the 'hundreds' relay. When a total of 999 pulses has been stored the next pulse received from the rain-gauge bucket restores all the relays to zero and the counting cycle recommences.

The transmitter is basically a British Post Office type uniselector actuated by a relay and capacitor arrangement which, when scanning, allows each contact to be made in the uniselector for about half a second. As each counter relay is scanned an oscillator provides a tone lasting half a second at each position of the uniselector. Thus, if in the 'units' counter relay seven bucket tips are stored, seven short tones are passed down the telephone line. The fast switching required to operate the audio-frequency oscillator is achieved by using a trigger-controlled transistor bistable.*

The station identification unit senses the ringing tones of an interrogating call and initiates transmission of a short pre-recorded verbal identification message. This is followed by three groups of tones.

The counter store may be interrogated any number of times and the whole equipment is approved for use over the British GPO speech telephone lines. The equipment is housed in a strong, weather-proof metal box which may be easily attached to a pole or other support near the rain-gauge (see Plate II). Three months' operation should be achieved by the dry battery pack incorporated.

Other applications for the counter and telemeter parts of the system are under consideration by the Meteorological Office and by some potential industrial users. One device, under consideration by the Instrument Development Branch, will initiate a warning whenever a preset amount of rainfall has been received during a fixed period of time.

REFERENCE

1. BETZ, E.; A telemeter for use with telecommunications networks. *Aust. J. Instrum. Technol., Melbourne*, **17**, 1961, p. 75.

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*A bistable is a circuit which has two stable states.

551.501.45:551.524.36

ANNUAL MINIMUM AND ANNUAL MAXIMUM TEMPERATURES

By L. P. SMITH

Introduction.—Knowledge of the lowest air temperatures likely to be experienced during the year is required for such problems as the calculation of the heating needs of buildings and knowledge of the highest temperatures is used for example in the calculation of ventilation requirements. This article analyses the available data of the annual temperatures.

Data.—Over a hundred stations in Great Britain are available with records of 30–60 years during the present century. No attempt has been made to reduce these to a common period and it must be remembered that the winters of the first 40 years of this century were generally mild. Therefore the stations with the shorter period of observation, say 1920–60, are likely to indicate lower median values of annual minima than those with the full 60 years. The difference, however, is likely to be small.

Method of analysis.—

Annual minimum temperatures.—Because the range of annual minima is large and there is no obvious mode it is not easy to find a satisfactory simple method of analysis. For ease of extraction it was decided to record the median values and also the value which was only exceeded (in that temperatures were lower) 1 year in 5 (boundary of lower quintile).

Annual maximum temperatures.—Again to facilitate extraction the median values were recorded and also the boundaries of the upper and lower quintiles.

Table I gives the statistics arranged under county headings in alphabetical order. The station heights are shown and the number of years of data as well as the lowest and highest values of the annual minima and maxima, the median values and the root mean square of the variation from the median. Quintile values are given in columns headed 'seldom below' and 'seldom above.'

Discussion of the data.—Despite the simple method of treatment, certain interesting facts emerge from the minimum temperature data. The stations fall into four main groups—coastal, urban, country and hill stations. The coastal medians show considerable uniformity. In the south-west along the coast between Anglesey and Portland, the values lie chiefly within the range 27–29°F; elsewhere most coastal stations show values between 23° and 25°F. The urban stations are generally warmer than the surrounding countryside, for example Westminster, Birmingham, Sheffield and Manchester all have a median value of either 22° or 23°F. The country stations range between 15° and 20°F with the coldest areas in the east Midlands, Kent, Salisbury Plain and around Shrewsbury. The few hill stations in England and Wales, for example Buxton and Rhayader, have medians chiefly around 13–14°F and in Scotland the medians may be below 10°F (Braemar 3°F, Balmoral 6°F). If the figures are plotted on a map this gives a good general picture of the distribution of the median values but it is inadvisable to draw isopleths to represent the data as minimum temperatures are essentially a local phenomenon.

If the median values of the maximum temperatures are plotted then the isotherm for 85°F includes all stations within an approximately circular area

TABLE I—STATISTICS OF ANNUAL MAXIMUM AND MINIMUM TEMPERATURES

ENGLAND	Height above MSL *feet*	Period of data *years*	Annual maximum temperatures: Highest	Seldom* above	Median	Seldom* below	Lowest	Root mean square†	Annual minimum temperatures: Period of data *years*	Lowest	Seldom* below	Median	Highest	Root mean square†
			degrees Fahrenheit							*degrees Fahrenheit*				
BERKSHIRE														
Reading University	148	54	95	91	87	82	78	4.3	40	9	17	20	25	3.7
Shinfield	200	42	95	89	88	83	77	4.4	40	5	15	19	24	4.1
BEDFORDSHIRE														
Woburn	291	53	94	89	85	81	74	3.8	60	−5	9	16	21	6.1
CAMBRIDGESHIRE:														
Cambridge (Botanical Gardens)	41	48	96	91	87	83	78	4.1	60	1	11	18	24	5.4
CHESHIRE:														
Bidston	198	47	87	85	82	76	73	4.3	60	15	21	24	30	3.6
Macclesfield	500	49	88	87	83	80	74	3.8	60	7	14	18	24	4.2
CORNWALL:														
Bude	50	30	89	85	82	77	74	4.2	47	12	20	23	28	3.5
Falmouth	167	53	85	80	77	74	69	3.6	60	18	23	27	32	3.3
Gulval	50	31	86	82	78	76	73	3.5	35	13	24	27	32	3.9
Newquay	176	51	86	82	77	75	72	3.8	60	16	22	25	31	3.5
Penzance	55	36	85	81	78	75	70	3.9	60	17	25	29	33	3.6
CUMBERLAND:														
Keswick	254	41	91	84	82	78	75	3.1	47	0	11	18	25	5.7
Newton Rigg	560	51	87	84	81	78	73	3.2	55	0	8	13	22	5.4
DERBYSHIRE:														
Buxton	1007	53	88	83	79	76	70	3.9	60	−1	9	14	22	5.3
DEVONSHIRE:														
Barnstaple	25	20	90	87	83	79	77	3.6	60	3	17	20	27	4.0
Cullompton	202	50	92	88	85	82	76	3.7	52	2	16	19	26	4.4
Exmouth	195	38	86	82	78	75	70	3.9	46	10	20	23	28	4.3
Ilfracombe	25	49	86	83	80	76	73	3.2	60	19	25	28	32	3.0
Plymouth	87	53	87	83	80	76	70	3.9	40	16	21	24	29	3.4
Princetown	1359	39	86	80	77	75	69	3.3	50	8	15	19	27	3.3
Torquay	27	48	87	82	79	76	71	3.8	60	16	23	26	30	3.2
DORSET:														
Portland Bill	32	50	83	78	74	70	67	3.7	54	19	24	27	32	3.0
Shaftesbury	722	56	91	85	81	78	75	3.7	60	9	17	20	25	3.5
Weymouth	16	39	90	86	81	77	74	4.5	60	16	21	23	31	3.1
DURHAM:														
Chopwellwood	446	47	88	84	80	76	72	4.0	48	5	12	18	24	5.1
Ushaw	594	47	87	84	80	76	72	4.2	60	9	15	20	25	4.1
ESSEX:														
Earls Colne	160	29	96	89	86	82	78	4.1	34	6	15	19	23	4.2
Halstead	139	45	97	90	88	84	79	3.7	57	1	11	17	25	5.8
Shoeburyness	11	57	92	87	83	80	77	2.9	60	9	17	21	27	3.9
GLOUCESTERSHIRE:														
Cheltenham	214	46	93	89	86	82	78	3.9	56	6	16	20	25	4.1
HAMPSHIRE:														
Bournemouth	139	54	93	87	82	79	76	3.3	56	12	18	21	28	3.4
Long Sutton	512	33	92	89	86	83	76	3.7	36	8	10	17	22	4.6
Portsmouth	7	42	91	85	81	79	75	4.1	59	12	21	24	29	3.3
South Farnborough	226	45	94	90	87	83	79	3.7	45	2	10	16	24	4.6
Southampton	65	54	93	88	85	81	77	3.7	59	11	18	21	27	3.6

*'Seldom' = 20 per cent of occasions or 1 year in 5; the figures given are the upper and lower quintiles.
†Root mean square of the variation from the median.

TABLE I—STATISTICS OF ANNUAL MAXIMUM AND MINIMUM TEMPERATURES—*contd*

	Height above MSL	Annual maximum temperatures: Period of data	Highest	Seldom* above	Median	Seldom* below	Lowest	Root mean square†	Annual minimum temperatures: Period of data	Lowest	Seldom* below	Median	Highest	Root mean square†
	feet	*years*			*degrees Fahrenheit*				*years*			*degrees Fahrenheit*		
HEREFORDSHIRE:														
Ross-on-Wye	223	49	91	87	84	81	75	3.5	46	−3	13	18	23	6.3
HERTFORDSHIRE:														
Rothamsted	420	58	92	88	84	80	73	4.2	60	4	13	18	24	4.6
ISLE OF MAN:														
Douglas	284	53	82	79	75	73	68	3.2	40	19	24	26	30	2.7
ISLE OF WIGHT:														
Sandown	13	52	88	82	80	77	74	3.4	53	13	21	24	29	3.5
Ventnor	443	57	89	84	79	76	73	3.7	41	12	21	25	32	4.0
KENT:														
Dover	19	50	89	85	81	77	73	4.0	49	12	18	22	29	3.9
East Malling	122	36	92	89	85	83	80	3.3	35	0	12	16	24	5.3
Folkestone	128	44	90	87	81	77	75	4.5	47	12	19	24	29	4.4
Margate	51	52	94	88	83	80	75	4.6	56	18	21	25	32	3.4
Tunbridge Wells	351	56	95	90	86	82	76	4.2	58	4	13	17	24	4.2
LANCASHIRE:														
Bolton	342	49	89	86	83	78	74	3.6	60	7	15	20	26	4.2
Manchester	125	49	91	88	85	80	74	4.2	56	8	16	22	25	4.3
Morecambe	23	35	89	86	81	77	75	4.0	44	8	17	21	26	4.3
Southport	35	52	91	87	82	78	74	4.4	60	7	16	20	26	4.3
Stonyhurst	377	53	86	83	80	76	71	3.7	60	7	15	20	25	3.9
LINCOLNSHIRE:														
Cranwell	204	39	92	89	86	81	74	4.6	41	4	13	18	24	5.1
Skegness	15	57	89	84	80	78	76	3.3	56	10	16	21	28	4.4
LONDON:														
Hampstead	450	49	95	89	85	82	76	4.1	49	9	17	21	26	3.9
Westminster	27	58	96	91	87	83	78	4.0	57	14	20	23	28	3.1
NORFOLK:														
Cromer	178	57	94	89	85	81	78	4.0	57	14	20	23	28	3.0
Sprowston	93	35	95	88	85	81	76	4.1	35	7	11	18	25	5.2
Yarmouth	5	57	89	84	79	77	74	3.7	60	12	18	23	27	3.8
NORTHAMPTONSHIRE:														
Raunds	213	48	98	90	87	83	77	4.1	53	−1	10	17	22	6.1
NORTHUMBERLAND:														
Cockle Park	326	51	86	82	77	74	70	4.1	60	6	15	20	25	4.5
Tynemouth	95	49	86	80	77	74	70	3.3	48	11	19	23	30	4.2
NOTTINGHAMSHIRE:														
Nottingham	192	58	94	89	84	82	75	4.2	60	7	14	19	26	4.3
Sutton Bonington	157	31	91	88	85	81	75	3.9	36	0	11	15	23	5.5
OXFORDSHIRE:														
Oxford	208	57	95	89	86	82	75	3.9	60	3	16	19	24	4.0
ISLES OF SCILLY														
St. Mary's	163	53	82	76	73	70	67	3.6	60	25	30	32	37	2.7
SHROPSHIRE:														
Shrewsbury	184	45	93	87	84	80	78	3.6	45	0	7	15	25	6.5
SOMERSET:														
Bath	67	58	93	88	84	81	76	3.9	60	4	16	20	25	4.5
Cannington	95	29	92	87	84	80	74	4.0	31	4	17	21	28	5.5
Long Ashton	162	41	93	88	84	81	76	3.6	40	7	16	20	24	4.9
Weston-super-Mare	28	34	91	88	84	81	77	3.7	45	11	19	21	27	3.6

*'Seldom' = 20 per cent of occasions or 1 year in 5; the figures given are the upper and lower quintiles.
†Root mean square of the variation from the median.

TABLE I—STATISTICS OF ANNUAL MAXIMUM AND MINIMUM TEMPERATURES—*contd*

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	feet	*years*	*degrees Fahrenheit*						*years*	*degrees Fahrenheit*				
SUFFOLK:														
Felixstowe	10	55	86	82	80	78	74	2.8	38	14	19	23	29	3.3
SURREY:														
Croydon	220	51	95	90	86	83	78	3.7	41	5	14	20	26	4.0
Wisley	150	57	96	91	87	83	78	4.1	57	5	13	18	25	4.6
SUSSEX:														
Bognor	24	46	90	82	79	75	74	3.8	57	12	19	23	29	3.7
Brighton	32	50	90	86	83	79	75	3.7	52	14	20	23	29	3.1
Eastbourne	23	48	90	83	79	77	73	3.4	56	12	19	23	29	3.8
Worthing	25	46	90	83	80	77	74	3.3	60	13	20	23	29	3.4
WARWICKSHIRE:														
Birmingham	536	53	94	87	83	80	74	3.9	60	11	18	22	27	4.0
Coventry	338	58	94	89	86	81	76	4.1	60	0	14	18	24	4.7
WILTSHIRE:														
Porton	362	43	93	88	85	81	76	3.8	41	5	12	16	24	3.7
Marlborough	424								60	0	10	16	23	5.3
WORCESTERSHIRE														
Malvern	377	46	91	88	84	79	75	3.9	58	7	17	20	26	3.7
YORKSHIRE:														
Ampleforth	313	51	89	84	80	77	73	3.8	60	11	16	20	27	3.7
Huddersfield	762	53	92	87	82	80	74	4.4	60	7	13	18	23	4.4
Hull	8	59	91	87	83	80	76	3.8	60	12	17	22	28	4.2
Ilkley	315	28	90	85	83	79	75	3.5	37	3	12	17	22	4.5
Scarborough	118	57	90	84	79	77	72	4.2	60	16	23	25	29	3.0
Sheffield	429	53	92	87	82	80	74	3.9	60	11	18	22	28	3.5
Spurn Head	29	57	86	82	78	76	73	3.3	60	10	24	26	30	3.3
Wakefield	115	49	90	88	84	81	76	3.9	54	5	14	19	25	4.3
York	57	53	92	88	83	81	76	3.9	60	7	14	19	26	4.7
WALES														
ANGLESEY:														
Holyhead	26	57	91	81	76	73	69	4.8	60	10	23	27	32	4.9
CAERNARVON:														
Llandudno	13	58	90	86	79	76	71	4.9	60	10	22	25	28	3.9
CARDIGAN:														
Aberystwyth	12	52	91	84	80	77	71	4.0	60	12	20	24	27	3.6
Aberystwyth Plant Breeding Station	452	36	88	83	80	76	73	3.8	35	12	18	22	26	3.7
FLINT:														
Hawarden	17								60	0	11	20	26	6.2
Rhyl	31	56	91	86	81	77	71	4.3	56	10	16	22	26	4.6
GLAMORGAN:														
Cardiff	202	56	91	85	82	79	75	3.7	57	2	18	22	28	4.8
Swansea	27	51	89	84	80	78	72	3.8	48	14	21	25	30	3.7
MONMOUTH:														
Newport	265	41	93	87	85	81	76	3.7	43	4	18	21	29	4.9
MONTGOMERY:														
Welshpool	254	43	90	87	83	81	77	3.4	42	−4	12	16	23	6.0
PEMBROKE:														
St. Ann's Head	142	51	86	79	75	72	66	3.8	47	19	24	27	33	3.1

*'Seldom' = 20 per cent of occasions or 1 year in 5; the figures given are the upper and lower quintiles.
†Root mean square of the variation from the median.

TABLE I—STATISTICS OF ANNUAL MAXIMUM AND MINIMUM TEMPERATURES—*contd*

	Height above MSL *feet*	Annual maximum temperatures: Period of data *years*	Highest	Seldom* above	Median	Seldom* below	Lowest	Root mean square†	Annual minimum temperatures: Period of data *years*	Lowest	Seldom* below	Median	Highest	Root mean square†
			degrees Fahrenheit							*degrees Fahrenheit*				
RADNOR:														
Rhayader	757	37	87	85	81	78	74	3·5	37	−10	11	13	20	5·7
CHANNEL ISLANDS														
Jersey	273	45	96	89	83	81	75	4·4	50	17	25	27	34	3·8
SCOTLAND														
ABERDEEN:														
Aberdeen	170	53	83	78	75	73	66	3·9	58	5	14	19	27	5·2
Balmoral	927	55	88	83	78	75	71	4·2	55	−10	0	6	16	5·5
Braemar	1113	52	85	82	78	75	73	3·2	54	−13	0	3	14	5·4
Craibstone	300	36	84	80	76	74	70	3·2	35	10	15	17	27	4·3
Logie Coldstone	608	37	86	82	79	75	74	3·0	38	−10	3	7	18	6·0
ANGUS:														
Arbroath	95	41	86	80	76	73	69	3·9	60	4	15	19	27	4·7
Dundee	147	53	86	83	79	77	70	3·7	45	8	16	21	27	4·9
Kettins	222	32	86	82	78	76	73	3·4	36	−5	5	13	22	6·7
Montrose	186	33	83	80	76	74	71	4·4	59	5	16	20	26	3·9
ARGYLL:														
Oban	229	44	85	81	77	75	71	3·5	49	10	19	22	28	3·6
Tiree	29	34	79	76	72	70	64	3·7	34	20	23	25	31	2·7
AYR:														
Colmonell	170	51	88	81	78	75	71	3·6	53	5	15	18	24	4·0
Kilmarnock	115	53	90	84	81	78	72	3·8	47	0	11	18	24	5·8
BANFF:														
Banff	80	41	84	81	77	74	70	3·4	44	5	15	20	29	5·2
BERWICK:														
Marchmont	498	53	87	83	79	76	71	3·7	60	5	12	18	25	4·4
BUTE:														
Rothesay	150	51	84	80	77	72	70	3·8	59	12	22	25	31	3·4
CAITHNESS:														
Wick	119	56	80	73	70	67	64	3·3	60	8	13	18	28	3·8
DUMBARTON:														
Helensburgh	293	46	85	82	78	76	73	3·0	60	7	16	19	27	4·2
DUMFRIES:														
Dumfries	140	55	91	83	80	78	73	3·6	60	5	14	18	23	4·5
Eskdalemuir	794	51	85	81	78	75	66	3·6	51	−1	7	11	23	5·0
Ruthwell	95	42	90	86	83	80	74	3·3	49	1	11	16	22	5·1
EAST LOTHIAN:														
N. Berwick	151	35	88	82	78	74	72	4·1	37	6	14	21	26	5·2
FIFE:														
Cupar	82	38	85	81	78	75	72	3·2	52	3	12	17	25	5·2
Kirkcaldy	137	40	87	83	78	75	72	3·8	43	6	14	21	27	5·3
Leuchars	35	38	84	81	77	75	70	3·5	39	10	13	19	26	4·4
St. Andrews	13	41	86	82	78	75	70	3·7	46	7	12	19	25	4·6
INVERNESS:														
Dalwhinnie	1176	28	86	83	78	74	68	4·2	30	−7	0	4	14	5·3
Fort Augustus	70	50	87	81	78	75	71	3·8	50	−1	9	14	23	4·6
Fort William	27	48	86	81	79	76	71	3·6	49	5	11	18	25	4·6
Inverness	13	43	87	81	77	73	70	4·1	58	9	13	19	26	4·5
Onich	48	36	86	82	79	76	70	3·5	35	12	16	20	26	3·3

*'Seldom' = 20 per cent of occasions or 1 year in 5; the figures given are the upper and lower quintiles.
†Root mean square of the variation from the median.

TABLE I—STATISTICS OF ANNUAL MAXIMUM AND MINIMUM TEMPERATURES—*contd.*

	Height above MSL	Annual maximum temperatures: Period of data	Highest	Seldom* above	Median	Seldom* below	Lowest	Root mean square†	Annual minimum temperatures: Period of data	Lowest	Seldom* below	Median	Highest	Root mean square†
	feet	*years*	*degrees Fahrenheit*						*years*	*degrees Fahrenheit*				
LANARK:														
Dungavel	798	32	83	80	78	75	70	3.2	37	9	12	18	25	4.4
MIDLOTHIAN:														
Boghall	639	25	84	81	76	75	71	4.1	36	6	14	19	26	4.6
Edinburgh	200	47	83	81	77	75	70	3.4	60	14	19	22	28	3.2
MORAY:														
Gordon Castle	104	52	86	83	79	77	73	3.7	60	−1	12	18	26	6.0
NAIRN:														
Nairn	20	57	86	82	78	75	72	3.6	60	2	[illegible]	16	25	5.2
PEEBLES:														
West Linton	800	51	89	83	77	75	70	4.4	53	−6	5	10	20	6.4
PERTH:														
Crieff	400	34	89	82	78	76	73	3.9	37	4	13	18	25	5.0
Perth	77	47	89	84	80	78	74	3.6	60	−7	8	13	21	6.2
RENFREW:														
Abbotsinch	19	13	86	84	79	78	77	3.4	40	0	11	16	23	4.6
Greenock	200	47	84	81	77	74	71	3.4	60	14	20	23	30	3.7
Paisley	105	47	86	84	80	77	73	3.5	60	8	15	20	27	4.5
ROSS AND CROMARTY:														
Achnashellach	220	37	88	82	79	76	72	3.5	35	3	10	15	25	5.6
Fortrose	15	49	83	79	76	72	69	3.5	50	13	18	22	30	3.6
Stornoway	11	57	78	75	72	68	65	3.3	60	10	17	22	28	3.2
ROXBURGH:														
Kelso	195	44	87	85	81	77	72	3.8	60	−3	9	15	22	5.9
Wolfelee	537	30	88	84	81	77	73	3.8	46	0	6	11	22	5.7
STIRLING:														
Stirling	151	36	87	83	79	77	72	3.3	43	6	14	19	26	5.0
ZETLAND:														
Baltasound	78	43	77	71	67	64	60	4.2	45	13	17	21	29	3.9
Lerwick	269	49	76	69	66	62	58	3.5	60	16	20	24	30	3.4

*'Seldom' = 20 per cent of occasions or 1 year in 5; the figures given are the upper and lower quintiles.
†Root mean square of the variation from the median.

centred at Woburn and having a radius of about 75 miles; the area extends, for example, to Gloucester, Nottingham, Lincoln, Norwich, Tunbridge Wells and Southampton. The isotherm for 80°F excludes the coasts of England (except the strip between Rhyl and Carlisle), the Pennines, the Welsh Mountains, and most of Devon and Cornwall. In Scotland all reporting stations, except those in the extreme north, lie within the 76–80°F range.

Acknowledgements.—The author wishes to acknowledge the help of Miss N. Roulston, Mr. R. Stratton and Mrs. D. Humphries who assisted in the preparation of the table.

NOTES AND NEWS

551.5(091):551.508.41

An account of some old barometers

During the course of recent months seven Meteorological Office barometers of unusual age have come to light at stations where they have been in regular use until recently. Of these barometers, four were of the 'Fishery' type, loaned to harbourmasters or other local authorities as a safeguard to fishermen before the days of radio forecasts. As the old Meteorological Office stores ledgers are still in existence for virtually all instruments issued from 1855 to 1911, the detailed history of these old barometers can be traced.

The oldest of the group is Fishery Barometer No. 19. This was first issued to a Captain Walker, R.N., at Cawsand Bay, on 12 August 1858, where it remained until at least 1911. In 1920 it was issued to Ullapool, in Ross and Cromarty, where it remains awaiting collection.

Of almost equal age, Fishery Barometer No. M.O. 60 was supplied to St. Helens (presumably Isle of Wight) in 1862. It was transferred to the coastguard, Ryde, in 1875 and to the Harbour Officer, Newlyn, in 1921, from whom it has now been returned. This barometer also bears the mark "No. 285," this presumably being the manufacturer's serial number. It is in excellent condition apart from a broken vernier scale which can be easily repaired.

Just failing to achieve its 'century,' Fishery Barometer No. 99 was first issued to the Town Clerk, Tynemouth, in October 1866, for use at North Shields, where it remained until July 1964. Apart from a broken attached thermometer it is still in good condition.

Relatively a newcomer, Fishery Baromometer No. 244 has come to light at Badachro, near Gairloch, Ross and Cromarty. This was issued to the station in June, 1897, where it has remained ever since, apart from a short period when it was returned for repair.

Barometers in regular use for synoptic obervations do not as a rule share the longevity of the fishery barometers, largely owing to the risks during their more frequent transfer from station to station. However two very similar station barometers have recently been returned, No. M.O. 1523 from the coastguard synoptic station at St. Mary, Isles of Scilly, and No. M.O. 1525 from the Meteorological Office, Leuchars, Fife. Both are barometers made by Calderara, with iron cisterns, and calibrated at Kew in 1920. The former was issued to St. Mary in 1929, its former history not being known, while the latter reached Leuchars in 1934 after some years in the Science Museum, South Kensington.

Even more unusual, in view of the hazards of life at sea, an old marine barometer made by 'H. Negretti and Zambra' was returned in May 1964 after 44 years of service. This barometer bears the marking of an upright arrow and the figures '99' and is presumably one obtained under War Office contracts placed during or immediately after, the First World War. It also was certified at Kew in 1920 and has been repaired on three occasions, without recertification. The records show that during its life it passed through the hands of the Port Meteorological Officers at Liverpool, London and Southampton, and although no record of all the ships in which it served is available, it was recovered in 1964 from *Capetown Castle.*

The long life of each of these barometers reflects considerable credit upon those responsible for safeguarding and using them. All have been in regular use until recently and in most cases retesting after their return has not disclosed serious defects or errors. At the same time it is not advisable to retain barometers or any other instruments required for accurate measurements for prolonged periods without regular recalibration against a central standard.

A. L. MAIDENS

Decisions of the World Meteorological Organization's Scientific Advisory Committee

The World Meteorological Organization (WMO's) Advisory Committee, the newest committee of WMO consisting of 12 well-known scientists, held its second session in Geneva from 8–12 February 1965. Dr. R. C. Sutcliffe (U.K.) was unanimously elected chairman of the session.

A new feature of the session was the organization of some scientific discussions jointly with the newly-created International Union of Geodesy and Geophysics Committee on Atmospheric Sciences. The meeting of this Committee also took place in the WMO building during the same week. Dr. Blamont (France), Professor Charney (U.S.A.) and Professor Kondratiev (U.S.S.R.) presented papers for these scientific discussions. Professor Sheppard (U.K.) and Dr. Cressman (U.S.A.) also made major contributions.

At one of these discussions, Professor Kondratiev gave an interesting paper on the future possibilities of meteorological satellites including the possible use of meteorologically qualified cosmonauts to obtain observational data. The speaker also discussed the possibilities of establishing a lunar observatory which would have similar characteristics to the planned stationary satellites placed in an equatorial orbit.

Much interest was shown in some important experiments now being developed in the United States and France which would involve the release of a large number of special balloons equipped with suitable instruments and floating with the wind at a number of constant levels. Dr. Blamont, who led the discussions on this subject, explained that the meteorological observations made by these special balloons may be interrogated either by a satellite or by ground stations and the experiments would constitute a feasibility study to find out whether such floating balloons in future could be used as a complement to conventional observations to fill the large gaps over the oceans and in the southern hemisphere. The results of such experiments will play an important role for the planning of the future World Weather Watch.

Many millions of observations have been collected by merchant ships over the last 80 years or so. Among these are measurements of sea surface temperature which now assume new significance to many scientists working on long-term changes in weather and climate. The Advisory Committee agreed that a special effort is necessary to analyse and publish all these long records of data and recommended that WMO should engage a short-term consultant to study this matter.

The Advisory Committee paid considerable attention to questions of meteorological training and in view of the rapidly developing WMO activities in this field, it recommended that the WMO Executive Committee should create a panel of experts to act as a focal point for these activities and to deal with all aspects of scientific and technical meteorological training.

The question of establishing and supporting international research institutes aroused great interest. The Committee was not at the present time in favour of creating one single World Institute under the auspices of WMO but preferred other means of giving support to the various types of such institutes. A new feature of such support was a proposal that WMO should sponsor a WMO international visiting programme. Under this programme, if approved, qualified scientists may be appointed as WMO Visiting Fellows, and assisted to make extended visits for research or educational purposes at participating Research Institutes.

The recommendations of the Advisory Committee will be considered by the WMO Executive Committee at its seventeenth session which will open in Geneva on 27 May 1965. The third session of the Advisory Committee will be held in spring 1966.

METEOROLOGICAL OFFICE DISCUSSION

Operational numerical forecasting

At the Meteorological Office discussion held on 21 December 1964 at the Royal Society of Arts, the opening speaker was Mr. P. Graystone. His topic was the introduction of numerical forecasts in the Meteorological Office on a routine basis, which is intended to follow the installation of the new KDF 9 computer COMET.

Mr. Graystone spoke of the three stages in the production of a computed chart—data extraction, analysis and numerical forecast. Each of these posed new problems in view of the proposed expansion of the forecast area—the latter is intended to cover four times the area of earlier numerical forecasts made with the previous computer METEOR. The larger area should reduce the influence of boundary errors over the essential parts of the chart and permit some extension of the forecast period. The prediction model has been well tested on the previous machine; it has yielded good forecasts at 500 and 200 mb, and the surface forecasts have given useful guidance. The operational system envisages a twice-daily forecast, based on 0000 and 1200 GMT data, with later versions supplemented by 0600 and 1800 reports. It is hoped that the continuity of the new system will lead to an improvement in the computed analyses, which will be reflected in forecasts of greater accuracy.

The discussion was concerned to a large extent with the adaptation of these forecasts for operational use. The computed forecasts are not intended to handle small-scale features, and the detail will need to be inserted; the jet stream in particular is a feature which may cause some difficulty. Another drawback pointed out is that a computed chart carries no degree of confidence, and the forecaster may have a difficult decision when it differs substantially from his own expected development.

The Director-General considered that the introduction of numerical forecasts was the most important advance in meteorology since the Norwegian frontal model. Automation brought problems wherever it was introduced, but in meteorology the experience and judgement of forecasters would still be required.

REVIEWS

A colour guide to clouds by R. Scorer and H. Wexler. 7¾ in × 5 in, pp. vi + 66, *illus.*, Pergamon Press Ltd., Headington Hill Hall, Oxford, 1964. Price: 12*s.* 6*d.*

As its name implies the book is intended as a guide to the study of clouds, not only their identification but the processes which cause their formation. In addition to a brief introduction to cloud names and their derivation, there are 11 diagrams with explanatory text to illustrate the physical processes involved in cloud building. The reader is then presented with 48 coloured cloud photographs, two to a page, with notes on the opposite page explaining the processes which cause the cloud formation and drawing attention to any point of special significance. In one or two cases the authors have not expressed themselves clearly (plates 16 and 18). The last two pictures, taken from a Mercury satellite, bring the book right up to date. Finally there is a four-page section on practical studies, with helpful advice on the determination of cloud height, speed of movement, growth and development, and brief tips on cloud sketching and photography.

The authors intend the book to be carried to the office, workshop or school and on all trips so that the clouds can be studied at all times and the book size and the excellent index have been well designed for this purpose.

The authors are well known and respected in meteorological circles. Professor Scorer has long campaigned for the identification of cloud forms by virtue of their formation rather than by their Latin names as used by meteorologists for coding and reporting purposes and this book presents his ideas to the amateur. It will appeal to the physicist, naturalist, geographer, artist and layman with only an amateur interest in the sky. Little knowledge of physics is required to understand and use the book. Schoolboys interested in the weather will find it both useful and instructive.

Some of the coloured photographs are reproduced from colour slides and, as is usual, have suffered in the reproduction process but, for its price, the book is excellent value for money.

It is rather surprising that one so experienced as Professor Scorer should wrongly define cumulonimbus in Plate 13 and thus misname both Plates 10 and 11. In international meteorological terminology cumulonimbus clouds are only so named after their tops have lost their turreted form and become fibrous showing that glaciation has occurred.

R. K. PILSBURY

The English climate by H. H. Lamb. $7\frac{3}{4}$ in × 5 in, pp. xi + 212, *illus.*, English University Press, 102 Newgate Street, London E.C.1, 1964. Price: 12*s.* 6*d.*

Ten years after the first edition of this book by the late Dr. C. E. P. Brooks, a much modified version has been prepared by Mr. H. H. Lamb. As the Foreword says, the author "has considered our weather as part of a whole, that of the Northern Hemisphere." The book is intended for all interested in weather, professionally or otherwise, and care is taken to familiarize the non-professional with the recently adopted Celsius scale of temperature, etc.

Chapters 2–4 contain much new material and reflect the rapid developments in synoptic and dynamical climatology. Chapter 2 outlines the general circulation of the atmosphere and the role of the oceans. Heat and momentum transport are mentioned, but there is surprisingly no reference to moisture flux and its climatological significance. Chapter 3 deals with atmospheric perturbations and their associated weather patterns. The approach via tracers of wind motion, tropospheric and stratospheric flow, and the jet stream and polar front is particularly interesting. This is followed in Chapter 4 by an examination of winds, warmth and weather types. The characteristics of air masses over Britain and the author's classification of weather types are summarized, although this section would be strengthened by a closer interrelation of these two concepts and by illustrations of synoptic situations.

The major lines of Chapters 5–9, which are more specifically concerned with Britain's climatic characteristics, are unchanged from the first edition, but there are several new maps, and added material dealing, for example, with cloud processes and the incidence of driving rain. The discussion of orographic rainfall as a distinct type (pp. 65–66) requires amendment. Our lack of progress in bioclimatology, compared with dynamical climatology is evident in Chapter 8—Climate and health. Nevertheless, Huntington's views on climate and civilisation could occupy a less prominent place. Adherence to the layout of the first edition in these five chapters rather detracts from the author's attempt to examine our climate in modern synoptic terms.

Chapter 10—Seasons and Saint's days—returns to the theme of synoptic climatology and might more appropriately follow Chapter 4 in a future edition. The chapter provides an intensive summary of recent studies of natural seasons, spells and singularities, particularly Mr. Lamb's own notable contributions, and it is supplemented by a useful calendar of singularities in Appendix I. The student of the general circulation will find much of interest in the outline of hemispheric circulation processes and their physical bases. However, it seems strange that the opportunity to outline the methods employed in long-range forecasting was not taken. Chapter 11 deals briefly with post-glacial and historic changes of climate and is also supplemented by a calendar of historic weather events since 1500 (Appendix II). The final chapter on weather maps could be incorporated with Chapter 3 or placed as an Appendix.

Only a few misprints were noted: the heading of Table 4, and 'High' and 'Low' omitted on Figure 1. The suggested comparison (p. 9) of Figures 1 and 2 is made inconvenient by setting one horizontally and the other vertically and numbering of all tables would simplify references to them. Standard deviation (p. 98) is not defined and significance levels (p. 144) require fuller explanation.

The layout of the new edition benefits greatly from the use of sub-headings and the indexing is improved.

Numerous up-to-date references will make the book especially valuable to students. The author's style is eminently readable and the book provides a welcome addition to the literature on our climate at a very moderate price.

R. G. BARRY

551.571.2(412):551.571.36

LETTER TO THE EDITOR

A new record of low humidity

The article on low humidities in 1964* was completed just before the occurrence of the longest spell of very low humidities yet recorded at the Cairngorm high-level climatological stations. This spell, which lasted from 8 to 11 November may well be the longest ever autographically recorded in the British Isles.

The steep drop in relative humidity, as recorded by the hair hygrograph, began at both stations between 1500 and 1600 GMT on 8 November, and the final steep rise about 1000 GMT on 11 November. During this period of over 66 hours, there was only one break of 8 hours (from about 2000 GMT on 9th to about 0400 GMT on 10th) during which the relative humidity ceased to be remarkably low. For 33 hours the relative humidity as recorded on the Cairngorm hair hygrograph was below 20 per cent and at the Coire Cas Shieling also it remained below 20 per cent nearly as long as this. The lowest levels were reached during the afternoon of 10 November, when it was 10 per cent or below for about 12 hours at the upper station and for about 4 hours at the lower station. The very lowest value of about 8 per cent at each station, occurred about 2000 GMT on that day.

The nearby station at Achnagoichan showed values not very different from usual except for a steep drop on 10 November, about 0700 GMT, followed by a gradual rise; the lowest value recorded was about 31 per cent at 0900 GMT. In the *Daily Weather Report* the only occurrence noted of an unusually low relative humidity was at 0000 GMT on 11 November, when it was 23 per cent at Cape Wrath.

Inspection of the wet-bulb and dry-bulb temperature observations made four times a day (0300, 0900, 1500 and 2100 GMT) at the two high-level stations, Lowther Hill (2377 ft) and Great Dun Fell (2780 ft) did however reveal that exceptionally low relative humidities occurred there. At the former the lowest reading was 18 per cent at 1500 GMT on 10th, while at the latter it was 7 per cent at both 2100 GMT on 9th and 0900 on 10th. The 0900 GMT observations at Moor House (1825 ft), near Great Dun Fell, did not indicate a relative humidity below 60 per cent.

The surface synoptic situation on 8 November was of a high extending from the Black Sea to Denmark. This slowly retreated eastwards, while a deep depression over the Atlantic began to dominate the situation during 11 November. The *Daily Aerological Records* show a pronounced high centred over England on the 500 mb contour chart for 8 November; this had moved slightly eastward on the 9th and 10th, but was beginning to disappear on 11th. The upper air soundings reveal an unusually thick layer of strikingly dry air extending from

*GREEN, F. H. W.; The incidence of low relative humidity in the British Isles. *Met. Mag., London*, **94**, 1965, p. 81.

the tropopause down to below the 800 mb level. The lowest relative humidity noticed was 7 per cent at the 703 mb level during the 2330 GMT sounding from Aughton on 9 November, but relative humidities of 25 per cent or below were quite common down to at least 850 mb level, which is not so very much higher than Cairngorm. So it looks as though this dry, subsiding air reached the surface at a few places, such as Cairngorm, Lowther Hill and Great Dun Fell. There are however no other recording stations than these above 2000 ft, so it could well be that very low humidities occurred on many other hills where no instruments are maintained.

The Nature Conservancy, Speyside Research Station, F. H. W. GREEN
Aviemore, Inverness-shire

OFFICIAL PUBLICATION

The following publication has recently been issued:

GEOPHYSICAL MEMOIRS

No. 109—*Mean streamlines and isotachs at standard pressure levels over the Indian and west Pacific Oceans and adjacent land areas, by R. Frost, B.Sc. and P. M. Stephenson, M.Sc.*

This Memoir consists primarily of charts of the mean wind flow at 700 mb, 500 mb, 300 mb and 200 mb for the mid-season months of January, April, July and October, based on the latest available rawind data supplemented by pilot-balloon and aircraft observations.

The main features of the flow patterns are discussed and a simple explanation is offered of certain features which have no parallel elsewhere in the tropics.

The Memoir will be of considerable value to aviation planners and to climatologists as well as to forecasters in the region who will find in the charts a useful basis for daily analysis and prognosis.

PUBLICATION RECEIVED

Atlas of planetary solar climate Vol. IV by Clyde J. Bollinger. 12 in × 8½ in, pp. 44, *illus.*, Bollinger Climatic Research Service, Norman, Oklahoma, U.S.A., 1964.