Met.O.880
METEOROLOGICAL OFFICE

the meteorological magazine

APRIL 1975 No 1233 Vol 104
Her Majesty's Stationery Office

METEOROLOGICAL OFFICE Met.O.880

THE METEOROLOGICAL MAGAZINE

Vol. 104, No. 1233, April 1975

PROFESSOR SVERRE PETTERSSEN, C.B.E.

With the passing of Professor Sverre Petterssen at his London home on 31 December, international meteorology lost one of its outstanding figures.

Born in Norway in 1898, Petterssen graduated at Oslo University in 1924, took his Ph.D. in 1933, and served in the Norwegian Meteorological Service from 1924 to 1939, during the last eight years as a regional director. In 1939 he left Norway to become Professor of Meteorology at the Massachusetts Institute of Technology but, in 1942, came to England as a Lieutenant Colonel in the Norwegian Air Force and served for the rest of the war in the Meteorological Office at Dunstable where he established techniques of upper-air analysis which have since become standard throughout the world. As a senior member of the team responsible for producing the weather forecasts for the D-Day landings in Normandy, he received a letter of commendation from General Eisenhower. His services to the war effort were further recognized when he was appointed C.B.E. in 1948, and Commander of the Order of St Olaf by the Norwegian Government in 1949.

While serving with the Norwegian Meteorological Service, Petterssen made many highly original contributions to the theory of frontogenesis and convection, to the kinematics of weather systems, to the theory of development of the pressure field and to the physics of fog. In all his work he saw the problem from the forecaster's point of view, and although he sought to elucidate the fundamentals of the problem, he presented his results in a manner which could always be readily applied to forecasting. The textbook which he published in 1940 was the first book to attempt to deal with the forecasters' problems in an organized and quantitative way. Earlier textbooks had either been purely descriptive, or had treated meteorology as a largely academic discipline in which the forecaster had to find his own applications of the theoretical results if he could. Petterssen's book came at an opportune time when the Allied Meteorological Services were expanding rapidly to meet the requirements of the Second World War, and his influence on British forecasting practice was made more penetrating by a number of unpublished memoranda on technical problems which he wrote for distribution to forecasters. Several generations of students were brought up on successive editions of his *Introduction to meteorology* which was translated into Russian, Polish and Hindustani and which probably sold more copies than any other meteorological textbook.

In 1945 Petterssen returned to Norway and served as Chief of the Norwegian Weather Forecasting Service until 1948 when he was appointed Director of Scientific Services of the United States Air Force Weather Service. In 1952 he returned to academic life as Professor of Meteorology in the University of Chicago and served as Chairman of the department from 1960 to 1963. During this decade Petterssen played a major part in the rapid expansion of meteorological research and education in the United States within both government and academic institutions. His interest in synoptic and forecasting problems did not diminish and the research which he carried out or initiated among his students and fellow workers continued to emphasize the analysis and interpretation of the real atmosphere at a time when theoretical and mathematical treatments were in vogue.

These major achievements were recognized by the award of the Symons Gold Medal, the highest award of the Royal Meteorological Society, in 1969, the Buys Ballot Gold Medal (awarded only once in a decade) by the Netherlands Academy of Sciences and several honours by the American Meteorological Society of which he was president in 1958–59. His great meteorological knowledge and wisdom were in great demand in the councils of the International Meteorological Organization where he served as president of the Commission for Maritime Meteorology (1939–46) and of the International Aerological Commission (1946–50). In 1965 the World Meteorological Organization awarded him its greatest honour, the IMO Gold Medal and Prize.

After retirement from the University in 1963, Professor Petterssen spent two happy years as U.S. Science Attaché to the Scandinavian countries, having been a United States citizen from 1955 until he relinquished this citizenship in 1974. He chose to spend his final years with his English wife Grace in London, where he continued to write until the day of his death. In his autobiographical 'Kuling fra Nord', which has just appeared in Norwegian, he sums up the experiences and philosophy of an extremely active, exciting and fruitful life.

His colleagues and friends will greatly miss a remarkable and lovable man who made a profound and lasting impression on meteorology which continued to excite him to the very end.

B. J. MASON
J. S. SAWYER

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EXTREME TEMPERATURES OVER THE UNITED KINGDOM FOR DESIGN PURPOSES

By J. S. HOPKINS and K. W. WHYTE

Summary. Extreme maximum and minimum temperatures at a network of over 200 stations over the United Kingdom have been analysed, and maps of once-in-50-year extreme temperatures prepared. A correction diagram is also presented which enables estimates for other return periods to be made.

Introduction. For a number of engineering design applications a knowledge of extreme high or low air temperatures which may be attained is important. For example, certain steels used in the construction of masts, pylons and the like are subject to brittle fracture at low temperatures. In general, steels with guaranteed ductility at low temperatures are more expensive, and so the designer is interested in identifying areas where low temperatures frequently occur so that the best decision can be made on the type of steel to be used for a particular job.

Bridges are sensitive to extreme temperatures at both ends of the scale, and so allowance must be made at the design stage for the safe expansion and contraction of the deck. A recent draft Code of Practice[1] has specified that the once-in-120-year extreme temperatures should be used in the design of the main structural elements in bridges and once-in-20-year extremes used where non-structural equipment is being considered.

Thus, as with the problems of wind loading of structures, a simple statement of the extreme value recorded at a climatological station in the area is not sufficiently statistically precise for modern design methods. A study of the statistics of extremes is needed, so that the designer may make his decisions regarding cost and safety on as sound a basis as possible.

Methods of analysis. The estimation of the extreme values to be expected at low probabilities is normally accomplished by assigning to the ordered set of n available annual extremes x_m ($m = 1, 2, \ldots n$) some convenient cumulative probabilities p_m (such as $p_m = m/(n+1)$ or preferably $p_m = (m - 0{\cdot}31)/(n + 0{\cdot}38)$), and then fitting a straight line

$$x = x_0 + \alpha y, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where the 'reduced variate' $y = -\log_e(-\log_e p)$, and x_0 and α are parameters to be determined. Defining the return period T as $\frac{1}{1-p}$, the once-in-T-years extreme value is then the value x given by (1) for $y = -\log_e\left(-\log_e\left(1 - \frac{1}{T}\right)\right)$. This is the approach popularized by Gumbel.[2]

Jenkinson[3] showed that the straight line (1) is the special two-parameter case of the more general three-parameter distribution

$$x = x_0 + \alpha\left(\frac{1 - e^{-ky}}{k}\right) \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

when the curvature parameter k is zero, and he devised a computational scheme[4] for determining the maximum-likelihood solution for the parameters in both (1) and (2).

Jenkinson has also suggested that it may be appropriate to weight the members of a set of annual extremes so as to simulate a set of five-year extremes and ensure that any extrapolation is based on the upper (lower) part of the distribution of annual maxima (minima).

The various maximum-likelihood solutions for the different methods are shown in Figure 1 for the particular example of annual maximum temperatures at Oxford for the period 1853–1972.

It might be thought that the three-parameter solution with positive k giving the upper limit $x_0 + \alpha/k$ would be the most appropriate distribution to choose, since on physical grounds it cannot reasonably be expected that maximum temperatures will increase without limit. However, in the analysis of the various series of annual extreme temperatures it was found that the three-parameter maximum-likelihood solution often gave unrealistically low values for the upper limit in both the weighted and unweighted cases. Typically,

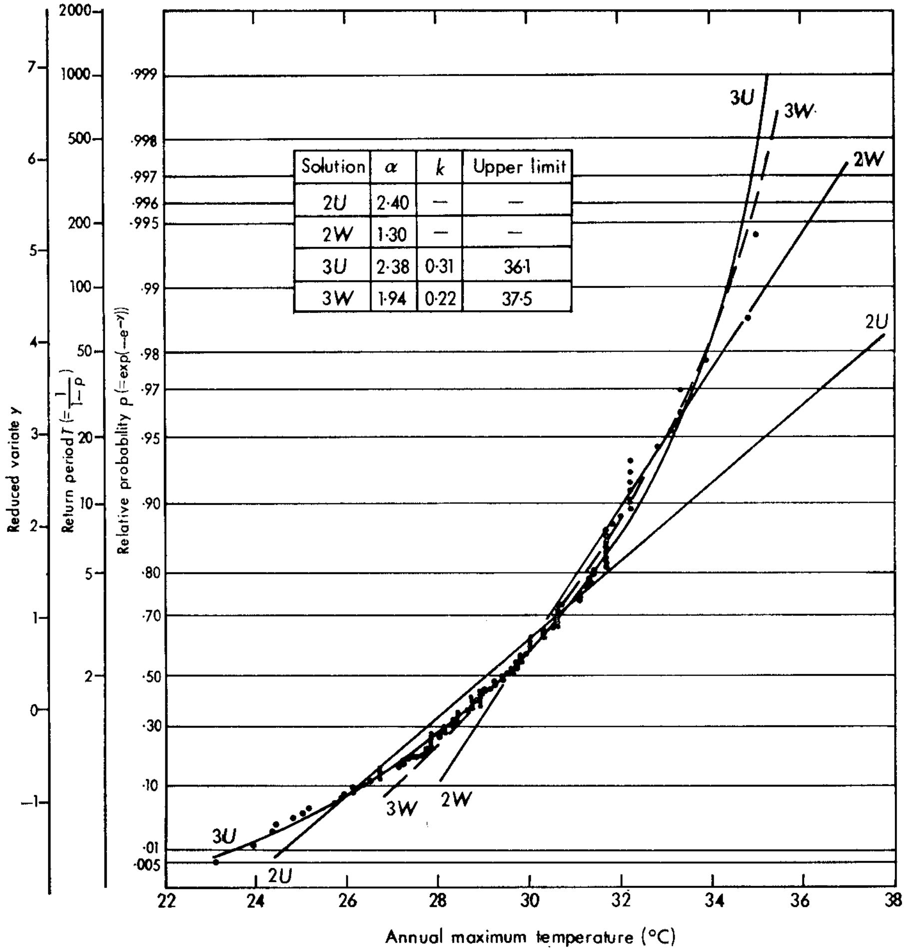

FIGURE 1—EXTREME-VALUE ANALYSIS OF ANNUAL MAXIMUM TEMPERATURES AT OXFORD (1853–1972)

Each point (·) represents one annual maximum temperature, plotted according to the scheme $p_m = \frac{m - 0{\cdot}31}{120 + 0{\cdot}38}$,
where m is the rank (= 1, 2, . . . , 120).

The four solutions obtained by maximum-likelihood methods are:
- 2 *U* — the 2-parameter unweighted solution,
- 2 *W* — the 2-parameter weighted solution,
- 3 *U* — the 3-parameter unweighted solution, and
- 3 *W* — the 3-parameter weighted solution.

Note. The right-hand *y*-axis label should read 'Cumulative probability . . .'

values of k were about 0·5 and this exaggerated curvature meant that the limiting value was little different from the most extreme observed temperature. Though this problem occurred more frequently with maximum temperatures it also arose with the minimum-temperature analysis at several stations. With minima, however, it was more usual to obtain smaller positive or even occasionally negative values of k.

For design purposes, it is obviously better for an estimate to err on the 'safe' side, and the two-parameter weighted solution does tend to give slightly higher maxima and lower minima at a return period of 50 years than do the three-parameter solutions. It is therefore considered that for both maximum and minimum temperatures the two-parameter method with five-year weighting (being effectively a straight-line extrapolation of the upper (lower) part of the observed distribution) gives the most satisfactory estimates of the extreme temperatures corresponding to return periods of the order of 100 years. Clearly for longer return periods, any estimates of extreme temperatures based on a comparatively short period of record might be unreliable because of long-term climatic fluctuations.

Data available and choice of period. The choice of basic data for this analysis was dictated by the fact that extreme temperatures for the period 1941–70 were readily available on magnetic tape for 219 stations in the United Kingdom, of which 121 had values for the full 30 years and the remainder had values for at least 20 years. Ideally, we would wish the 1941–70 extremes to be representative of the *next* few decades, since the computed extremes will be used for planning structures which will be exposed to air temperatures over that future period. However, if it can be shown that the chosen 30-year period yields extreme-value estimates which agree with those derived from longer periods of record, then the choice of 1941–70 can be accepted with reasonable confidence.

Fifty-year return-period values of maximum and minimum temperatures were calculated for 15 long-period stations whose data had been collated (sometimes by combining different sites from the same town) by the Synoptic Climatology Branch of the Meteorological Office. The results obtained by using both the full available period of record and the 1941–70 period are shown in Table I. At almost all stations, the once-in-50-year minimum temperature derived from 1941–70 data is higher than that derived from the full period of record, and especially so at sites within large urban areas such as Bradford, Kew, Oxford and Sheffield. This would suggest that for estimation of minima, the latest period of data, reflecting current urban influences, forms the most suitable basis for design purposes. (However, see the later discussion on mapping of urban minima.) There is no such systematic difference between 50-year maxima, maximum positive and negative differences of the order of 1 degC being found. This suggests that the 1941–70 period has experienced a sample of extreme maximum temperatures which is reasonably representative, over the country as a whole, of a 'typical' 30-year period, and so extreme-value estimates based on this period are likely to be acceptable for design purposes.

TABLE I—COMPARISON OF ESTIMATES OF ONCE-IN-50-YEAR TEMPERATURES (°C) AT SELECTED STATIONS BASED ON FULL AVAILABLE RECORD AND ON PERIOD 1941–70

	No. of years in full period	Once-in-50-year temperatures (°C) estimated from: A Full period		B 1941–70		B − A (degC)	
	(Max./Min.)	Max.	Min.	Max.	Min.	Max.	Min.
Armagh	108/107	30·0	−13·7	30·0	−13·0	0·0	+0·7
Bradford	65	31·6	−14·0	31·8	−13·1	+0·2	+0·9
Bidston	102	31·8	−11·6	31·6	− 9·6	−0·2	+2·0
Cambridge (Botanic Gardens)	40/42	35·5	−16·1	34·8	−16·7	−0·7	−0·6
Cardiff	60	32·3	−13·9	32·0	−13·2	−0·3	+0·7
Durham	42	32·5	−16·3	31·4	−15·6	−1·1	+0·7
Edgbaston	42/43	33·0	−11·3	32·8	−10·9	−0·2	+0·4
Edinburgh (Blackford Hill)	77	30·2	−10·1	30·0	−10·2	−0·2	−0·1
Hastings	41/42	32·4	− 9·7	32·8	− 9·1	+0·4	+0·6
Kew (North Wall screen)	92	34·6	−12·3	35·6	−10·0	+1·0	+2·3
Nottingham	49	33·6	−13·4	33·6	−13·3	0·0	+0·1
Oxford	120	34·3	−15·8	34·2	−14·3	−0·1	+1·5
Plymouth	99	30·7	− 8·8	31·0	− 9·1	+0·3	−0·3
Sheffield	89/90	33·1	−12·0	33·2	−10·3	+0·1	+1·7
Southampton	110/107	33·8	−12·1	34·9	−11·2	+1·1	+0·9
Mean differences						+0·02	+0·77

Preparation of maps. Figures 2 and 3 are based on once-in-50-years extreme temperatures calculated by the weighted two-parameter method for each station in the 1941–70 network. The aim in mapping the results of the extreme-value computations was to show the broad-scale pattern resulting from the maritime influence, or lack of it, on extreme temperatures. In order to enable a reasonably smooth pattern to be drawn on a relatively small-scale map (the working chart was $1:2 \times 10^6$), reduction of the plotted values to a common datum level was necessary. Comparison of data from the few available high-level stations with nearby low-level sites indicated that 0·5 and 1·0 degC/100 m seemed reasonable altitude correction factors for the reduction to mean sea level of extreme minimum and maximum temperatures, respectively. When adjusted by these factors, the plotted values generally proved easy to analyse, and gave patterns which were physically realistic.

With the maximum temperatures, very few plotted values (adjusted for altitude) departed by more than 1 degC or so from the final analysed isopleth pattern. With minimum temperatures, there were many more such departures at urban sites and at low-lying sheltered sites having higher and lower minima respectively than at nearby open country sites. The map of once-in-50-year minima has therefore been analysed with little weight being given to estimates at sites in frost hollows and urban areas. Observations in the London area, however, *have* been analysed, since the considerable spatial extent of the conurbation can be represented on a small-scale map and there are sufficient stations available to define the pattern over and around London. Apart from in and around London therefore, the map (Figure 2) describes conditions to

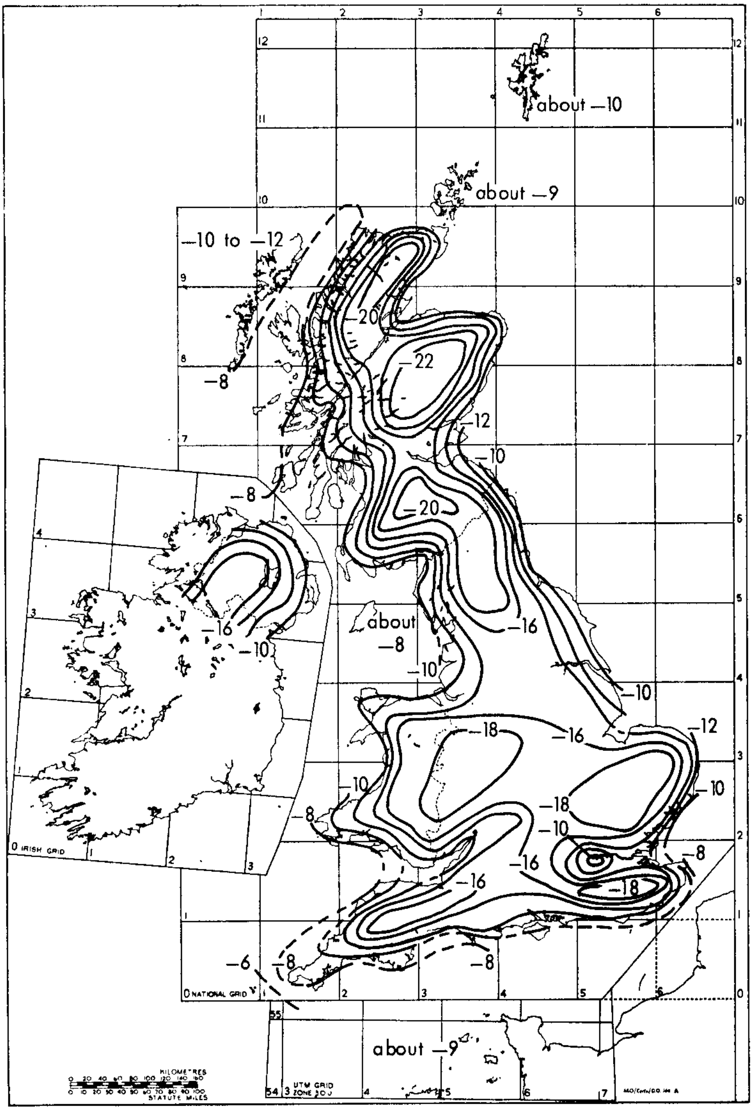

FIGURE 2—ANNUAL MINIMUM TEMPERATURE (IN DEGREES CELSIUS) LIKELY TO OCCUR ONCE IN 50 YEARS AT MEAN SEA LEVEL

To correct for altitude, subtract 0·5 degC per 100 m from map value.

Notes. (a) In sheltered low-lying areas, values are likely to be appreciably lower than map values.

(b) In urban areas (except London), values are likely to be appreciably higher than map values.

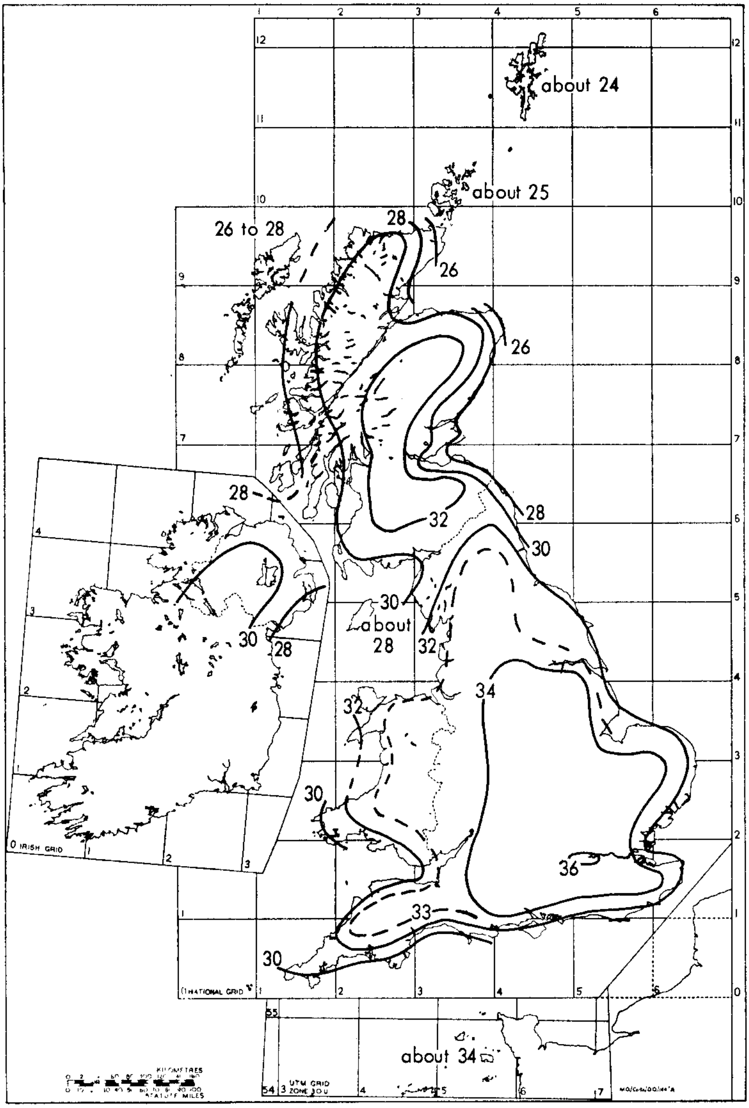

FIGURE 3—ANNUAL MAXIMUM TEMPERATURE (IN DEGREES CELSIUS) LIKELY TO OCCUR ONCE IN 50 YEARS AT MEAN SEA LEVEL

To correct for altitude, subtract 1·0 degC per 100 m from map value.

be expected in open level country (reduced to sea level), and if interpolated values are to be used for design purposes at sites in urban areas or frost hollows, then some further adjustment should be made. The magnitude of this adjustment will obviously depend on local circumstances (detailed topography or urban extent and density), but a couple of examples will serve to show what differences can arise.

The frost hollow at Houghall, about 1·5 km from Durham, has been described by Catchpole[5] and a change in the position of the Houghall site in 1960 has been documented by Smith.[6] Because of this site change, for comparison purposes the analysis of the annual minimum temperatures has been carried out for the period 1941–60. From this 20-year record, the estimated once-in-50-year minima at Durham and Houghall (both corrected to mean sea level) are −16·5°C and −24·5°C respectively. Figure 2 has been analysed following the Durham estimate derived from the 1941–70 record, since this value was broadly consistent with the other open country stations in the area, but the above comparison indicates that the 'true' Houghall value may be expected to depart by about −8 degC from the local map value. Nottingham Castle, in the centre of the city, has an estimated 50-year minimum of −13·0°C, whereas Sutton Bonington, a rural site less than 15 km to the south-south-west, has an estimated value of −17·5°C (both corrected to mean sea level). The Sutton Bonington value, broadly consistent with other rural sites in the area, has been followed in the analysis of Figure 2, and so the Nottingham estimate departs from the local map value by about +4 degC.

Estimation of extremes for other return periods. It is desirable to have a simple method of obtaining extreme temperatures for other return periods, given the once-in-50-year maps. For both maximum and minimum temperatures, the slope parameter α, evaluated by the maximum-likelihood fitting of a 2-parameter solution to the weighted series of annual extremes, was plotted on a map. For minimum temperatures, α displayed an overall range of from about −1·0 to −2·5, and there was a tendency for the lower values to occur inland and for higher values to occur around the coast. This reflects the greater variability of annual minima inland, and shows that for extreme minima the differences between coastal and inland sites are accentuated with increasing return period. Accordingly $\alpha = -1{\cdot}4$ and $\alpha = -2{\cdot}2$ were selected as being suitable 'typical' values to apply to coastal and inland sites respectively. For maximum temperatures, the overall range was about 1·0 to 1·5, and there was a fair degree of spatial coherence, but higher and lower values did not seem to be associated with geography. Accordingly a 'typical' value of $\alpha = 1{\cdot}4$ was selected as being reasonably representative of the whole country.

These three values of α were then used to construct Figure 4, from which corrections to be applied to the map values can be obtained. It can be seen that a variation in α yields a comparatively small change in the correction (less than 1 degC difference at 150-year return period for $\alpha = -1{\cdot}4$ and $\alpha = -2{\cdot}2$) and therefore the choice of 'typical' values for α for national coverage seems justifiable for practical purposes.

Acknowledgement. The computer program used to perform the extreme-value analysis was devised by A. F. Jenkinson and written by D. M. Pusey.

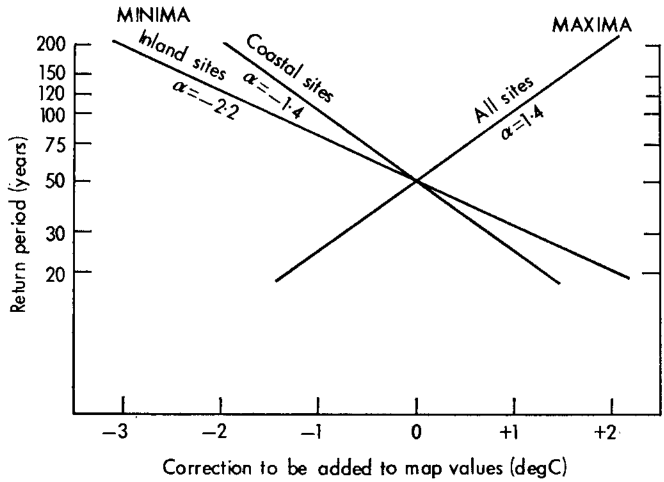

FIGURE 4—CORRECTION DIAGRAM TO BE USED IN CONJUNCTION WITH FIGURES 2 AND 3 TO ESTIMATE EXTREME TEMPERATURES AT OTHER RETURN PERIODS

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COMPUTER QUALITY CONTROL OF DAILY AND MONTHLY RAINFALL DATA

By R. J. SHEARMAN

Summary. An account is given of the quality-control programs recently developed by the hydrometeorological section of the Meteorological Office for routine processing of daily and monthly rainfall data.

Introduction. Daily rainfall totals are measured at approximately 6000 locations throughout the United Kingdom and monthly rainfall totals are recorded at a further 1500 sites. All the daily and monthly rainfall totals are communicated to the hydrometeorological section of the Meteorological Office at Bracknell during the month following that in which the readings were taken. The large quantity of rainfall data, approximately 180 000 values each month, inevitably contains a substantial number of errors. There are many possible reasons for incorrect data, including rainfall-observing errors, etc. Before the data can be used for any serious hydrological or hydrometeorological investigation, these errors must be identified and corrected by some form of quality control.

Manual checking of rainfall data is not practicable when the number of rainfall stations exceeds one thousand. A computerized objective method is required to control the quality of rainfall data for the United Kingdom raingauge network. Such a method involving English Electric KDF9 computer programs was used by the Meteorological Office during the years 1964–72, but even this method (Allen[1]) was too slow to meet many operational requirements. During 1973 a new set of quality-control programs was brought into operational use. These programs utilize the speed and large storage capacity of the IBM 360/195 computer recently installed at the Meteorological Office Headquarters, Bracknell. The new quality-control routines for daily rainfall totals (Figure 1) can be considered as being composed of four separate stages. The quality control of monthly rainfalls will be discussed later.

The calculation of an interpolated rainfall value. An objectively estimated rainfall value at the station under scrutiny is obtained by interpolating between the rainfall values at surrounding stations. The initial selection of neighbouring stations would be an arduous task if it were performed manually, therefore an objective method has been programmed which is flexible enough to take account of recently established rainfall stations.

Ideally the stations selected as neighbours should be physically representative of the area in which the station under scrutiny is situated. With this aim in view only stations within a circle of radius 25 km are considered, and a maximum of two stations allowed in each octant of this circle. The latter condition ensures that the neighbours are reasonably evenly distributed. Eight neighbours are chosen and their identifiers are stored with the daily data for each station in the rainfall archive.

Before interpolation, suspect neighbouring values are filtered out, leaving a maximum of six mutually consistent totals for each day, and each of these is converted to a percentage of the appropriate station's annual average rainfall. The use of percentages enables the interpolation procedure to take into consideration the variations in rainfall due to topography.

A weighted mean is used to compute an interpolated rainfall, with weights inversely proportional to the square of the distance:

$$R = \frac{\sum_i \frac{R_i}{D_i^n}}{\sum_i \frac{1}{D_i^n}},$$

where R = interpolated rainfall (percentage of annual average),
R_i = rainfall at station i (percentage of annual average),
D_i = distance between neighbour i and station under scrutiny in kilometres, and
n = 2.

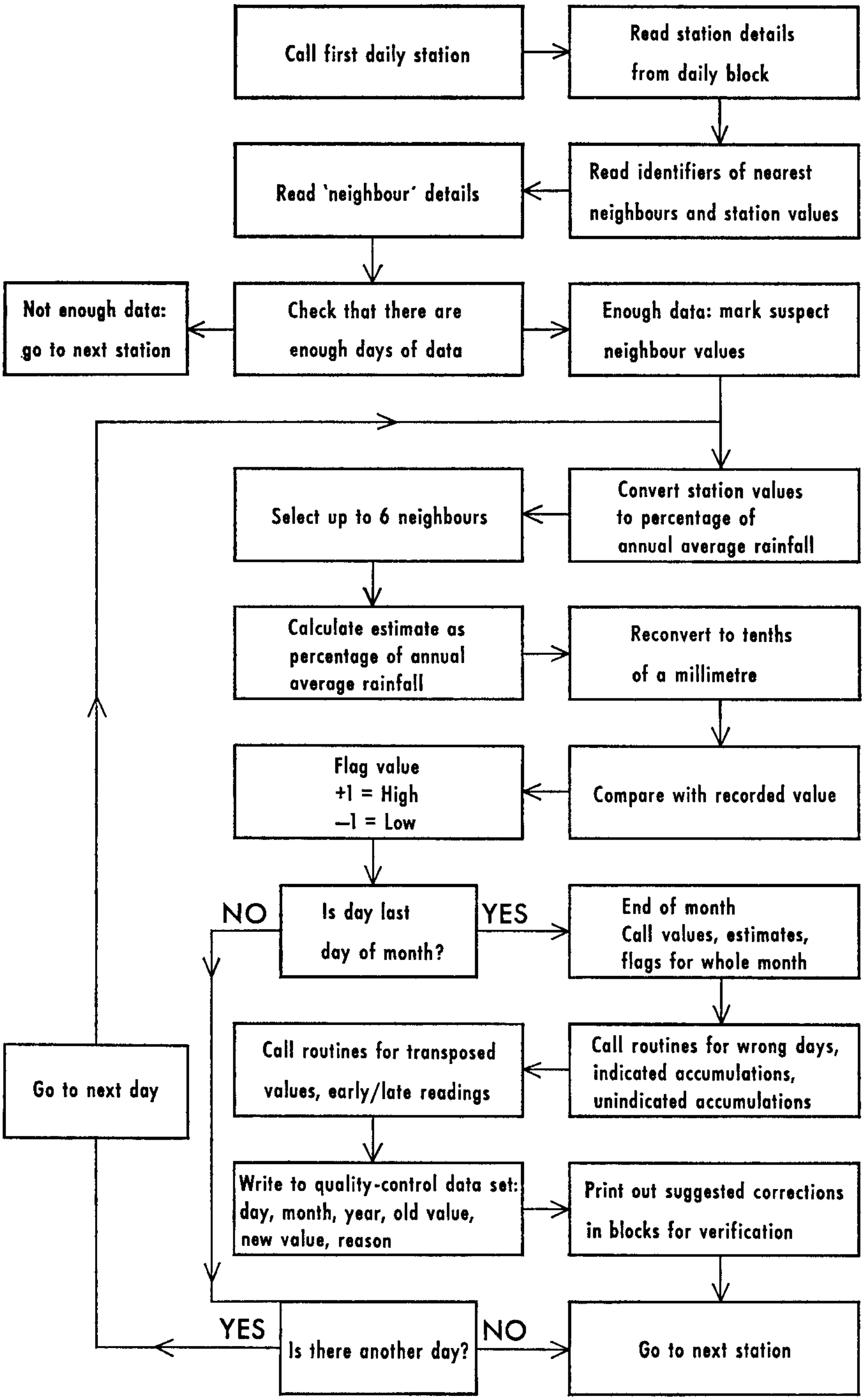

FIGURE 1—STEPS IN DAILY QUALITY-CONTROL PROGRAM

By 'details' in for example block 2 is meant such information as National Grid Reference, station annual average rainfall, etc.

If $n = 1$, it has been found that maxima and minima are accentuated, and undue weighting is given to distant stations. Kelway[2] has shown that $n = 1{\cdot}65$ is an optimum value for a particular station network. For the United Kingdom rain-gauge network $n = 2$ gives equally good results. Some experiments have been carried out to obtain interpolated values by fitting a plane to the data by using a least-squares technique, but the operational advantage of adopting this method are not obvious.

Comparison of recorded rainfall with estimated value. The difference between the recorded and the estimated value is considered to be insignificant if the following conditions are met:

$|\text{DIFF}| \leqslant 2{\cdot}5$ mm, and
$|\text{DIFF}| \leqslant C \times$ error in estimate.

DIFF = difference between recorded and estimated values and C = constant (2·0 for daily quality control and 4·0 for monthly quality control). These values were determined empirically, using the experience of scrutineers to assess the action of the program. If the difference is unacceptably high, the figure is flagged $+1$ or -1, depending on whether the observed total is greater or less than the estimate.

Identification of commonly occurring errors. There are five commonly occurring errors which are suitable for automatic amendment. These are:

(a) Wrong days;
(b) Indicated accumulations;
(c) Unindicated accumulations;
(d) Transposed values; and
(e) Incorrect time of observations.

(a) *Wrong days.* Often an observer will credit the rainfall to the wrong day, for all or part of a month, or alternatively he may put too many or too few zeros in a dry spell, resulting in the rest of the month's values being one or two days out of phase. The amendment routine allocates the observed rainfall totals to the correct day. This is done by shifting the rainfall values backwards and forwards one or two days and correlating the observed data with the interpolated values. The day-shift giving the highest correlation coefficient greater than 0·95 is taken as authentic. Any embedded accumulations are apportioned with this shift applied.

(b) *Indicated accumulations.* It is inevitable that rainfall will occasionally accumulate because an observation has been missed; this is particularly so now that many organizations are working a five-day week. The observer normally marks any accumulations clearly before sending the record to the Meteorological Office. It is relatively simple to apportion the accumulated total in the ratio of the estimated values on the day concerned by using the relationship

$$R_i = \frac{R_{tot}}{\sum\limits_i RE_i} \times RE_i,$$

where R_i = apportioned rainfall for day i,
R_{tot} = accumulated total, and
RE_i = estimated rainfall on day i.

(c) *Unindicated accumulations.* Sometimes an accumulation is not marked, and must be identified before any attempt can be made to apportion the total. This is done by seeking a +1 flag and searching backwards and forwards for a period of 10 days and accepting days with −1 flags and no rainfall, but terminating the run when a day with measurable rainfall is found. The accumulated total is then apportioned by use of exactly the same method which is applied to indicated accumulations.

(d) *Transposed values.* Values may be transposed owing to clerical or other error; the routine is designed to look for pairs of ± flags, and to compare the recorded rainfall on the day flagged +1 with the estimate on the day flagged −1, and vice versa. The values may be transposed if the following relationships hold:

$| \text{DIFF} | \leqslant 2{\cdot}5$ mm, and
$| \text{DIFF} | \leqslant C \times$ error in estimate,

where DIFF = difference between recorded rainfall total and estimated value, and C is the constant defined above.

(e) *Incorrect time of observation.* In many cases it is impossible for an observer to measure the rainfall total at the nominal time; a delay of an hour or two may occur, and in extreme cases a delay of several hours. If there is appreciable rainfall during this time the rainfall total for one day will be enlarged and that for the next day decreased.

The computer program identifies continuous runs of +1 and −1 flags and calculates the sum of the recorded values and the sum of the estimates for each run. If the two totals agree within the limit imposed by the two criteria

$| \text{DIFF} | \leqslant 2{\cdot}5$ mm, and
$| \text{DIFF} | \leqslant C \times$ the combined error in the estimate,

where DIFF is the difference between the totals, then an apportionment is made between the days of the run by using the ratio

$$R_i = RE_i \times RTOT/\sum_i RE_i,$$

where R_i = apportioned value on day i,
RE_i = estimated value on day i, and
$RTOT$ = sum of recorded values in run.

Apportioned values are flagged to indicate the reason for the change.

Storage of amended data on archival rainfall-data disc. The final step in any operational quality-control scheme is the automatic correction of erroneous data, and an indication of the reasons for the amendment. Such a step is being developed, and will eventually be included in the quality-control routines.

The amended values suggested by the computer program are written into the rainfall archive, but data must never be lost by computer action, and therefore a corresponding entry is made in the quality-control data set. This entry consists of station number, date, the original rainfall total, the corrected value, and a reason for the change. Thus the data can be reconstructed if the computer action is judged unnecessary by the scrutineers.

Quality-control of monthly rainfall totals. Figure 2 shows an outline of the steps in the program used to check monthly rainfall totals. Nearest-neighbour stations are used to produce an estimated rainfall total in exactly the same way as for quality control of daily totals. The program then compares both the recorded monthly total and the sum of the daily 'best-estimate'

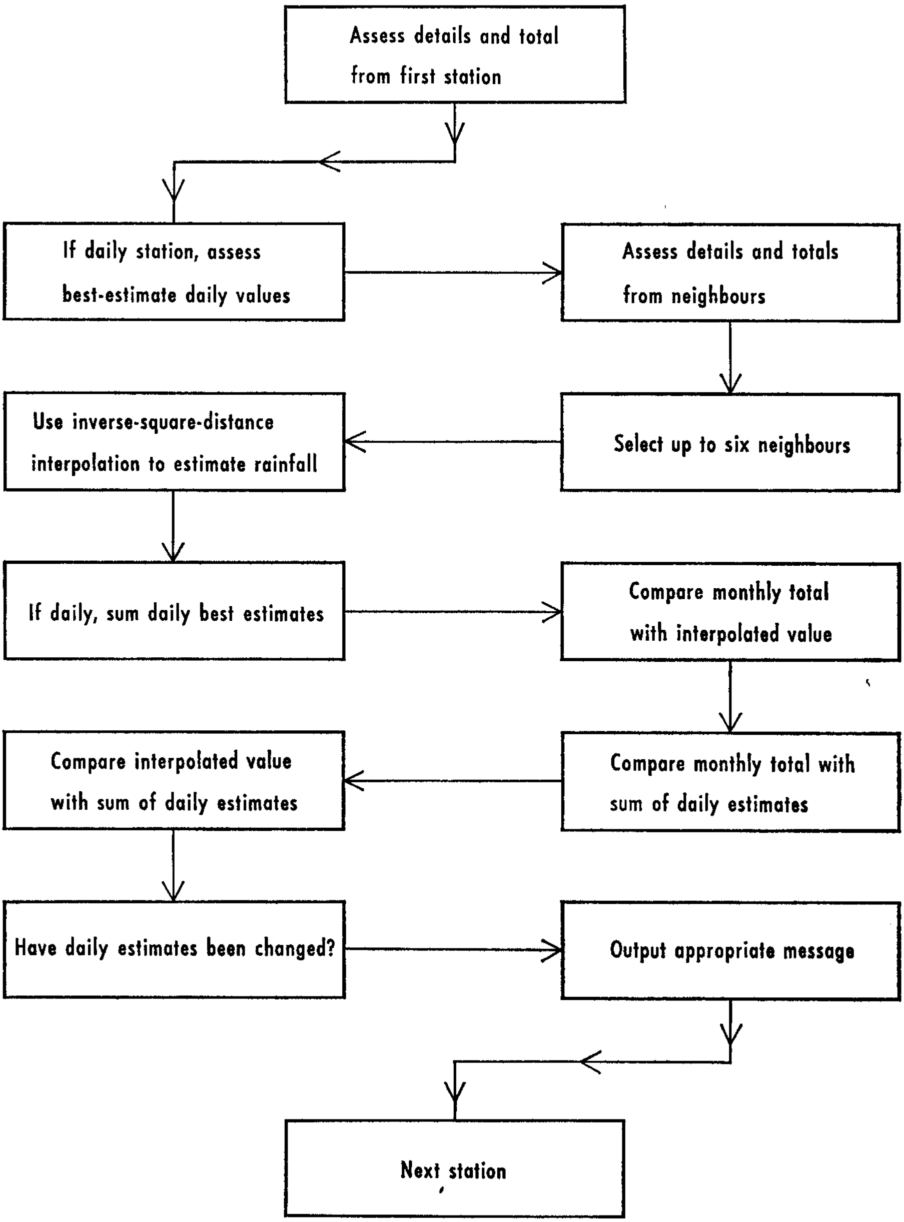

FIGURE 2—STEPS IN MONTHLY QUALITY-CONTROL COMPUTER PROGRAM

totals with the estimated monthly total. The latter comparison acts as a check on the daily quality control. Inconsistencies are flagged, and an error message printed out as guidance for the scrutineer. No attempt is made to amend totals automatically, any alterations being entered manually after verification.

Conclusion. The quality-control routines described in this paper have proved to be a useful tool for operational processing of rainfall data. Computing a rainfall value for comparison purposes by interpolation from surrounding observations is an improvement on previous methods, which were based on area means. The large storage and high speed of the IBM 360/195 computer have enabled the scheme outlined in this paper to control in one operation the quality of a whole month of data from every station in the national network. The time taken for this task is about 30 minutes. Subsequent scrutiny takes a minimum of three weeks at present and is necessary not only to check computer action, but also to resolve cases which the computer is unable to deal with.

There is scope for further experiment with interpolation techniques: a least-squares method of fitting a plane to the data could possibly give a better interpolated value. However, it is doubtful whether a more advanced method than this would be worth while. The constant factor used in flagging errors could be varied regionally in order to reflect the density of the rain-gauge network. It is also desirable, in any automatic rainfall quality-control system, to relate the thresholds used for flagging data to the synoptic situation. The thresholds used operationally are a compromise, giving a reasonably good quality control in most circumstances, but obviously the tolerance allowed before a value is declared erroneous in frontal rain should be different from that used in a very unstable showery situation.

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551.577.37

THE HEAVY RAINFALL OVER NORTHERN ENGLAND IN JULY 1973*

By M. J. PRIOR

Summary. During 15 and 16 July 1973, heavy rainfall occurred over a large area of northern England and the North Midlands. Some places had their heaviest 24-hour and 48-hour rainfalls since records began, and the long duration and large area affected by the fall resulted in widespread flooding, especially in areas adjacent to the southern Pennines.

Introduction. This paper is based on a detailed examination of the heavy rainfall which occurred over a large area of northern England and the North

* This paper is a shortened version of an unpublished report entitled 'The heavy rainfall of mid July 1973' available in the Meteorological Office, Bracknell.

Midlands on 15 and 16 July 1973 and of the meteorological situation which caused it, and as such it complements an earlier article by P. A. Smithson.[1]

The rainfall

Spatial distribution. In the 24-h period beginning at 09 GMT on 15 July 1973 totals in excess of 25 mm were measured over a large part of northern England and the North Midlands, and it has been estimated that over 10 000 km² of northern England had more than 50 mm of rainfall; the areas which received amounts in excess of other thresholds are given in Table I.

TABLE I—THE SIZES OF AREAS WITH RAINFALL GREATER THAN SPECIFIED AMOUNTS IN MID JULY 1973

Period	Size of area with rainfall exceeding			
	150 mm	125 mm	100 mm	75 mm
		square kilometres		
15/09 GMT–16/09 GMT	—	110	620	2600
15/09 GMT–17/09 GMT	240	700	2240	7300

A notable feature of the rainfall distribution was the effect of topography, with the higher totals over and to the east (the windward side) of the Pennines and further heavy falls over the Lincolnshire Wolds, as shown by the isohyetal map for the 48-h period beginning at 09 GMT on the 15th (Figure 1). The 2-day totals, however, resulted not only from frontal rainfall but also from thunderstorms which occurred late on the 16th; these storms gave rainfall amounts exceeding 25 mm in places south-east of the Pennines. The highest 2-day totals were recorded at Derwent Dam (169·7 mm), Howden Dam (167·6 mm) and Rivelin (165·4 mm), all in the southern Pennines. The highest 24-h totals were also measured at these places and details of these and other 24-h totals are given in Table II.

The 119·2 mm recorded at Sheffield on the 15th was the heaviest fall there in a rainfall day since records began in 1881 and the significance of this and of the other 24-h and 48-h rainfalls which were measured east of the Pennines is emphasized when these falls are considered as percentages of the 1916–50 average annual rainfall (AAR). The return period of the rainfalls of various durations is discussed later.

Temporal distribution. Two sources of rainfall affected northern England and the North Midlands during the period 15–17 July. These were:

(a) a prolonged period of heavy rainfall which moved in from the east early on the 15th and intensified early on the 16th, after a lull during the evening of the 15th, and

(b) thundery rain which moved in from the south late on the 16th.

An analysis of tilting-siphon autographic rain-gauge records for about 25 rainfall stations located across northern England made it possible for a study to be made of rainfall as a function of time. Graphs of the cumulative rainfall amounts versus time at four representative sites are given in Figure 2. The graphs show the two periods of heavy rainfall referred to above and cover a period of about 26 hours. The westward movement of the heavier rain and the slow clearance from the south-east on the 16th are also well illustrated.

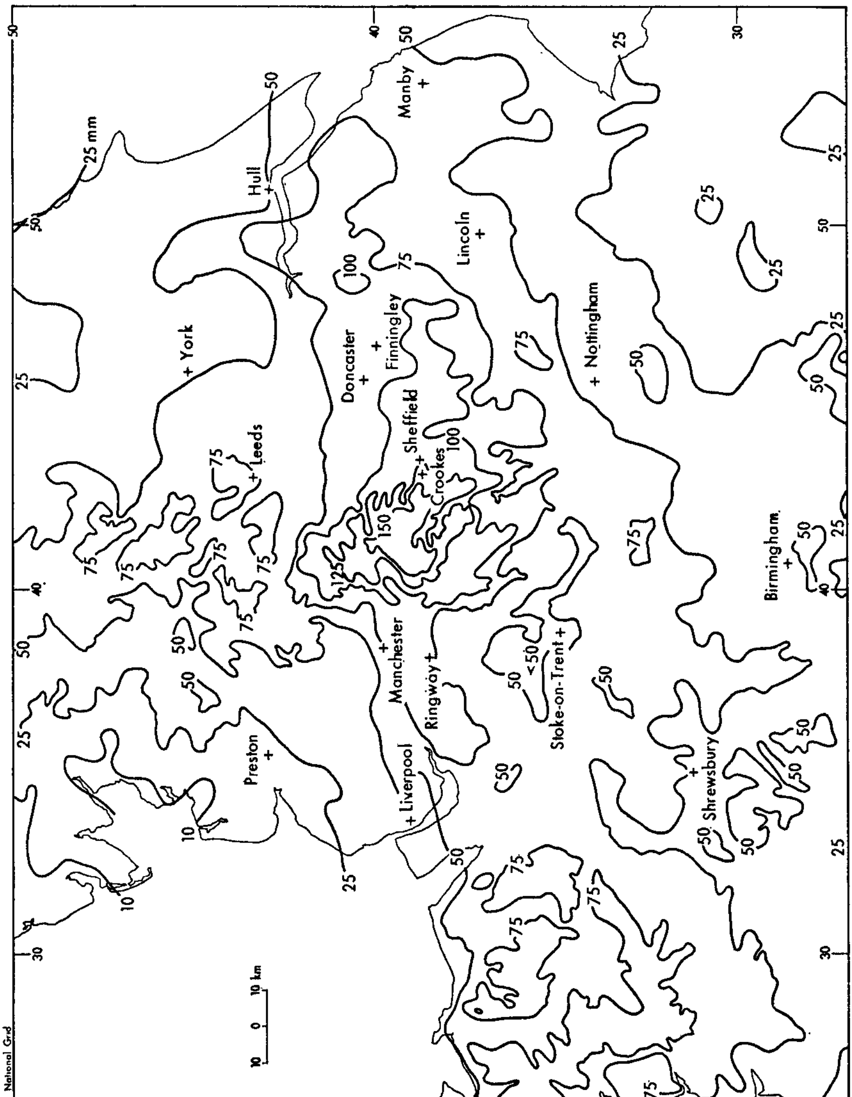

FIGURE 1—RAINFALL IN MILLIMETRES FOR THE 48 HOURS BEGINNING AT 09 GMT ON 15 JULY 1973 FOR NORTHERN ENGLAND AND NORTH WALES

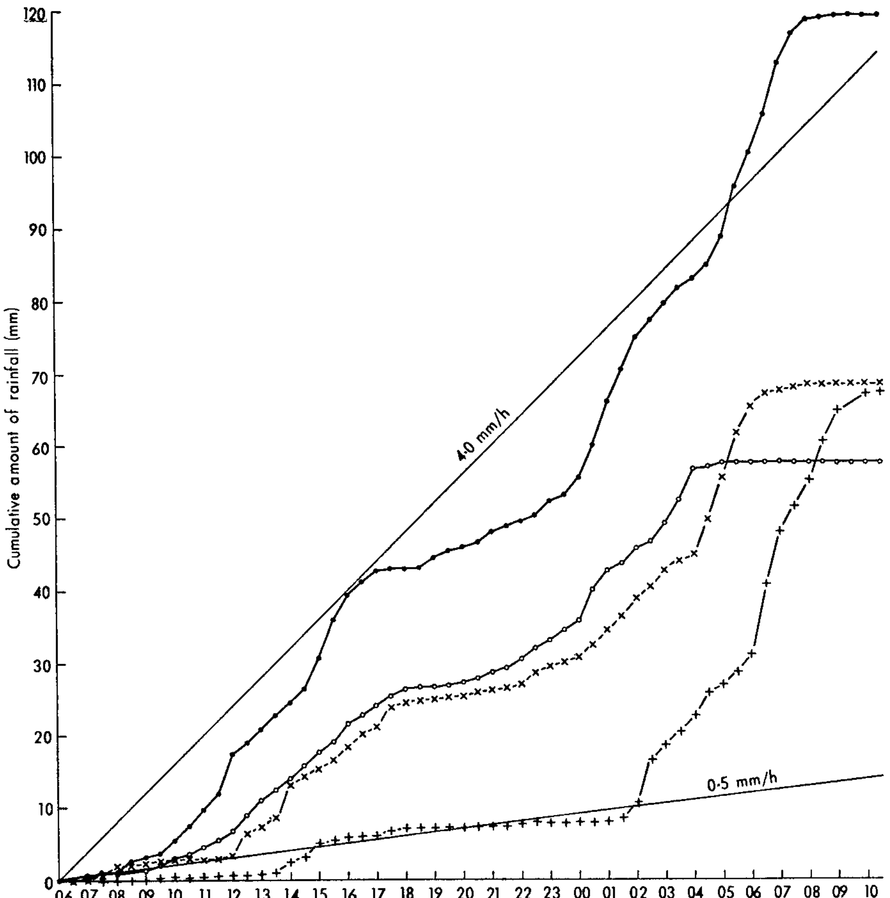

FIGURE 2—GRAPHS SHOWING CUMULATIVE AMOUNTS OF RAINFALL FOR FOUR RAINFALL STATIONS IN NORTHERN ENGLAND FOR THE PERIOD 06 GMT, 15 JULY TO 1030 GMT, 16 JULY 1973

Graph	Station	Number	Grid Reference	Altitude (m)
+——+	Ringway, Manchester*	564419	(33)818850	76
●——●	Crookes, Sheffield	082580	(43)330872	192
×——×	Finningley, Notts.	125843	(43)658988	10
○——○	Manby, Lincs.*	136580	(53)391869	17

These graphs have been compiled by using tilting-siphon autographic records, the totals of which have been adjusted to secure agreement with the stations' check gauges.

* It was necessary to use a tipping-bucket record to complete the graphs for Ringway after 09 GMT on 16 July and for Manby before 09 GMT on 15 July.

In the context of frontal rainfall, that falling at a rate between 0·5 mm/h and 4·0 mm/h is classed as moderate, rain falling at a rate >4·0 mm/h is termed heavy, and a rate <0·5 mm/h is classed as light.

The location of the four stations is given in Figure 1.

Further heavy, thundery rain (not shown in Figure 2) moved into most of northern England by 21 GMT on the 16th and lasted until 06 GMT on the 17th in some parts.

Return periods and comparisons. The hydrometeorological section of the Meteorological Office has estimated the annual and seasonal return periods of the rainfall amounts measured in mid July 1973, by using the methods which were developed in the Flood Studies Project.[2] The annual return periods of some of the 24-h totals are of the order of hundreds of years (Table II), but over shorter durations the rainfall event was not so remarkable. The return periods of the 24-h totals were also calculated for the summer half-year (May–October) and the winter half-year (November–April) and it was found that the amounts recorded in the Sheffield area for example are two to three times more likely to fall there in summer than in winter. Similar results were obtained for other districts to the east of the Pennines and these are in agreement with Bleasdale's conclusion[3] that exceptionally heavy falls are predominantly a summer half-year phenomenon in the areas with lower average annual rainfall (i.e. eastern areas).

The return periods of the areal rainfall over the areas with 2-day rainfall greater than 100 mm and 150 mm were estimated to be 200 years and 500 years respectively. However, the return period of a similar rainfall event occurring in some part or other of Lincolnshire, Nottinghamshire, Derbyshire or Yorkshire is perhaps of the order of 25 years, as suggested by Table III.

On a depth-area-duration basis, events similar to that of July 1973 appear to have been those of 13–15 October 1892[4] and 6–7 August 1922.[5] Moreover, the meteorological situations which caused these two falls of rain in some respects resemble the situation which prevailed in mid July 1973. On both occasions a slow-moving deepening low-pressure area lay over or near the English Channel, and eastern England experienced prolonged rainfall accompanied by strong east-north-east winds. The meteorological situation and its development on 14–15 September 1968[6] also had much in common with the 1973 event, although a different and larger area was affected in 1968 (Table III).

The meteorological situation. The meteorological situation at 00 GMT on the 15th is depicted in Figure 3. The main features are (a) the slow-moving low-pressure area centred to the south-west of the United Kingdom, (b) the contrasting air masses and (c) an easterly flow over Scotland. The front over western France marked the boundary of cold polar maritime air, which was being advected round the depression and towards England. The cold occlusion, which had resulted from an earlier burst of cold air, was preceded by a very moist, warm air mass of western Mediterranean origin and a strong low-level easterly flow was continuously conveying this abundant supply of moisture-laden air towards England.

The first period of heavy rainfall over northern England on the 15th was associated with the cold occlusion (Figure 4). After a lull in the rainfall during the evening of the 15th the arrival of a fresh supply of cold air, associated with the cold front, led to the development of further heavy rainfall which lasted for most of the morning of the 16th (Figure 2). The rainfall area moved very slowly northwards and westwards and tended to die out as it did so as a result of the continual occluding process of the frontal system.

TABLE II—TWENTY-FOUR-HOUR RAINFALL AMOUNTS EQUALLING OR EXCEEDING 100·0 mm RECORDED IN NORTHERN ENGLAND ON 15 AND 16 JULY 1973

Station number	Name	National Grid reference	Amount *mm*	Estimated return period *years*	Percentage of Average Annual Rainfall for 1916–50	Period (GMT)
078701	Ramsden	(44)116051	104·9	90	6·8	15/0900–16/0900
081548	Harden	(44)150035	109·3	80	7·8	15/0900–16/0900
081875	Flouch Road	(44)205004	101·9	110	9·1	15/0800–16/0800
081892	Langsett Res.	(44)211003	108·2	150	10·2	15/0800–16/0800
081895	Upper Midhope	(43)215999	102·8	100	9·6	15/0800–16/0800
081915	Midhope	(43)219994	103·4	110	8·8	15/0700–16/0700
082093	Broomhead Res. No. 2	(43)272959	106·3	210	12·0	15/0800–16/0800
082111	Morehall Res.	(43)289957	108·3	250	12·7	15/0800–16/0800
082295	Bradfield Filters	(43)261916	121·5	320	12·1	15/0800–16/0800
082512	Redmires Res.	(43)267856	116·0	320	10·9	15/0800–16/0800
082527	Rivelin	(43)287869	137·4	840	14·5	15/0800–16/0800
082580	Crookes	(43)330872	117·4	450	14·5	15/0800–16/0800
082583	Sheffield	(43)339873	119·2	540	15·3	15/0900–16/0900
082851	Sheffield, Riverdale Road	(43)324859	116·9	430	14·6	15/0900–16/0900
084834	Aldwarke S. Wks	(43)444943	105·4	390	16·6	15/0900–16/0900
084927	Firsby Res.	(43)495958	114·3	520	16·9	15/0900–16/0900
085831	Wortley Res.	(43)308998	100·3	210	12·3	15/0700–16/0700
106238	Howden Dam	(43)168924	128·7	200	10·0	15/0800–16/0800
106295	Derwent Dam	(43)175899	133·8	320	10·1	15/0800–16/0800
106430	Wood Cottage	(43)128896	108·5	100	7·1	15/0900–16/0900
106601	Bamford Filters	(43)212830	107·4	190	10·5	15/0900–16/0900
106869	Bamford	(43)202829	112·0	240	11·1	15/0800–16/0800
107149	Eyam Hall	(43)217764	106·8	200	11·4	15/0900–16/0900
107268	Barbrook Res.	(43)281770	108·5	250	11·9	15/0800–16/0800
124801	Ranskill S. Wks	(43)668878	139·0*	1430	23·7	15/1400–16/1400
558489	Kinder Filters	(43)054880	124·7	180	10·7	15/1030–16/1030

* The total measured at Ranskill S. Works (North Nottinghamshire) is suspect when compared with the neighbouring values of about 80 mm for the wetter 24-h period beginning 15/0900 GMT.

TABLE III—DATES, PLACES AND ESTIMATED AREAS AFFECTED BY FIVE WIDESPREAD, HEAVY FALLS OF RAIN IN EASTERN ENGLAND

Dates and areas affected	Size of area with rainfall exceeding 200 mm	150 mm	125 mm	100 mm	75 mm
	square kilometres				
13–15 Oct. 1892 Yorks., Lincs.	—	50	600	2900	8000
6–7 Aug. 1922 Yorks., Derby., Notts.	—	—	350	2300	8600
3–4 Sept. 1931 Yorks., Derby., Notts.	Not yet calculated, but very large				
14–15 Sept. 1968 South-east England	13	575	2350	6250	12500
15–16 July 1973 Yorks., Derby., Lincs.	—	240	700	2240	7300

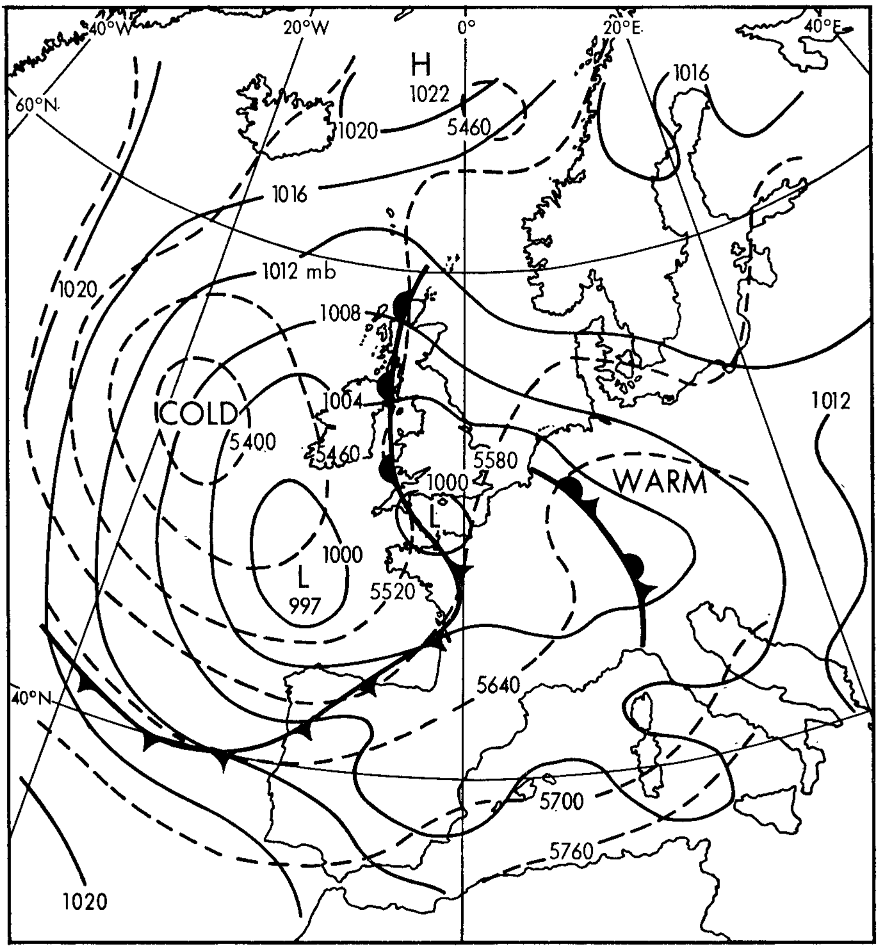

FIGURE 3—SURFACE AND 1000–500-mb THICKNESS CHART FOR 00 GMT ON 15 JULY 1973

——— Surface pressure — — — 1000–500-mb thickness in geopotential metres

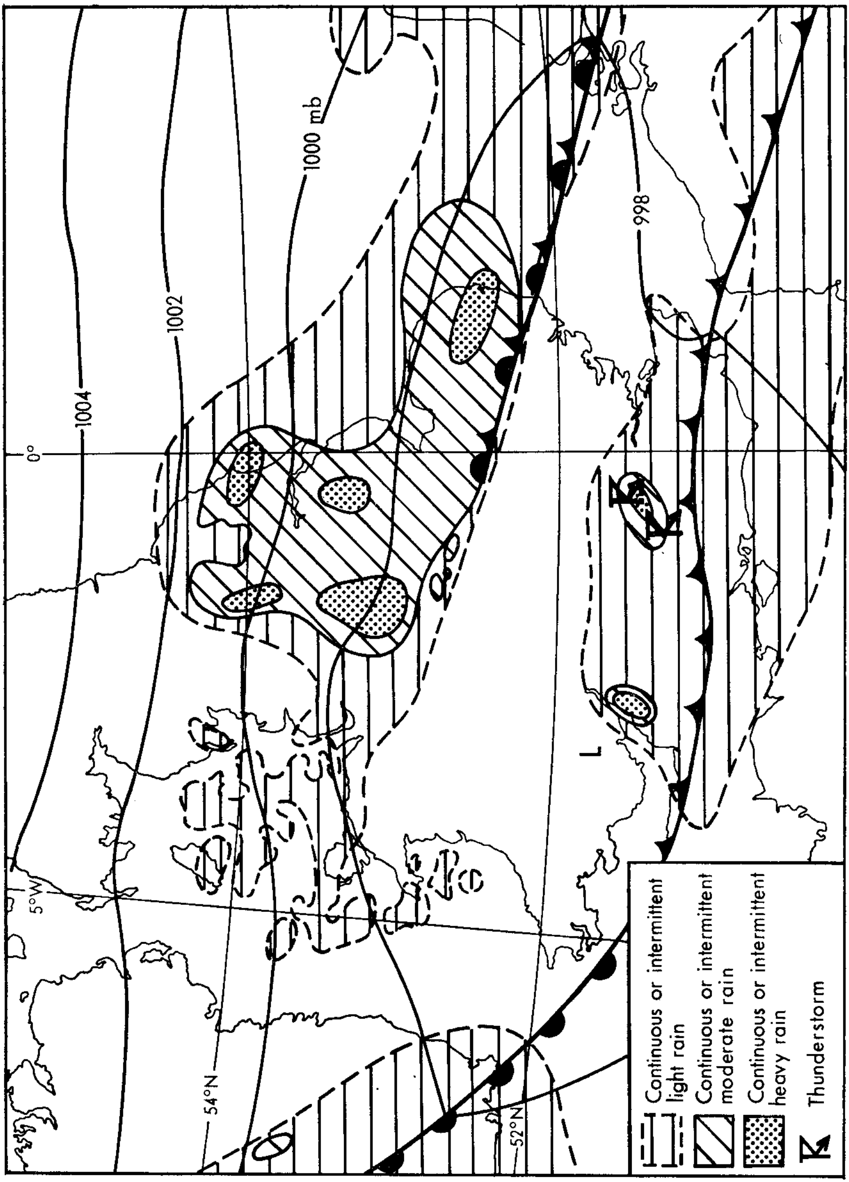

FIGURE 4—SURFACE CHART FOR 12 GMT ON 15 JULY 1973

The processes which produced the rainfall over northern England were (a) low-level convergence chiefly as a result of surface friction, (b) forced ascent of the moist easterly airstream by topography and (c) ascent of the easterly flow at the frontal surface. High pressure was maintained to the north of the British Isles and this had an overall blocking effect which helped to maintain the rather strong easterly flow and hence the supply of warm moist air.

The subsequent pool of very cold air, extending to high levels, was associated with the depression over southern England at 00 GMT on the 16th (Figure 5).

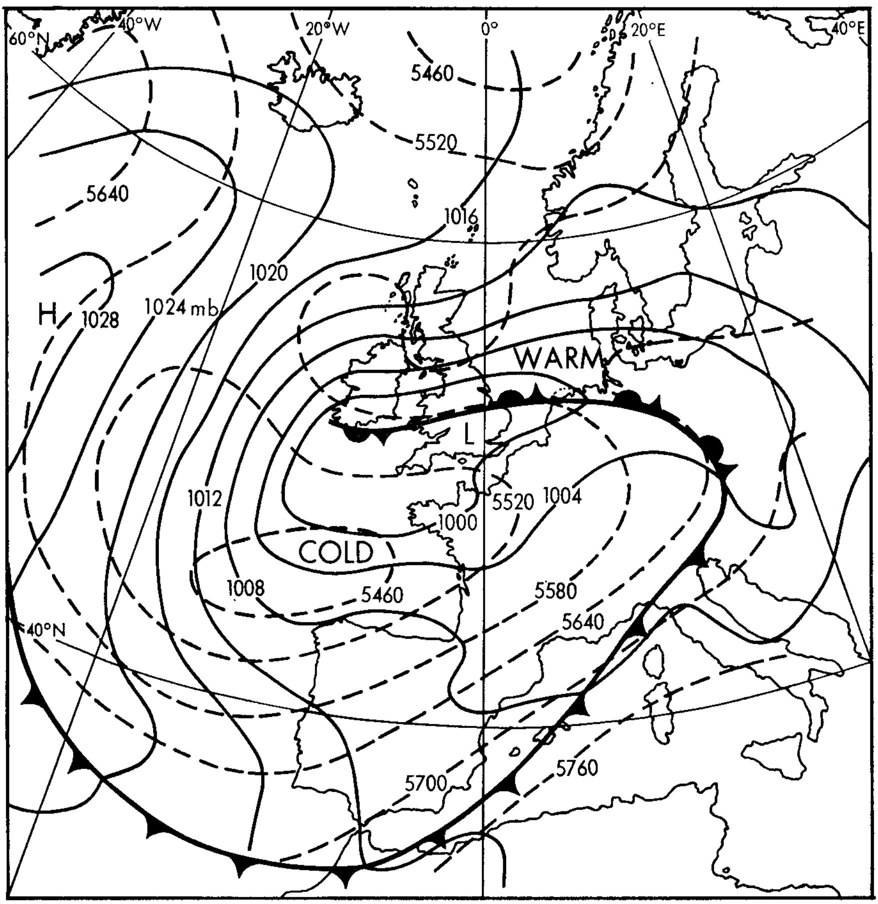

FIGURE 5—SURFACE AND 1000–500-mb THICKNESS CHART FOR 00 GMT ON 16 JULY 1973

——— Surface pressure — — — 1000–500-mb thickness in geopotential metres

Such conditions are ideal for the development of thunderstorms, especially over land during the summer months. Thunderstorms had developed over southern parts of the country by 12 GMT on the 16th (Figure 6) and the

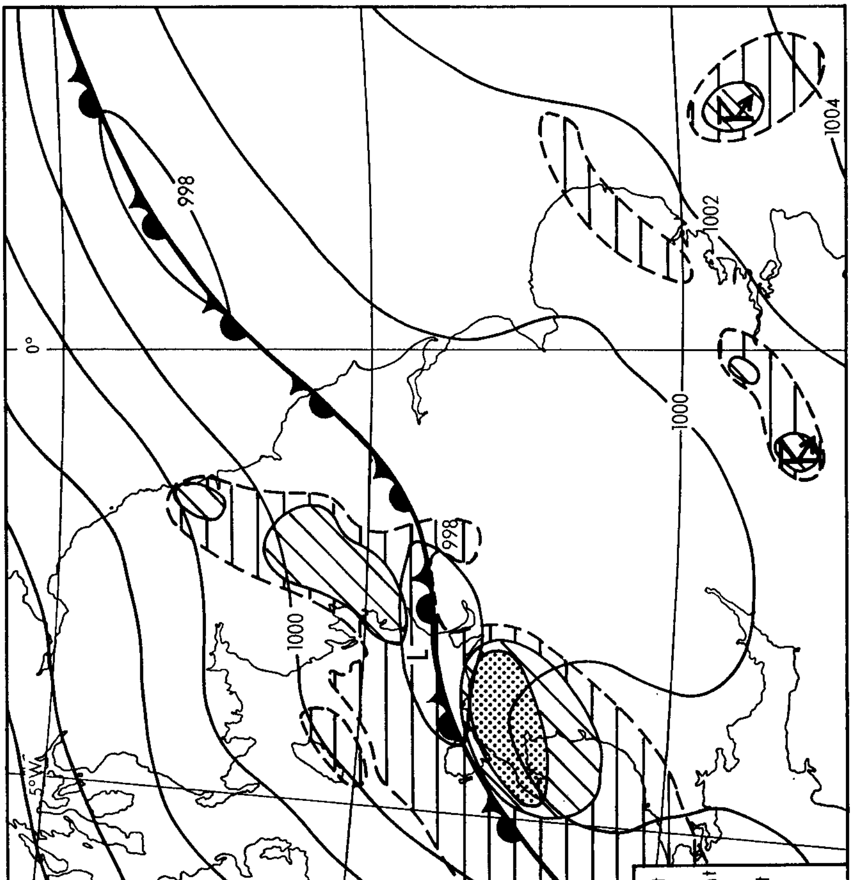

FIGURE 6—SURFACE CHART FOR 12 GMT ON 16 JULY 1973

thundery rain became more organized whilst it moved northwards. The rainfall attributed to these thunderstorms amounted to more than 25 mm in some parts of northern England.

The July 1973 rainfall event occurred when (1) the soil moisture deficit (SMD) was large in parts of northern England (over 100 mm SMD in west Yorkshire on 11 July) and (2) the south Pennine reservoirs were about 75 per cent full. Hence both the soil and the reservoirs were capable of absorbing a significant proportion of the rainfall and the subsequent flooding (principally in the valleys of the Rivers Mersey, Don, Rother, and Derbyshire Derwent) was not as disastrous as it might have been.

It is of interest to consider whether a similar rainfall event could happen in the winter months when conditions (1) and (2) above might not apply. The possibility of a negative answer to this question has been indicated in the section dealing with return periods and comparisons, and this is cautiously confirmed by meteorological considerations. The criteria for this type of prolonged rainfall are the proximity of a slow-moving depression—preferably to the south or south-west—with a flow of moist air being forced to ascend in a quasi-stationary convergent zone. The higher the temperature of this air, the greater its capacity to hold moisture and thus, in general, summer and early autumn are the favoured seasons for very heavy rainfall in eastern England.

Acknowledgement. I should like to thank my colleagues in the hydrometeorological section of the Meteorological Office for their assistance in the preparation of this paper, and in particular Mr M. C. Jackson and Mr P. Wescott for their contributions to the section dealing with return periods and comparisons.

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REVIEWS

An introduction to agrotopoclimatology, WMO *Technical Note* No. 133, by L. B. MacHattie and F. Schnelle. 275 mm × 210 mm, pp. xii + 131, *illus.*, Secretariat of the World Meteorological Organization, Geneva, Switzerland, 1974.

Although much of the subject matter of this *Technical Note* has been studied for centuries (under local climatology, and, more recently, mesoclimatology) the upsurge of interest which followed the Second World War in urban climate, in the control of industrial pollution, in certain aspects of aviation and aerospace activities and particularly in agricultural meteorology, has inevitably resulted in the need to amass, codify, synthesize and extend our knowledge of the effects on the climate of the lowest few tens of metres of the atmosphere exerted by the physiographic and physical properties of the earth's surface. K. Knoch (in Germany) and C. W. Thornthwaite (in the U.S.A.) firmly established these studies in the early 1950s and adopted the term 'topo-climatology' to distinguish it from the associated microclimatology. The further restriction to *agro*topoclimatology is self-explanatory.

The publication consists of (1) Introduction (pp. 1–4); (2) Elements of topoclimatology (pp. 5–17); (3) Conduct of agrotopoclimatological surveys (pp. 18–31); (4) Examples of surveys (pp. 32–35); (5) Bibliography (pp. 36–110)—an extended list (hardly the 'survey' as described in the Summary) of over 1000 items (arranged alphabetically by authors) and followed by titles and publishers of some 160 relevant scientific journals in which, nevertheless, the valuable series of Proceedings of Symposia held partly under UNESCO auspices is merely referred to as 'UNESCO Publications'.

Chapters 1 and 4 might well be read first to indicate the problems, motivation and investigational procedures. The remainder will be found to pack a considerable amount of information into the few pages devoted to each individual topic.

There is proper emphasis in Chapter 3 on the fact that the design of any investigation, the required observational accuracy and procedures etc., are significantly governed by the practical objectives which are typical of studies in agricultural meteorology. It is stressed, for example, that one needs to consider how data are to be analysed and presented before deciding upon the type and scheduling of the observations. Portions of this chapter may appear inappropriate for a *Technical Note*, but it must be realized that, in developing countries, WMO publications may well be the only authoritative, comprehensive and up-to-date meteorological literature available to the Meteorological Service.

Any reviewer can note some omissions, e.g. the parametric description of landscape, the effect on surface airflow of arrays of definable obstructions, and ground surface temperatures—but, all in all, this is a useful and by no means premature compilation.

R. W. GLOYNE

Solar activity and related interplanetary and terrestrial phenomena (Volume 1 of Proceedings of the First European Astronomical Meeting, Athens, 4–9 September 1972, edited by J. Xanthakis. 250 mm × 170 mm, pp. xv + 195, *illus.*, Springer Verlag, 1 Berlin 33, Heidelberger Platz 3, Berlin-West, 1973. Price: DM 94.

In an attempt to bring European astronomers into close contact with each other, the Greek National Committee for Astronomy organized the first European Regional Meeting in Athens in September 1972. This book is one of three volumes covering the proceedings and is restricted in subject matter to the solar system. The second and third volumes are concerned with 'Stars and the Milky Way System' (edited by L. N. Mavridis) and 'Galaxies and Relativistic Astrophysics' (edited by B. Barbanis and J. D. Hadjidemetriou) and neither of them contains papers of interest to meteorologists.

Following a review paper on Interplanetary Solar Phenomena by L. D. de Faiter, the discussion of solar activity deals mainly with solar-cycle studies and indices of activity and leads to discussions of correlations with terrestrial and lunar effects.

Meteorologists may be interested in the paper on Solar Activity and Precipitation by J. Xanthakis. In recent years there has been considerable discussion on the possible effects of variable solar activity on various meteorological and climatological phenomena. This paper joins the growing list of statistical analyses of the problem, but like many other contributions in this field, the paper is devoid of hypotheses to explain what is happening. Annual precipitation data for the northern hemisphere were examined for long-term periodicities and the results are suggestive of the influence of solar activity.

The empirical-statistical links between variable solar activity and large-scale meteorological phenomena are tantalizing. But we should guard against drawing strong conclusions until these results have been quantitatively analysed within a general meteorological framework.

There are four papers on planetary atmospheres in this volume; they are all very poor, and written in a parochial manner suggesting that all authors have little or no knowledge of the wealth of literature already published in their chosen fields. The discussions of the Martian atmosphere are the worst. Although they were written in 1972, no results are included from the MARINER 9 mission which radically changed our view and understanding of the Martian atmosphere.

The remaining articles in the volume are concerned with X-ray astronomy and discussions of large national and international astronomical projects and plans for the future development of ground-based and satellite installations for studying solar activity.

This book is very expensive and covers a rather limited scientific field both in content and in depth. I cannot believe that many libraries will buy it and certainly very few people will feel that this book is a worthwhile purchase. The small scientific community interested in this subject would have been better served with a less expensive 'conference proceedings' available more quickly after the meeting.

G. E. HUNT

Arizona climate 1931–1972, *revised second edition*, edited by William D. Sellers and Richard H. Hill. 240 mm × 310 mm, pp. vii + 616, *illus.*, The University of Arizona Press, Box 3398, Tucson, Arizona 85722, 1974. Price: $18.00.

This is the second edition of a book first published in 1964. About 40 pages are devoted to a general description of the climate of Arizona, and this is related to synoptic meteorology through consideration of the characteristic weather patterns leading to extreme temperatures, maximum precipitation and snowfall within Arizona. This section also presents the available data on wind direction and speed, cloudiness and evaporation. The major part of the volume, over 540 pages, consists of temperature and precipitation data for over 330 stations. There is a brief text describing the topography, vegetation and climate of each station, accompanied by a summary giving monthly and annual means and extremes. There are a number of photographs illustrating the varied topography of Arizona, but these are without captions and do not appear to relate specifically to the surroundings of the climatological stations.

The purpose of the publication is not altogether clear. It is unlikely that a customer desiring information for design or planning purposes will require data for more than a small fraction of the stations included in this volume and his needs could possibly be met more economically by print-outs from computer data-banks. Further it is probable that the customer's real requirement is for further analysis of the data, for example frequency tables of values of temperature, or bivariate frequency tables covering temperature and humidity, wind direction and speed, etc.; such requirements are not met in this volume, despite its considerable size.

P. G. F. CATON

551.515.3

LETTER TO THE EDITOR

Comments on 'The tornadoes of 26 June 1973'

I agree with the conclusions of Mr Whyte[1]—the storm of 26 June 1973 was undoubtedly 'a severe travelling storm of the wind-shear type'. As mentioned in his article, several other such storms have been observed in Great Britain. Furthermore, a number have been observed elsewhere in Europe, both by myself and by others—notably by the thunderstorm study group at the Atmospheric Physics Laboratory at the Swiss Federal Institute of Technology in Zürich (LAPETH, for short).

Nearly all severe storms occurring in Europe have the appearance of organized, travelling storms of the wind-shear type. Although exceptionally strong local convergence may cause a severe hailstorm to develop (see for example Staude[2]) such storms will be neither long-lasting nor organized. Of the 37 cases analysed thoroughly by Fenner,[3] a few fell into this category, but most were organized storms of the type proposed observationally by Browning[4,5] and theoretically by Moncrieff and Green.[6] (The dynamics suggested by Newton[7] are not supported by the substantially more rigorous work of Moncrieff and Green; his model must thus be revised.)

Mr Whyte noted the general absence of an environment characterized by a moist stable layer, with dry air above. The 37 cases cited above also show little evidence supporting such an air mass as 'typical' for Europe. Darkow[8] and Miller[9] noted that the 'typical tornado sounding' from the Pacific Northwest of the United States and Canada, a region far more similar to Europe than is the central area of the United States, does not contain an inversion. Soundings in Europe prior to severe local storm occurrences are similar to Miller's 'Pacific Northwest sounding'.

I also agree completely with all comments in Mr Whyte's first paragraph under 'Comparisons with similar situations' on pages 168–169; the main requirement for severe events accompanying thunderstorms is for the updraught to remain vigorous for comparatively long periods, i.e. to be 'steady'. Furthermore, the storm must have an organized downdraught, the importance of which is generally ignored! Without a vigorous, sustained downdraught, a storm cannot become an organized, travelling severe local storm.

There are three important interactions required before a thunderstorm evolves into a severe, organized, travelling storm: (a) between the updraught and downdraught in the 'mature' stage; (b) between the storm circulation and mesoscale circulation; and (c) between the storm and the wind shear. It is these three interactions which appear to cause organization.

It is common knowledge that severe storms characteristically move to the right of the path taken by 'non-severe' storms developing in the same area. After a storm becomes organized, it has an 'open' circulation (i.e. the environmental wind forms a part of the storm's circulation) and propagates continuously towards the direction which maximizes the kinetic energy of the low-level inflow air supply. The more common 'local' thunderstorms have a 'closed' circulation, i.e. it remains entirely within the storm.

In most cases, the low-level air entering the storm from upshear will have the greatest kinetic energy relative to the storm; in fact, in the 37 cases studied by Fenner, as well as the 26 June storm, the best predictor of severe storm movement was the mean wind-shear direction. On the contrary, for 'local' thunderstorms, which do not propagate continuously, the mean wind is the best forecast of movement.

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NOTES AND NEWS

Flood Studies Conference

A conference on Flood Studies will be held on 7–8 May 1975 at the Institution of Civil Engineers. The Flood Studies Report recently published by the Natural Environment Research Council will be considered, and authors and potential users will present papers discussing the results and their applications to practical problems. The Institution's draft manual on 'Floods in relation to reservoir practice' will be introduced and be open to discussion.

There will be six sessions at the conference, the first of which is expected to be chaired by Mr J. K. Bannon, Director of Services, Meteorological Office. Papers will be read by members of the Meteorological Office, the Institute of Hydrology, the Hydraulics Research Station, university departments and public water authorities.

Programmes and application forms may be obtained from the Conference Office, The Institution of Civil Engineers, Great George Street, Westminster, London SW1P 3AA.

Dial-the-weather Service for Lake District visitors

The Lake District National Park Information Service has installed an automatic telephone-answering system to cope with the hundreds of calls that it receives for weather information. Callers are now immediately connected to a recorded summary.

At first the service, specially provided in conjunction with the Main Meteorological Office, at Preston, covered conditions only at week-ends and on public holidays, but it is now being extended to become a full daily service.

At about 1630 an outlook for climbers and walkers is issued, covering the period from dawn to dusk on the following day; at about 0730 the next morning a more specific forecast is issued, covering all the usual weather elements.

The number to dial is Windermere 5151, and the service is being publicized through local newspapers and notices in hotels and guest-houses. The equipment used has an ultimate capability of accepting simultaneous calls on up to 10 Post Office lines, although initially only two lines have been in use.

Retirement of Mr J. Briggs

On 17 March 1975 Mr James Briggs retired from the Meteorological Office, where for the past three years he has held the post of Assistant Director, Special Investigations, having previously had an extremely varied career in both the Services and Research Directorates.

Mr Briggs joined the Office in May 1937 and after a short spell at the Training School at Croydon he was posted to Larkhill for sound-ranging duties. In September 1939 he was commissioned as a Flight Lieutenant in the Royal Air Force Volunteer Reserve and sent to France with the 1st Sound-ranging Battery, eventually being evacuated from Dunkirk in 1940. After a short spell in England he spent the rest of the war in North Africa and Italy, mainly as Senior Meteorological Officer at HQ 242 Group and at HQ 205 Group.

After demobilization in January 1946 Mr Briggs was posted as a Senior Scientific Officer to Dunstable where he served as an upper-air forecaster for seven years. On his promotion to Principal Scientific Officer in October 1953 he was posted as Senior Meteorological Officer to HQ 12 Group at Watnall, and at one time was in charge of 17 outstations.

In January 1961 Mr Briggs was moved to the Atmospheric Physics Branch, where he spent three and a half years doing research into clear-air turbulence. During this period several of his papers were published, one of the most interesting being concerned with wind-tunnel experiments using a model of the Rock of Gibraltar.

In July 1964 Mr Briggs was given a C.C. commission as Group Captain in the Royal Air Force and was posted as the Chief Meteorological Officer to SHAPE at Versailles, where he remained until the end of 1966. On his return he spent a short period in the Instruments and Observations Branch before joining the Special Investigations Branch. He became Head of this Branch on his promotion to Senior Principal Scientific Officer on 1 August 1972. During the last few years papers dealing with the probability of aircraft encounters with heavy rain and hail were among those written by Mr Briggs, and he has represented the Office on several national committees.

We all wish Mr and Mrs Briggs many years of happy retirement.

F. H. BUSHBY

HONOUR

The following honour was announced in the New Year's Honours List, 1975:

I.S.M.

Mr E. J. Crouch, Office Keeper I, OS4c, Meteorological Office Headquarters, Bracknell.

OBITUARIES

It is with regret that we have to record the death of Mr N. W. Baker, Scientific Officer, Met O 12 on 15 December 1974 and of Mr J. Kaye, Higher Scientific Officer, Watnall on 30 December 1974.

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It is requested that all books for review and communications for the Editor be addressed to the Director-General Meteorological Office, London Road, Bracknell, Berkshire, RG12 2SZ, and marked 'For Meteorological Magazine'.

The responsibility for facts and opinions expressed in the signed articles and letters published in this magazine rests with their respective authors.

Printed in England by Heffers Printers Ltd, Cambridge
and published by
HER MAJESTY'S STATIONERY OFFICE

28p monthly **Annual subscription £3·78 including postage**

Dd. 289060 K16 4/75 ISBN 0 11 723071 5