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Examples of banded rainfall distributions in potentially unstable conditions over southern England

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Summary

Maps of 24-hour rainfall totals during the period October 1977 to February 1978 have been examined with special regard to spatial variability of rainfall. Variability was greatest in unstable situations and marked rainbands, similar to those previously documented in warm-sector or pre-warm-sector conditions, occurred in several potentially unstable situations. It is suggested that the main factors involved in the formation of such rainfall distributions include orographic influences, variability of surface (land and sea) temperatures, localized low-level convergence and, on a larger scale, the effects of low-level troughs.

Introduction

Nicholass and Harrold (1975) showed that, if R_S is the rainfall in a stated period averaged over a subcatchment of area, say, 60 km^2, and if R is the rainfall in the same period averaged over a much larger area containing the subcatchment, the ratio R_S/R is dependent upon synoptic type and upon surface wind direction. It was found, generally, that R_S/R varied between about 0·5 and 2·0 and that the distribution of areal rainfall for particular synoptic types could be predicted, provided that the large-scale rainfall could be forecast perfectly over the whole catchment. However, the largest scatter of R_S/R was, not surprisingly, found to be in synoptic types giving showers and thunderstorms where, in one subcatchment, the ratio fell to 0·03.

Maps of 24-hour daily rainfall totals (09–09 GMT), plotted by computer and analysed by meteorologists, have been available as aids to the quality control of rainfall totals since October 1977, and a record has been kept of those charts displaying coherent isohyetal patterns of highly variable precipitation. From about 250 maps available for study, there were 34 which would appear to justify further investigation. Fourteen showed marked rainbands* and, of these, 7 were on days with broadly similar synoptic situations and characterized by sporadic outbreaks of rain or by showers. Circumstances

* A rainband is regarded as a distribution of rainfall shown by an isohyetal pattern with a long narrow area of high rainfall.

associated with these situations were examined, employing such information as would be available to a bench forecaster, in an endeavour to identify, in a qualitative way, possible associations with the appearance of the rainbands.

The rainband phenomenon has been studied in detail by Harrold (1973), Browning, Hardman, Harrold and Pardoe (1973), Browning and Bryant (1975), and Hobbs and Locatelli (1978), and is well documented. Harrold (1973) paid much attention to the 'conveyor-belt' as an important mechanism in the large-scale distribution of precipitation. He described the conveyor-belt as a 'well-defined stream of air, bounded at the top by air of a different origin advecting over the cold front, bounded in the west by the cold front and in the east by the edge of the significant northward flow of air'. Later, he stated that 'the effect which orography has on the precipitation within a baroclinic disturbance depends upon the stability of the atmosphere, the effects being more marked in an unstable atmosphere, that is toward the western warm-sector portion of the conveyor-belt'. The example he quoted, with a 24-hour rainfall total map for the period ending 09 GMT on 12 November 1969, was indeed most striking. It showed a rainband extending from the Brecon Beacons, north-eastwards, right across to the north-east coast of England, east of the Yorkshire Wolds. Almost all this rain, however, fell within a warm sector, whereas, in the examples which follow, the rainbands occur in showery, cyclonic situations and are again notable for their large gradients of rainfall depth.

Synoptic situations

(a) *5–9 October 1977*

A complex area of low pressure covered western parts of the British Isles throughout the period (Figures 1(a), 2(a), 3(a), 4(a)) with an associated upper vortex (Figures 1(b), 2(b), 3(b), 4(b)). As shown by the Camborne upper-air ascents (Figures 1(c), 2(c), 3(c), 4(c)), the air mass remained potentially unstable to at least 3500 m. Low 'D' intensified during the 5th with the main centre forming just off the Brest Peninsula and deepened to 984 mb by 06 GMT on the 6th. During the 6th a number of fronts developed and moved northwards over the British Isles (Figures 1(a), 2(a)). By 06 GMT on the 7th the whole of southern England was covered by cold air and was later affected by a series of troughs (Figure 4(a)); this situation persisted until the 9th. Winds at 700 mb were generally southerly over southern England throughout the period, backing temporarily south-easterly on the 7th and finally veering south-westerly by 00 GMT on the 9th.

Discussion. Shone (1979) has discussed the heavy rainfall over west Cornwall during the period 18 GMT on 5 October to 12 GMT on 6 October 1977 and suggested that, in common with a similar occurrence of heavy rain on 21 March 1976 (Shone 1978), backing and strengthening of the thermal wind and hence increasing baroclinicity was a significant contributory factor. The heaviest rain fell in a narrow band just west of the surface trough (Figure 1(a)) which travelled only a short distance east from St Mawgan and Culdrose before halting and returning westward. It is worthy of note that one rainfall station within this rainband reported 94 mm of rain during the 24-hour period ending at 09 GMT on 6 October, whilst another station, only 13 km to the east, reported only 11 mm (Figure 1(d)).

It would seem that, in addition to the strengthening of the baroclinic zone, marked low-level cyclonic wind shear on the surface trough could have contributed to the trigger required to release the potential instability shown by the Camborne ascent (Figure 1(c)), the rainband being aligned with the 700 mb wind (Figure 1(b)).

By 00 GMT on 7 October a separate upper vortex had developed in association with Low 'D', causing the 700 mb winds to back to south-easterly over south-west England (Figure 2(b)). Although the two cold fronts (Figure 2(a)) moved north-eastwards across the study area, the rainfall distribution

(Figure 2(d)) still had a banded structure with the bands aligned with the 700 mb wind direction. Some apparent orographic enhancement was also in evidence over the higher ground of Dartmoor and Exmoor. At midnight on 8 October there were no fronts over England or Wales (Figure 3(a)) but the low-level north-west-moving air mass remained potentially unstable (Figure 3(c)), requiring a temperature of around 16 °C to generate convection leading to showers. Figure 3(e) shows the five-day mean sea isotherms for 5–9 October for the English Channel. It can be seen that mean sea temperatures in the vicinity of the Isle of Wight were likely to have been generally about 16 °C; maxima of 17 °C were reported, high enough to initiate convection leading to shower formation. Once these convective cells had developed, they moved northwards in the southerly upper flow (cf. 700 mb wind flow, Figure 3(b)). Figure 3(d) shows that the rainfall distribution for the 24-hour rainfall period ending at 09 GMT on 8 October had two distinct bands of higher rainfall. The apparent association with the shallow Weymouth and Swanage Bays, both probably having sea temperatures a little higher than those off St Alban's Head, gives grounds for speculating that the rain-producing clouds were generated there.

The 12 GMT chart for 8 October (Figure 4(a)) shows a trough-line, separating low-level south-easterly winds from south-westerlies, moving up towards southern England from Brittany. This trough was responsible for fairly widespread outbreaks of rain over central southern England. Figure 4(d) shows, however, that the rainfall distribution still retained a definite rainband pattern: one rather wide band extending north-north-eastwards from the west Solent and further narrower bands extending north-eastwards, one aligned with the 700 mb flow (Figure 4(b)) from the South Downs, north of Selsey Bill, and another from near Bexhill. It would seem that potential instability (see Figure 4(c)) may have been released as the low-level flow was lifted over the South Downs which rise to 200 m in places; stations south of the Downs all reported less than 10 mm of rain during the 24-hour period ending at 09 GMT on 9 October. Further west, the higher inshore sea temperatures may have been a contributory factor to convection, as on the previous day.

(b) *20–22 October 1977*

The synoptic situation described is almost identical with that for 25 February 1978. On both occasions a depression remained almost stationary west of Ireland, near 20°W, with a warm southerly airstream covering the British Isles (Figures 5(a), 6(a)). The Crawley upper-air ascents (Figures 5(c), 6(c)) indicate that the air masses were potentially unstable, requiring only a trigger to set off convective activity. The 700 mb winds (Figures 5(b), 6(b)) were steady from 200–210 degrees on the east side of an upper vortex or trough associated with the surface depression.

Discussion. The remarkable rainfall total distribution shown by Figure 5(d) is not apparently associated with marked frontal activity (Figure 5(a)). The five-day mean sea isotherm chart (Figure 5(e)), covering the period, indicates a warm area, with maxima of 17 °C reported over the central Channel. This is the surface temperature value required to release the potential instability shown by the 00 GMT Crawley upper-air ascent (Figure 5(c)) for 21 October. Convective cells so generated would have moved with the upper-wind fields (of which the 700 mb chart (Figure 5(b)) is indicative), the band of rain so produced growing narrower and dying out some 150 km (2–3 hours' travel time for the rain cells) from the probable source. The gradient of rainfall accumulations east–west across the rainband was as much as 30 mm in 20 km. The rainfall distribution chart (Figure 5(d)) covers the 48-hour period ending at 09 GMT on 22 October. Most of the rainfall of the marked rainband fell during the period ending about 11 GMT on 21 October and hence spanned the two 'rainfall days'.

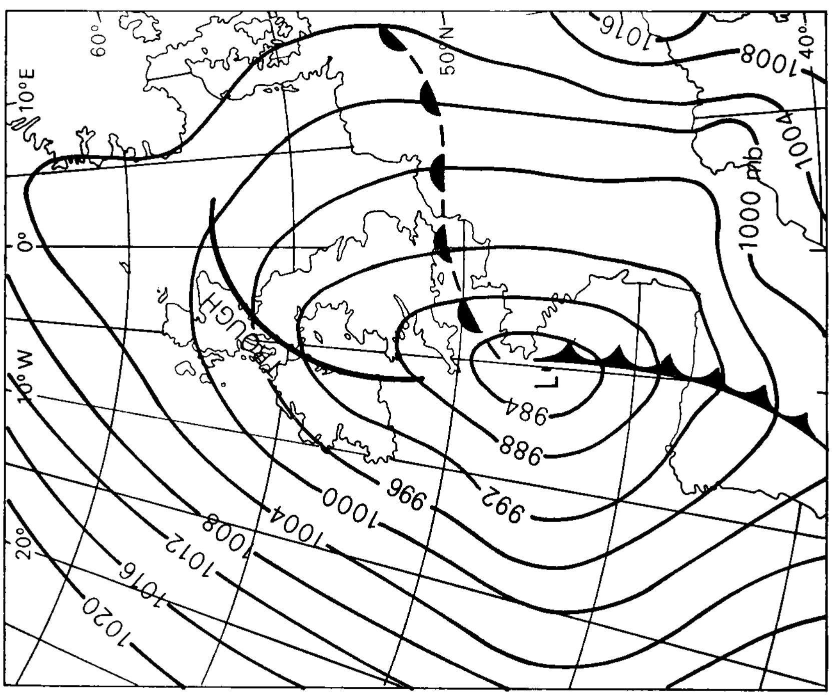

Figure 1(a). Synoptic chart for 06 GMT on 6 October 1977.

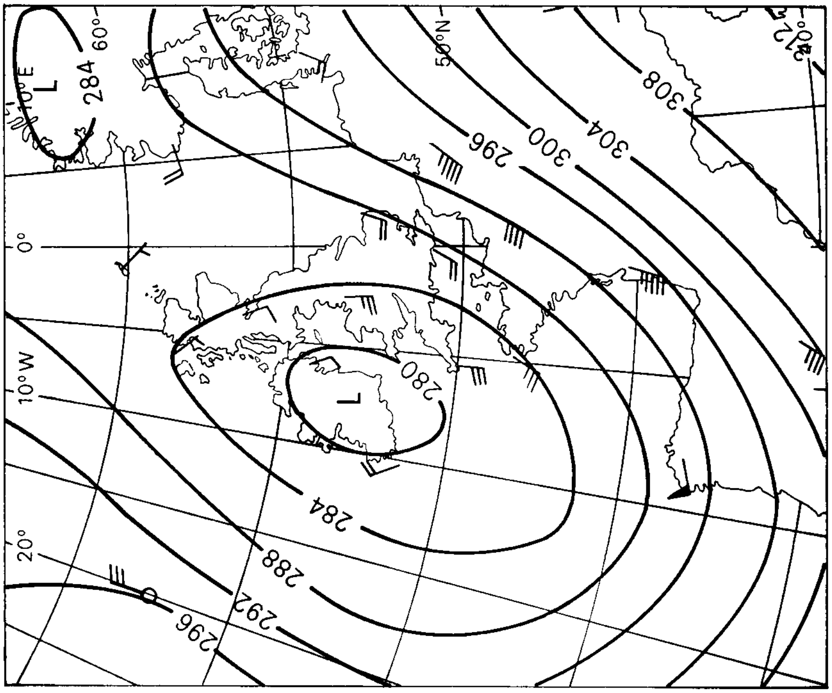

Figure 1(b). Chart for 700 mb at 00 GMT on 6 October 1977. Heights are in decageopotential metres.

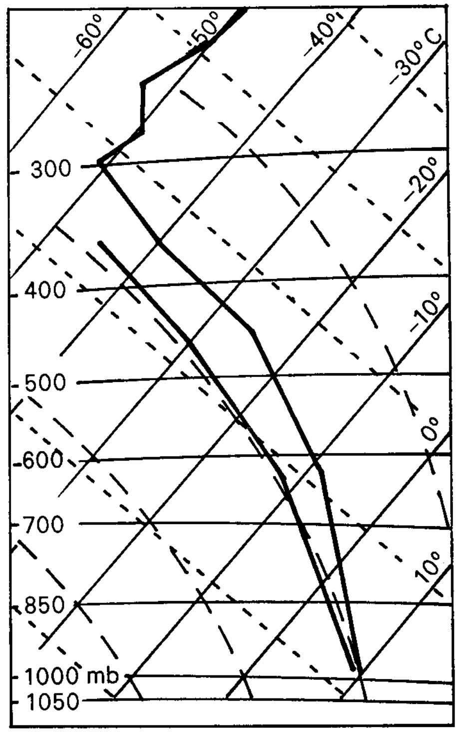

Figure 1(c). Tephigram for Camborne at 00 GMT on 6 October 1977.

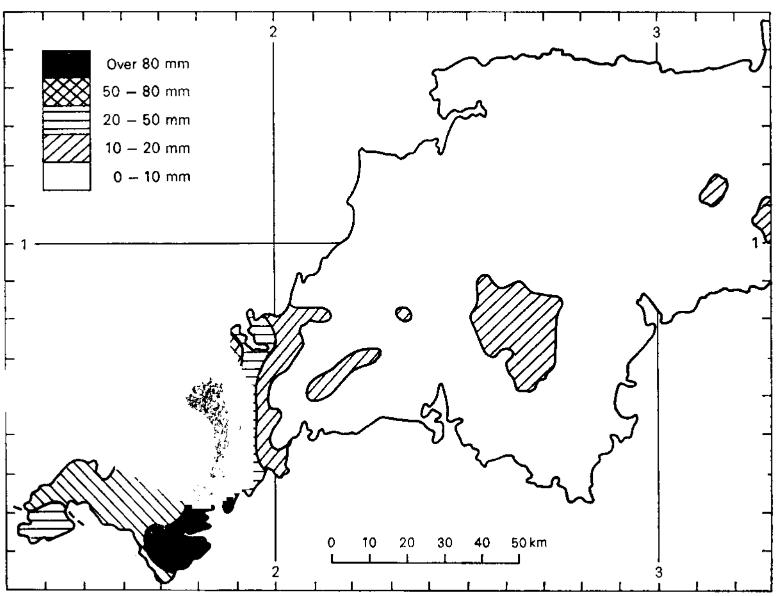

Figure 1(d). Rainfall totals for 24 hours from 09 GMT on 5 October 1977 to 09 GMT on 6 October 1977.

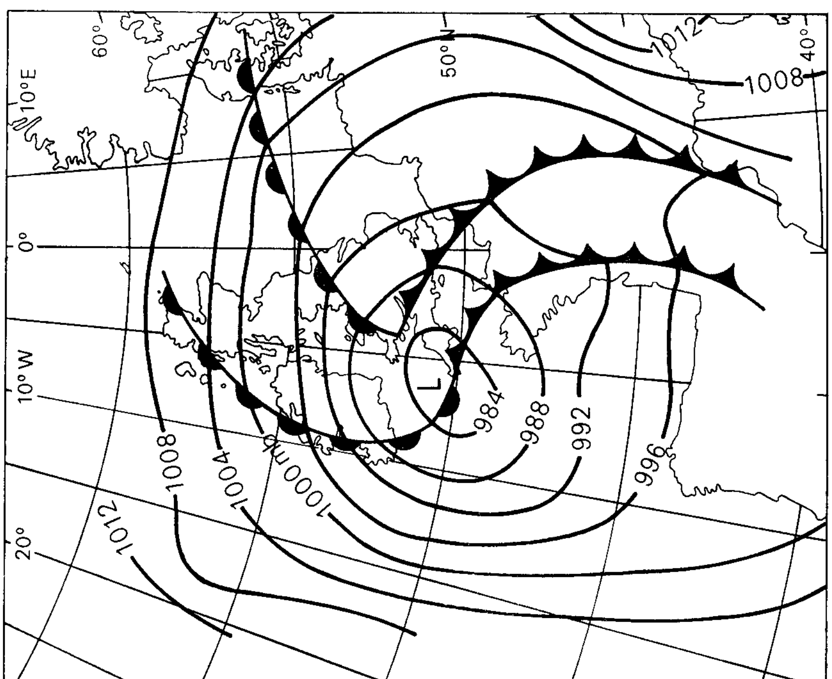

Figure 2(a). Synoptic chart for 18 GMT on 6 October 1977.

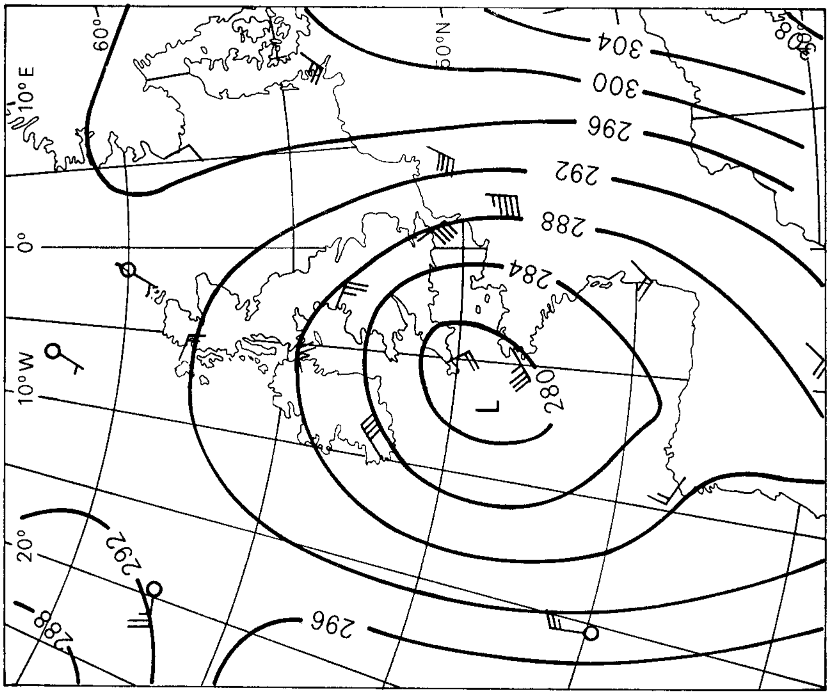

Figure 2(b). Chart for 700 mb at 00 GMT on 7 October 1977. Heights are in decageopotential metres.

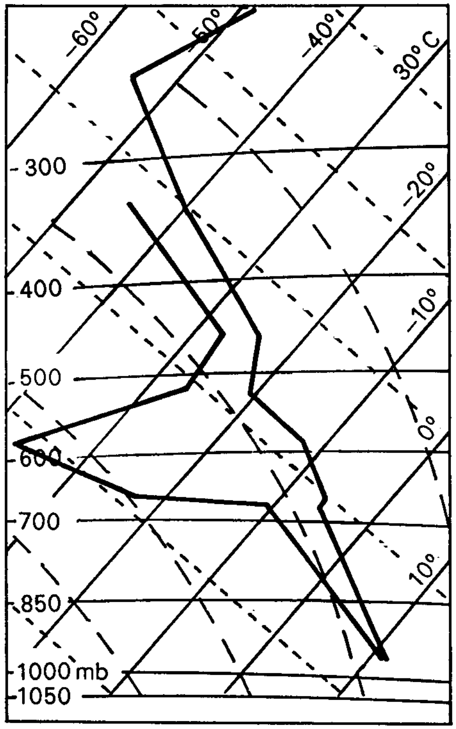

Figure 2(c). Tephigram for Camborne at 12 GMT on 6 October 1977.

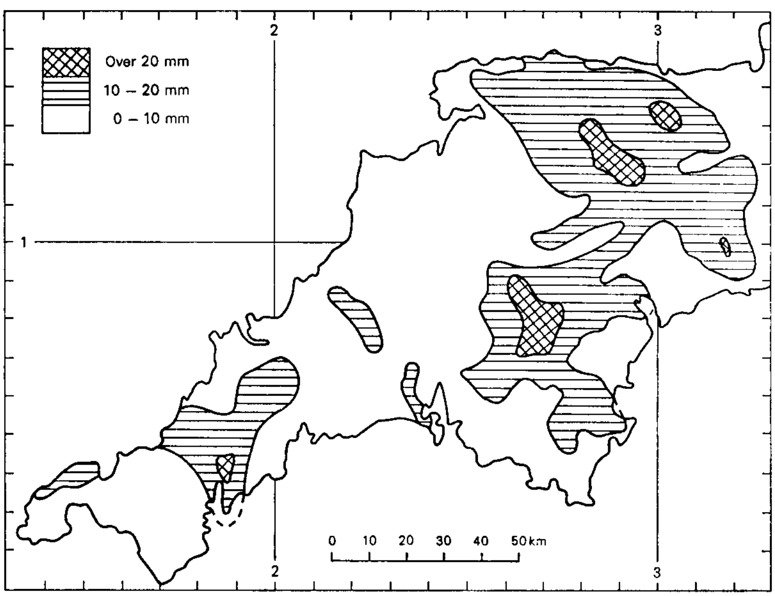

Figure 2(d). Rainfall totals for 24 hours from 09 GMT on 6 October 1977 to 09 GMT on 7 October 1977.

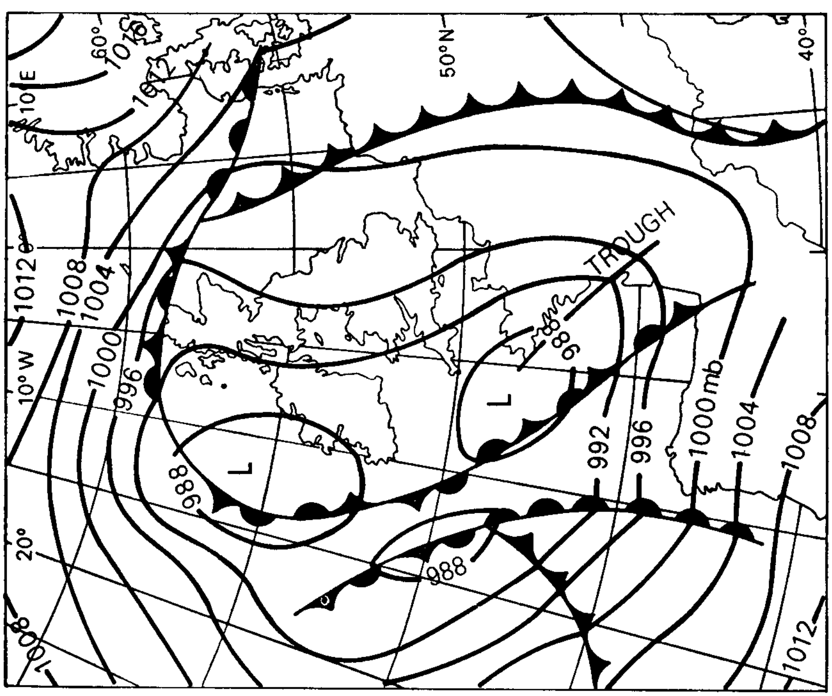

Figure 3(a). Synoptic chart for 00 GMT on 8 October 1977.

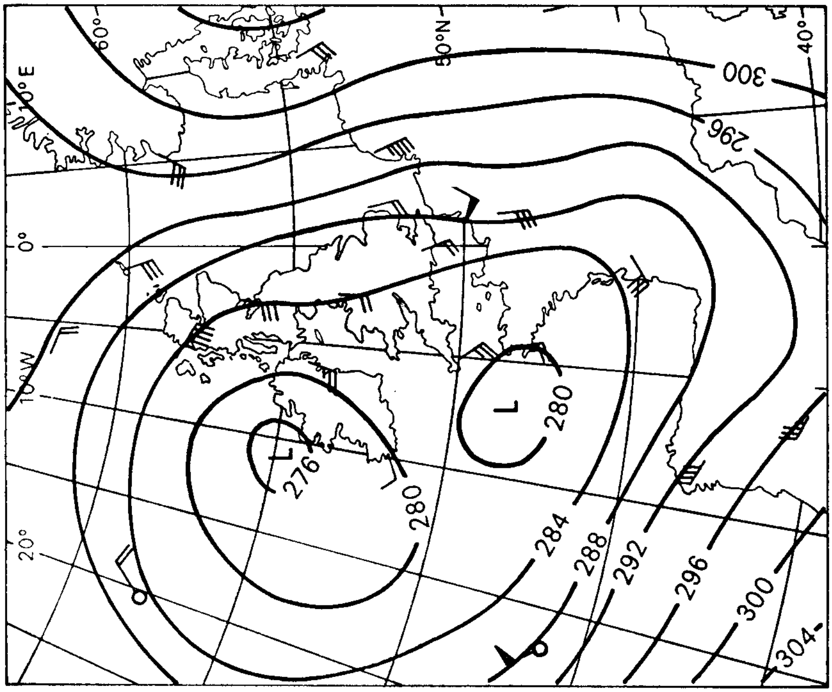

Figure 3(b). Chart for 700 mb at 00 GMT on 8 October 1977. Heights are in decageopotential metres.

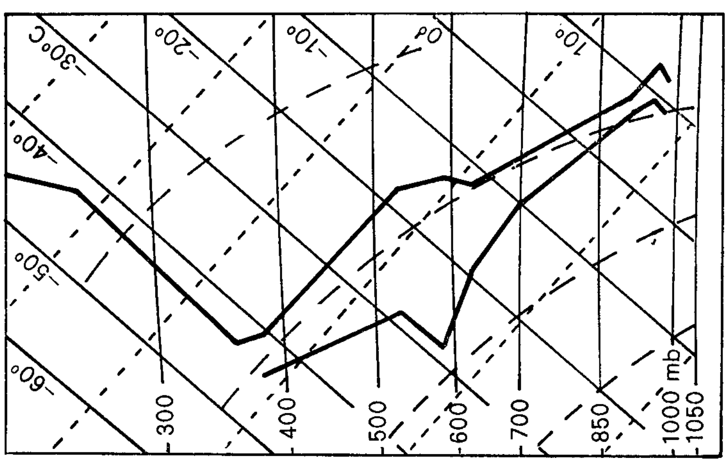

Figure 3(c). Tephigram for Camborne at 00 GMT on 8 October 1977.

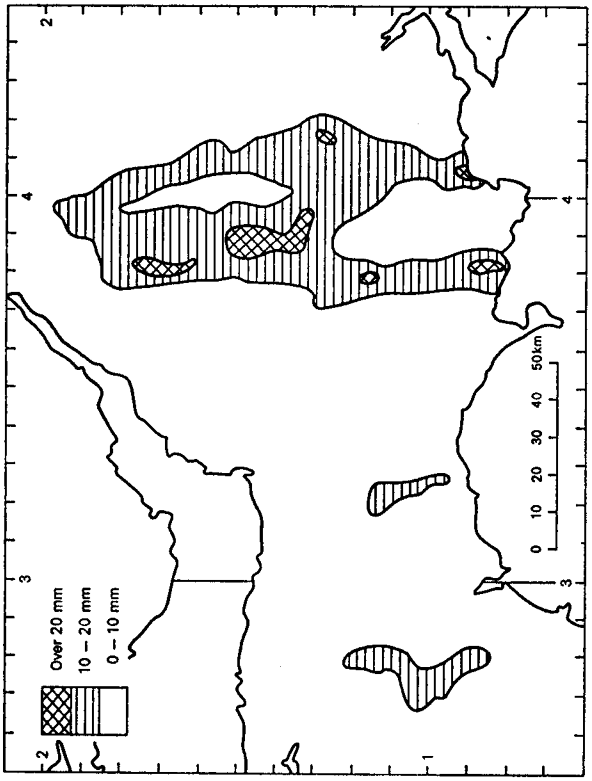

Figure 3(d). Rainfall totals for 24 hours from 09 GMT on 7 October 1977 to 09 GMT on 8 October 1977.

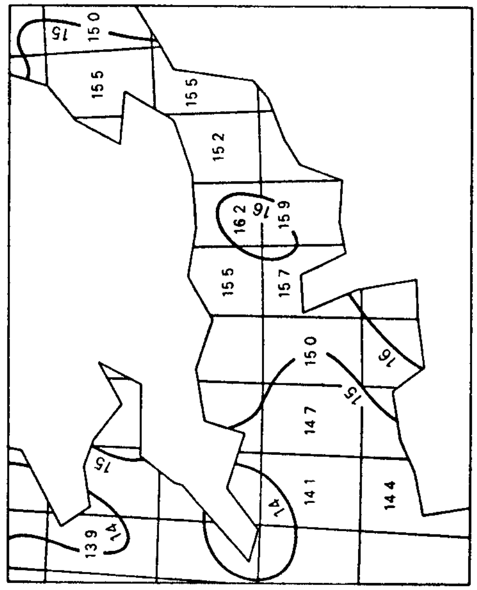

Figure 3(e). Five-day mean sea isotherms in degrees Celsius for 5–9 October 1977.

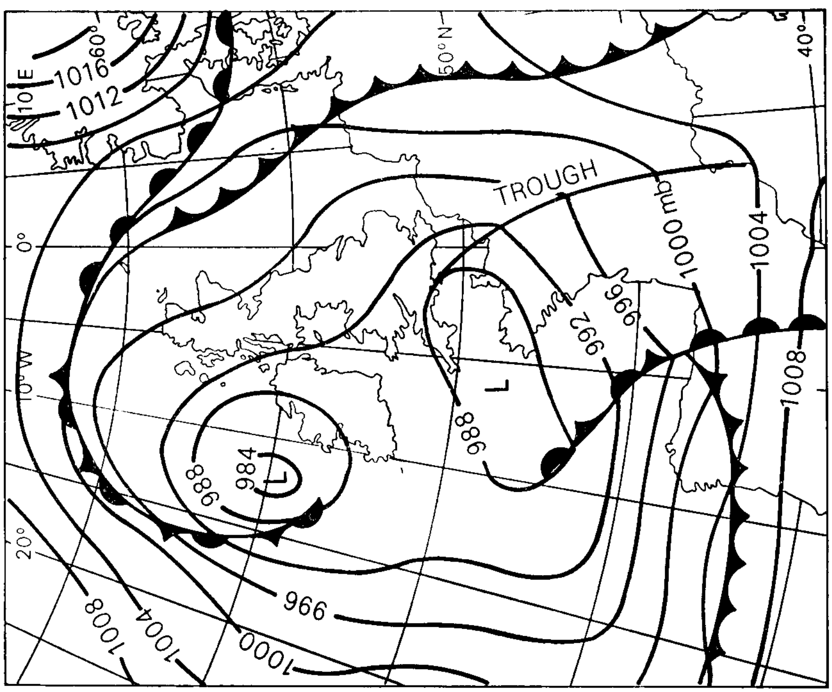

Figure 4(a). Synoptic chart for 12 GMT on 8 October 1977.

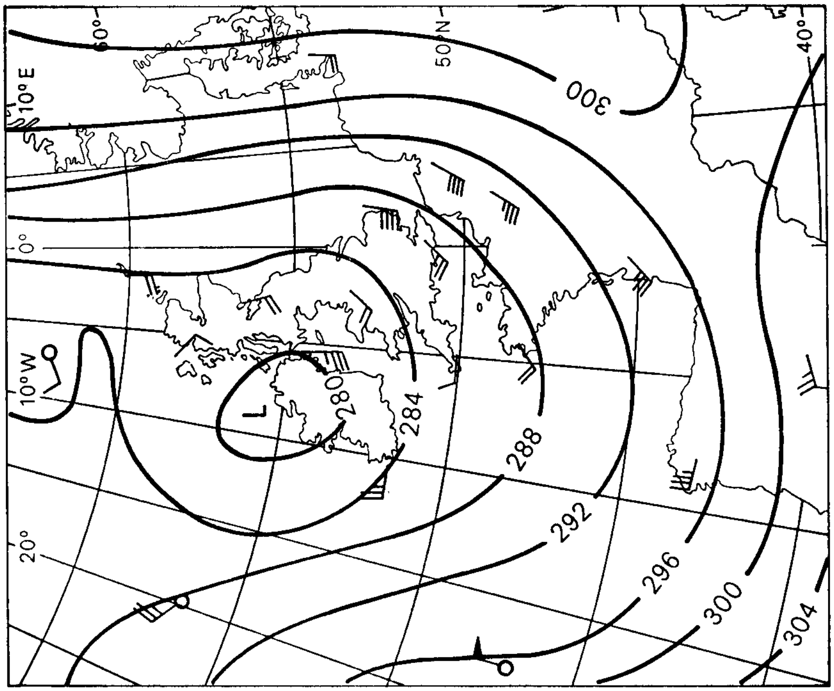

Figure 4(b). Chart for 700 mb for 00 GMT on 9 October 1977. Heights are in decageopotential metres.

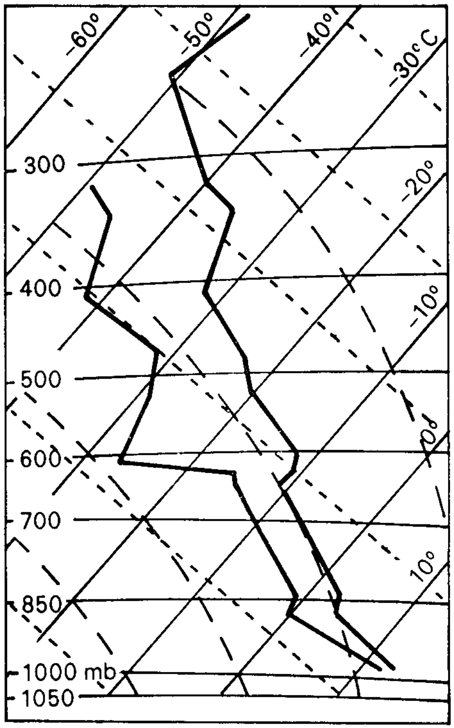

Figure 4(c). Tephigram for Camborne at 12 GMT on 8 October 1977.

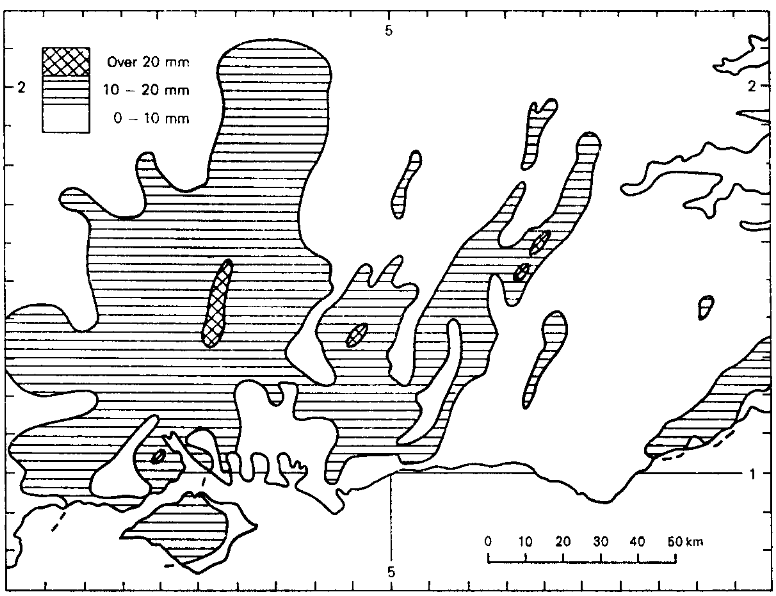

Figure 4(d). Rainfall totals for 24 hours from 09 GMT on 8 October 1977 to 09 GMT on 9 October 1977.

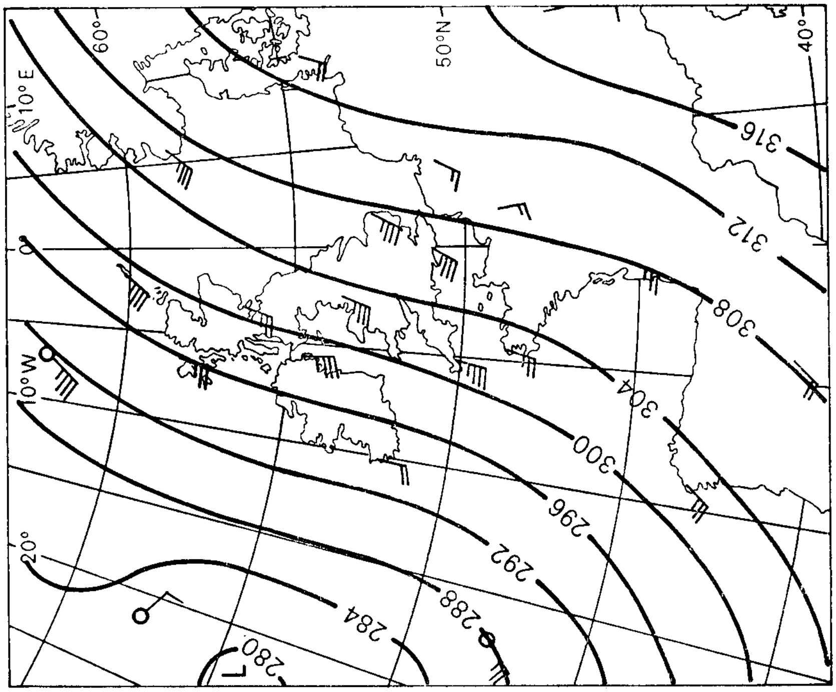

Figure 5(b). Chart for 700 mb at 00 GMT on 21 October 1977. Heights are in decageopotential metres.

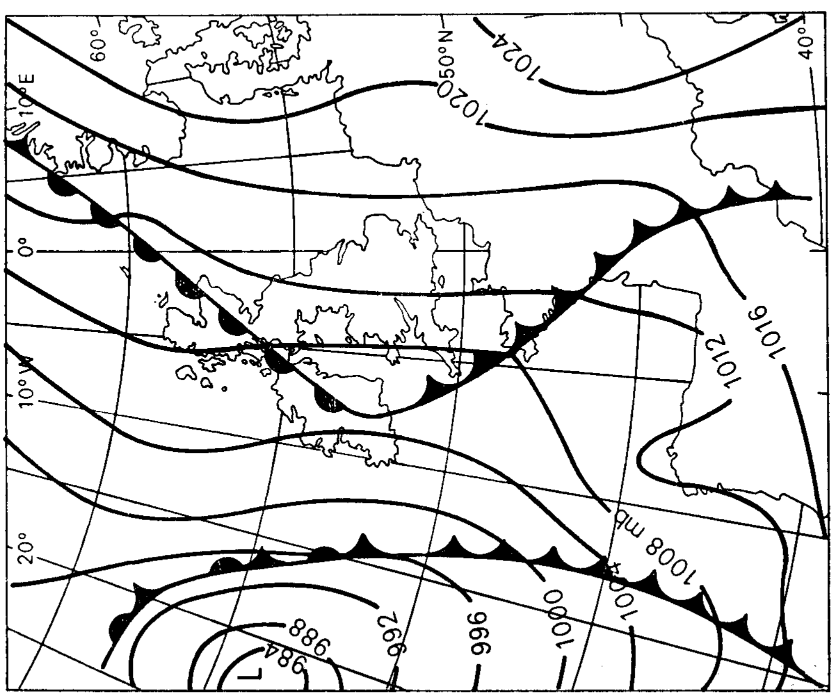

Figure 5(a). Synoptic chart for 00 GMT on 21 October 1977.

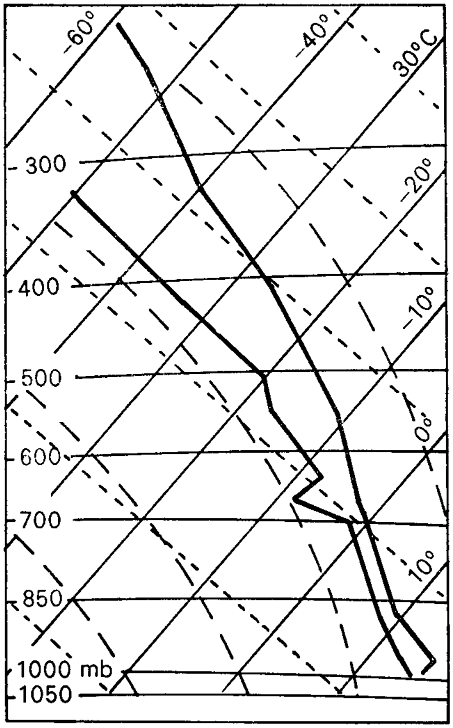

Figure 5(c). Tephigram for Crawley at 00 GMT on 21 October 1977.

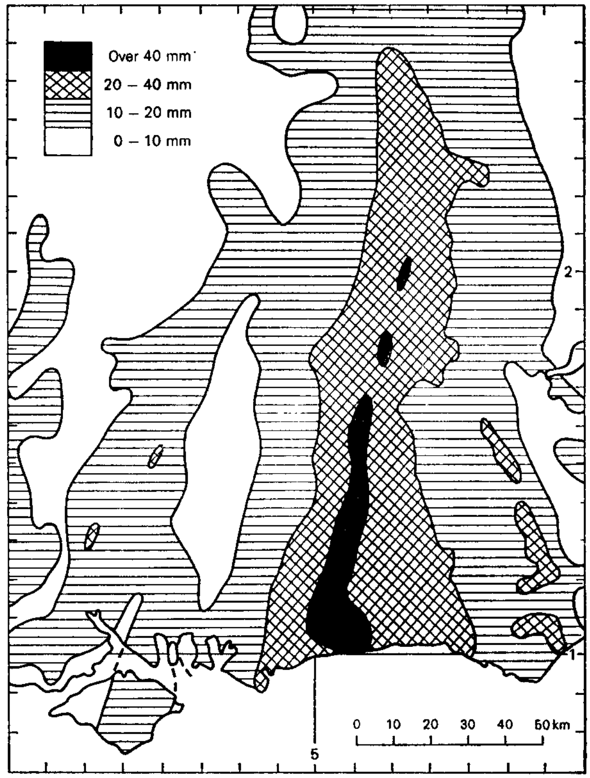

Figure 5(d). Rainfall totals for 48 hours from 09 GMT on 20 October 1977 to 09 GMT on 22 October 1977.

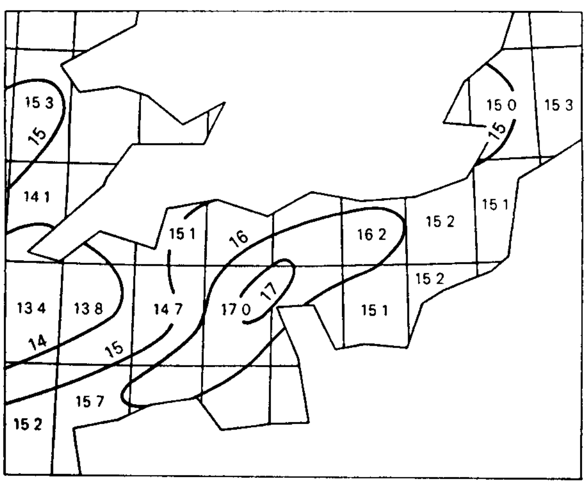

Figure 5(e). Five-day mean sea isotherms in degrees Celsius for 18–22 October 1977.

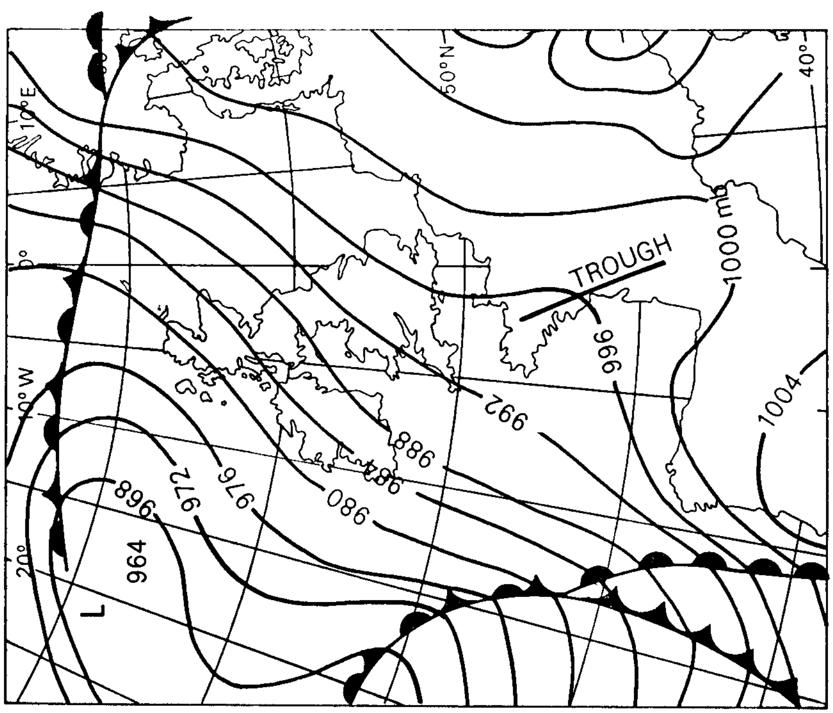

Figure 6(a). Synoptic chart for 18 GMT on 24 February 1978.

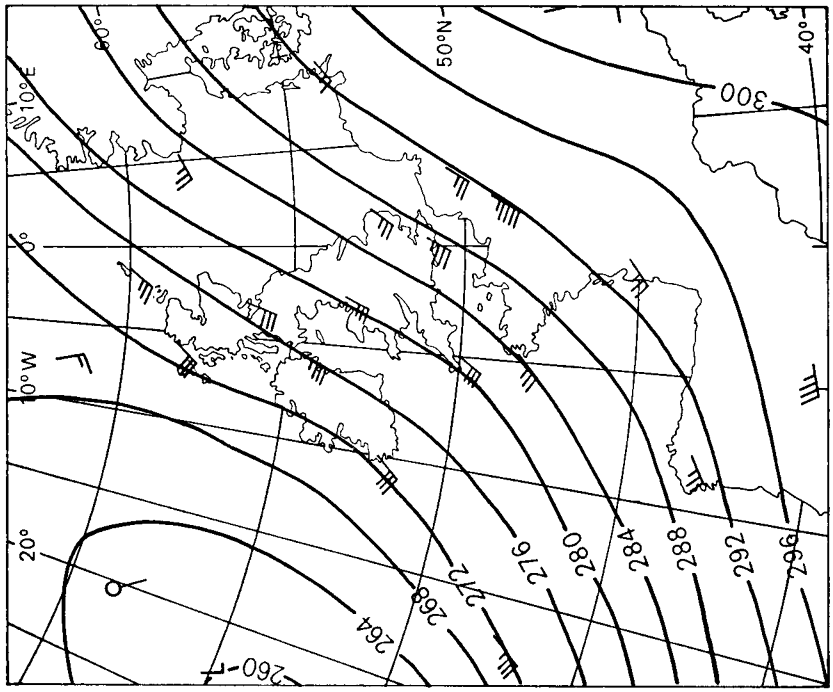

Figure 6(b). Chart for 700 mb at 00 GMT on 25 February 1978. Heighst are in decageopotential metres.

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Plate I. Mr C. Kyriacou receives the B.E.M. from Major-General W. R. Taylor, Administrator of the British Sovereign Base Areas in Cyprus, at Episkopi on 3 September 1979 (see page 28).

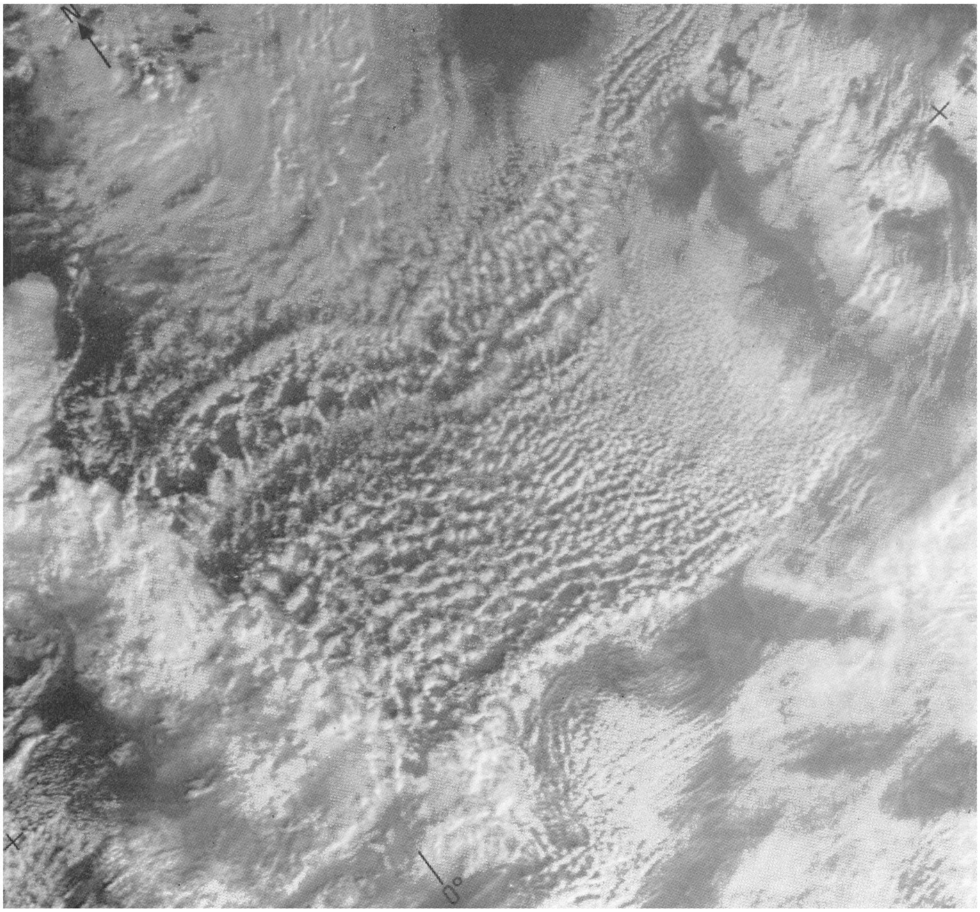

Plate II. Satellite photograph in the visible light obtained from NOAA 5 at 0952 GMT on 9 February 1978.

A very cold east to north-east airstream is flowing out over the North Sea from round an anticyclone centred over southern Norway. Note the clear areas along the coasts of Denmark and the Low Countries and how the size of the convective cells increases with increasing fetch over the relatively warm sea.

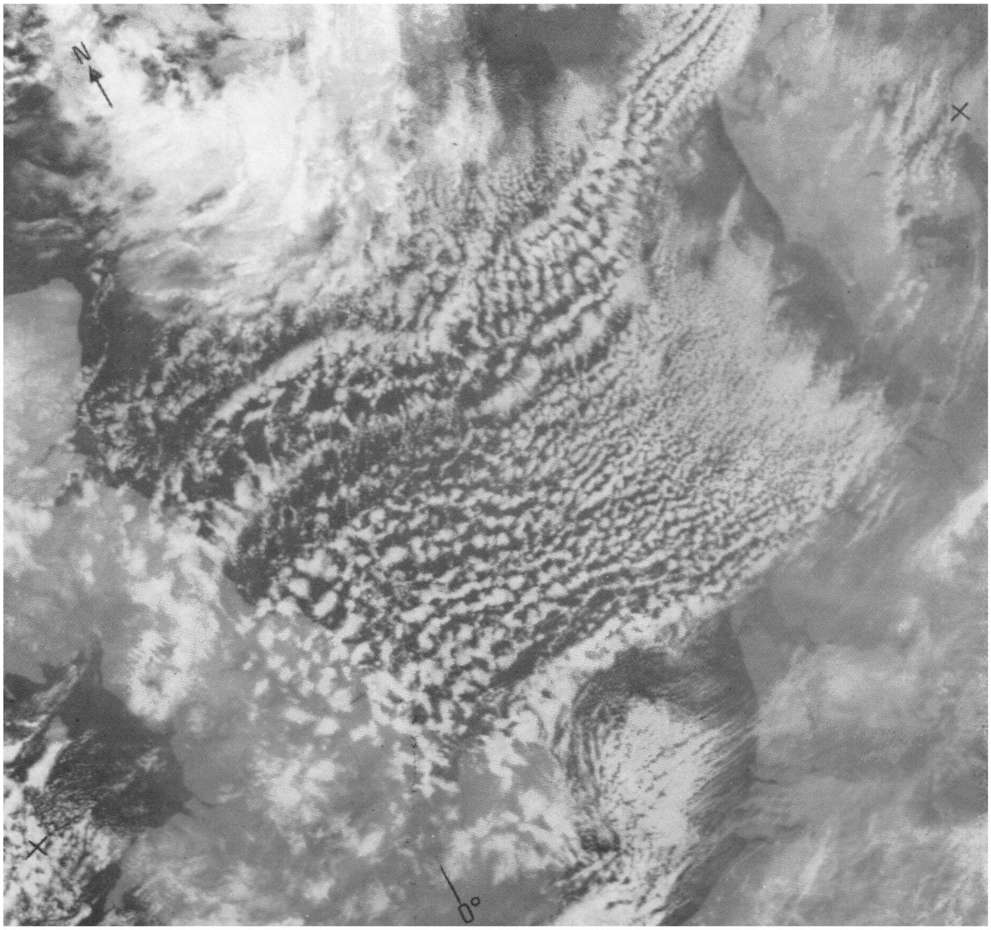

Plate III. Satellite photograph infra-red image obtained from NOAA 5 at 0952 GMT on 9 February 1978. See notes under Plate II.

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Plate IV. Sketch of a ruined house at Marchélepot, drawn by H. Cotton (see page 22).

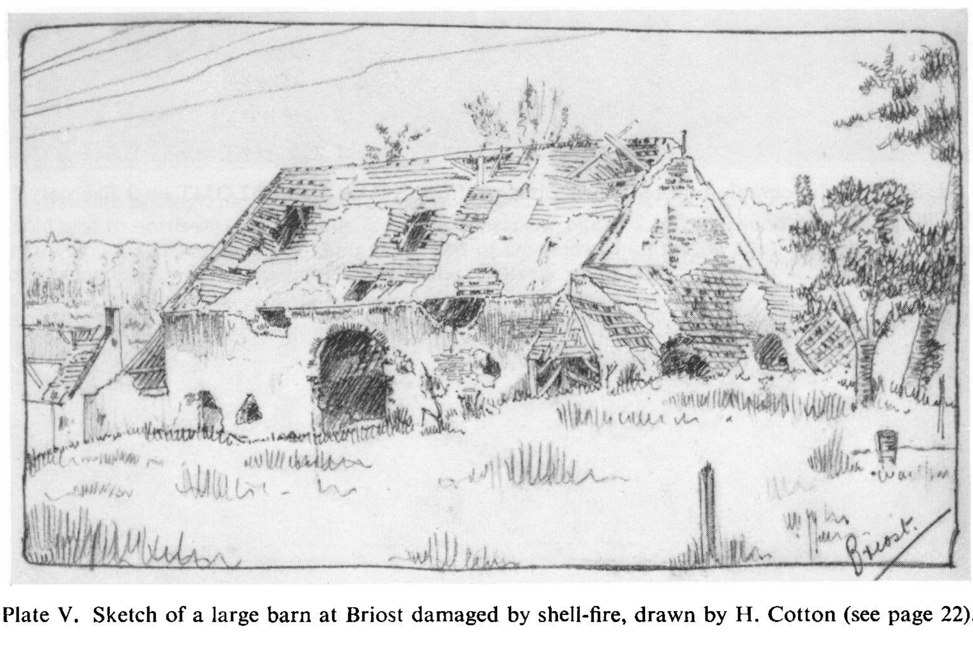

Plate V. Sketch of a large barn at Briost damaged by shell-fire, drawn by H. Cotton (see page 22).

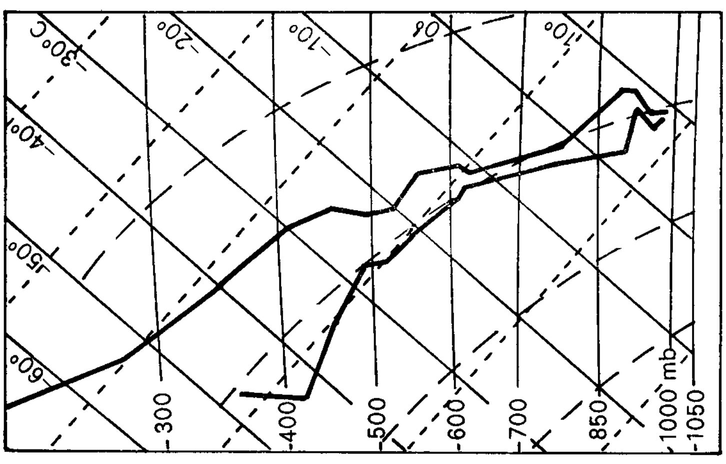

Figure 6(c). Tephigram for Crawley at 00 GMT on 25 February 1978.

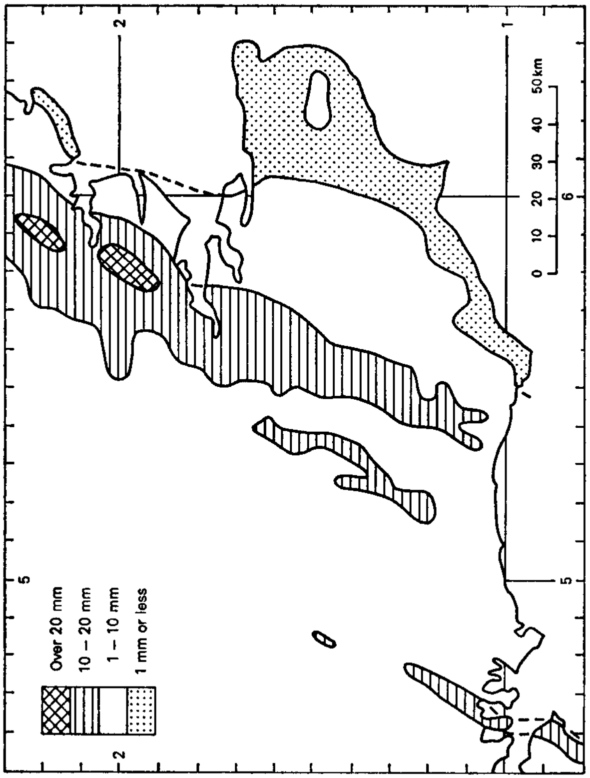

Figure 6(d). Rainfall totals for 24 hours from 09 GMT on 24 February 1978 to 09 GMT on 25 February 1978.

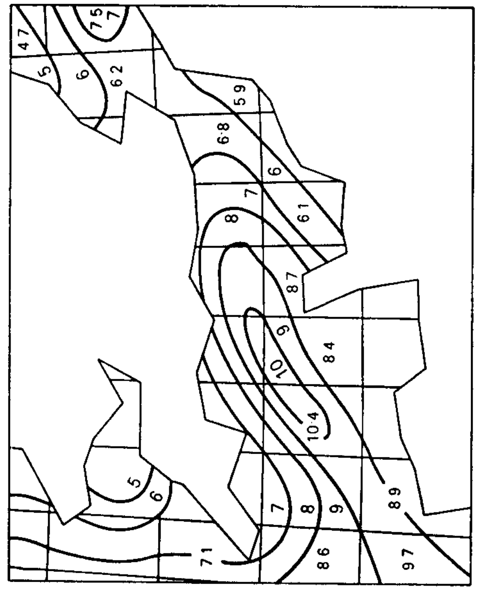

Figure 6(e). Five-day mean sea isotherms in degrees Celsius for 21–25 February 1978.

(c) *24–25 February 1978*

A trough (Figure 6(a)), south-west of Brittany at 12 GMT on 24 February, moved north-eastwards across Brittany during that evening. It seems probable that a northward extension of this trough moved across the English Channel, triggering the medium-level instability shown by the Crawley 00 GMT upper-air ascent for the 25th (Figure 6(c)). A pronounced rainband, evident from Figure 6(d), extended from the South Downs, across east London and up into Suffolk, with an orientation close to the 700 mb wind flow (Figure 6(b)). The five-day mean sea isotherm chart (Figure 6(e)), covering the period, shows a marked tongue of higher sea temperatures extending along the English Channel from the south-west.

Discussion. By simple inspection we can infer only vertical motion; no single factor stands out as the most likely cause of the rainbands observed. Among the more obvious possible contributory factors, however, we can now see a low-level convective-heat source downwind in the Channel, a low-level convective 'heat island' source provided by the Greater London area, low-level convergence, with contrasting air from the southern North Sea being drawn into inland areas of eastern England and Kent, together with orographic uplift provided by the higher parts of Essex and the Downs to the south of London.

Concluding remarks

The availability of computer-plotted 24-hour rainfall total maps has added a new dimension to the quality control of rainfall data. Whereas previously the rainfall at a station was compared only with that at a few neighbouring stations*, the significance of rainbands (pre-warm-front, warm-sector, or, as discussed here, of an instability type) has now been highlighted and the coherence of patterns of rainfall from stations up to about 80 km distant is now considered before apparently unacceptably high individual station values are rejected.

Whilst a climatology of rainfall depth patterns could perhaps lead to simple objective procedures for the local area forecaster, such a development is likely to be superseded by the advent of rainfall fields observed by radar. Nevertheless, for some time to come, the forecaster is likely to have to rely on his personal assessment of some of the effects listed below in his estimates of rainfall depth and variations across a region, which the examples shown suggest may not be entirely random, even in a convective situation:

(a) *General orography,* remembering that hills only a few tens of metres high (Bergeron 1960) can affect the fine-scale distribution of daily rainfall.

(b) *Land-surface temperatures.* It has been suggested (Jackson and Wescott 1977; Atkinson 1977) that urban effects may well enhance rainfall downwind of industrial sources.

(c) *Sea temperatures.* The exact effect of heating by the sea on the distribution of rainfall is difficult to evaluate on any given occasion, mainly because of the problems of obtaining reliable and sufficiently detailed sea temperature information. However, it is likely that mesoscale variations in sea temperature are instrumental in releasing potential instability over preferred areas.

(d) *Friction*: differences in frictional effects, especially at coastal boundaries.

(e) *Low-level convergence*: 'funnelling-effect' caused by local topographic features and sea-breezes on to promontories can be contributory factors.

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* In the Daily Quality Control computer program run by the Agriculture and Hydrometeorology Branch (Met. O. 8) normally the 6 'best-fit' neighbours out of 8 within a 25 km radius are compared with the station in question.

(f) *Surface troughs,* usually detectable on synoptic charts, often provide, by upward air motion, the necessary trigger required to release potential instability.

Acknowledgements

I am grateful to Mr J. Stancombe and his Rainfall Data Quality Control team in Met. O. 8b for their help in analysing and drawing the maps.

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	1979	A notable heavy rainfall over west Cornwall. *Weather,* **34**, 138–140.

551.5:02:681.3

MOLARS—Automating the National Meteorological Library*

By E. W. C. Harris (National Meteorological Library) and T. McSean (British Library)

Summary

The functions, subject coverage and stock of the National Meteorological Library are described. About 10 000 items are added annually to the collection, which is indexed by means of the Universal Decimal Classification. Catalogue card production, updating the subject catalogues and producing the Monthly Accessions List are processed on a Digital Equipment Corporation PDP 11/34 minicomputer, the system being known as MOLARS (Meteorological Office Library Accessions and Retrieval System). Based very closely on the existing manual library procedures, it replaced Flexowriters, eliminating the necessity of sorting tapes, and requires only one entry via a visual display unit (VDU). Special features of the system include an extensive range of quality-control and error checks. The Meteorological Office's main computer currently prints the catalogue cards twice weekly (this process should be speeded up considerably with the introduction of a Diablo 1620 printer) and prepares the Monthly Accessions List of some 800 entries. The bibliography update suite is then prepared. It is proposed to introduce soon a full on-line information retrieval and enquiry service, using the Library's catalogue data base. The hardware involved is an 80 megabyte disc unit with four VDUs. The file will contain all additions to the library since 1971. A serial control system is envisaged in the longer term.

Background

The National Meteorological Library is situated in Bracknell, at the headquarters of the Meteorological Office. The Library's principal function is to serve the professional needs of Meteorological Office staff, including those based at the many outstations around the country, and it has done so since its foundation in 1870. The Library also has a national role and may be used by any government department, local authority or serious enquirer. These 'outside' queries cover a surprisingly wide range of activity, including military matters, civil aviation, agriculture and civil engineering (with particular reference to overseas contracts).

The Library aims to collect most available meteorological and climatological published data and literature from all over the world. To a more limited extent it also collects material in related disciplines such as fluid dynamics, hydrology, oceanography, and planetary atmospheres. General material on other disciplines (e.g. physics, computer technology and mathematics) is also made available. The 120 000 volumes in stock consist predominantly of data, reports and journals. Conventional monographs represent a comparatively small proportion of this figure—currently only 100–150 textbooks are acquired each year. In addition, the Library maintains a pamphlet and offprint collection of over 30 000 items and there is a very large collection of daily weather reports from weather stations throughout the world, with some records being continuous for over a century. The collection mainly consists of printed material but microfilm and microfiche are becoming increasingly common. Much of the Library's material is acquired under international exchange agreements, of which there are currently more than a thousand.

No direct use is made of any public on-line information retrieval service, mainly because the Library operates mostly within a very narrow subject range and within that range the main data base currently available would not usefully improve either the depth or the currency of the service offered. Neighbouring government departmental libraries with facilities for on-line searches help out with the occasional query requiring a broader subject approach.

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* Adapted from an article in *VINE* 28 (Southampton University Library, 1979).

The catalogue

Library staff, who have a background of meteorology rather than librarianship, are always on hand to advise and assist users in getting the best out of the collection, but self-help is encouraged as much as possible. An author catalogue, including both personal and corporate authors, is available on some 400 000 cards. Subject indexing is detailed, and the subject catalogue is a loose-leaf compilation (in effect a series of subject bibliographies) housed in nearly 200 large binders. About 10 000 items are added to the catalogue each year, including individual journal articles and conference papers. The author catalogue dates back to the end of the nineteenth century and includes the occasional hand-written card. All additions to the catalogue since 1936 are indexed by means of the Universal Decimal Classification (UDC) which includes highly detailed schedules for climatology and meteorology. Each item is assigned an average of 2·5 class numbers.

The cataloguing code in use is that given in the World Meteorological Organization's *Guide to Meteorological Library Practice* (WMO Publication No. 39, TP14, 1955) which varies from the codes of the Anglo-American Cataloguing Rules—for example the sponsoring organization is always preferred to the individual author for the main heading when both are present. In addition, there are 'special' bibliographies for climatology, divided geographically, and for papers by members of the staff.

One of the most useful tools produced by the Library is the Monthly Accessions List, which is set out in classified order. More than 250 copies are printed for distribution within the Meteorological Office and to outside organizations (80 of which are overseas) and the list has proved an invaluable link between the Library and its sometimes rather dispersed user population.

On-line system

From the beginning of 1978 the first stage of a program of computerization has been in operation within the Library, with catalogue card production, the updating of the subject and special catalogues, and the preparation of the Monthly Accessions List all carried out by the use of a Digital Equipment Corporation PDP 11/34 minicomputer dedicated to Library use. The system is known as MOLARS (Meteorological Office Library Accessions and Retrieval System).

The Meteorological Office was a very early user of computers. At one time it boasted the most powerful machine in the country, and even today its massive IBM installation, comprising a 370/158 plus a 360/195, is among the five biggest. When the Library began to make plans for computerization it was fortunate to be able to call upon the considerable expertise of the Office's Systems Development Branch for systems analysis and programming. All the necessary software has been developed by the Branch, which also gave advice on the type and range of hardware required for the system. While it has been extremely useful to have the programming team so close at hand, the Library's comparatively low operational priority means that innovations may take some time to be translated into working systems.

The new system has been based very closely on existing proven manual library procedures. In some ways the whole process of analysis was made easier because of the specialized nature of the Library, and until the second stage of the computerization comes into effect—with on-line enquiry access to the catalogue—the visible operational procedures of the Library will not have been greatly affected, except that things now tend to happen rather more quickly than before.

The new system replaces one using Flexowriters that was introduced in the early 1960s. These machines eliminated the need to retype each entry completely in each catalogue sequence; however, the paper tapes had to be reread or reformated (or both) at least four times for each entry and a great deal of sorting of tapes to satisfy the various formats was necessary. Under the new system only one entry via a visual display unit (VDU) is required—all changes of format are done by the software, not by the typists. For each item received by the Library an input form is prepared. (As already mentioned, every item of interest in conference proceedings and new issues of journals is normally catalogued and classified separately.) The format of the input forms is matched by the format provided on the VDU, with the discrete ('protected') fields shown for ease of input. Most of these fields are obvious: author, title, source, miscellaneous (e.g. notes), UDC number, shelf location and catalogue. When multiple authors are cited in the author field, cards for each author are produced. When the main access point to a record is a corporate author, the system is able to spot the name of one or more personal authors in the title field (preceded by the word 'By') and to generate automatically the necessary added entries for the catalogue. Classification is very detailed, and where more than one class number is assigned the most important number is indicated by an asterisk because each entry only appears under one classification in the Monthly Accessions List.

A number of special features have been built into the input and output ends of the system. Particularly worthy of interest is the range of quality controls and error checks that has been built into the input routines. Checks are made on the punctuation, layout, number of characters, and so on in each field and, where appropriate, the presence or absence of alphabetic and numeric data is also checked. Likely errors are printed out to be checked by a member of staff. Many of these 'errors' turn out to be unusual rather than wrong, but nevertheless these routines are extremely useful as a supplement to normal proof-reading. The range and scope of automatic validation of input within the system undoubtedly stems from the high priority traditionally given to such things in weather forecasting programs, with the Meteorological Office Library benefiting from the Systems Development Branch's experience. Other aids to input have been incorporated. An on-line data base has been built up containing standard 'Source' details (title, imprint, etc.) for periodicals catalogued in depth by the Library. Correct details are added to a catalogue entry simply by keying in the appropriate Source index number. Pagination can be added to the short references and transient information (volume number, year, etc.) can be updated easily by the operator. Codes built into the catalogue format allow variations to the standard output: ST, for example, indicates an item written by a member of staff and generates an entry in the staff bibliography.

The Meteorological Office's massive main computer complex (COSMOS) is used for major sorting of files and (for the time being) for the twice-weekly printing of catalogue cards. Special continuous card stationery is used, giving four cards per page, which is later guillotined to the Library's historical 'standard' size. The loading of the specialized stationery and the setting up of the special print train required to print lower-case type has proved to be uneconomic for the necessarily short catalogue print runs. This problem should soon be overcome because the Library has acquired a Diablo 1620 printer. In the near future this will be used for card production, making possible high-quality printing on ready-cut card stock and the twice-daily printing of batches of cards, cutting out the present hiatus between the item going on the shelf and the card appearing in the catalogue. The printer is also being used for error messages and other systems output.

In the normal course of events, all the catalogue data for a particular month have been input by the second working day of the following month. The production of the Monthly Accessions List can then be initiated. This is also carried out on the COSMOS machine from the inverted files which have been built up from the card production runs. The program sorts the entries, inserts item numbers and pagination, and a contents page is prepared. The List is then output on to 35 mm film which is proof-read. If there are major errors these are corrected and the program is rerun; otherwise a full-sized camera-ready copy is prepared and dispatched to the printers. MOLARS has proved to be about three weeks quicker than its manual predecessor in producing the Monthly Accessions List, which is now available for distribution before the end of the following month.

A typical List contains some 800 entries, from which about 1250 author cards will be produced and some 1800 entries for the classified catalogue.

Once the List has been cleared for publication, COSMOS runs the program for the monthly updating of the subject bibliographies. Like most of the other Library work on COSMOS, this work is carried out in low-priority time, mostly at weekends. The Bibliography Update suite produces all the pages required to update existing bibliographies, reprinting all those pages that were not full and for which there are new entries. The bibliographies are kept in accession order, so a complete reprint for each new entry is not necessary.

Further development of MOLARS

There is no doubt that only a small part of the potential of the minicomputer has so far been realized. However, the first stage of the system has produced a useful range of services and has introduced the library staff gradually to the advantages and perils of automation. The noisy (and increasingly temperamental) Flexowriters have been replaced by more congenial VDUs; typing time has been reduced to a third of its previous level.

The next stage of automation will be the introduction of a full on-line information retrieval and enquiry service using the Library's catalogue data base. Within the present system a rudimentary information retrieval system is already available: entries from the present and preceding month may be recalled by keying in the first eight characters of the author's name. What is envisaged is a much more comprehensive system using the entire catalogue file with access via any part (or combination of parts) of the catalogue record and available to the Library's users as well as its staff. The idea will be converted into software as soon as the Systems Development Branch has the staff time available. The hardware, consisting of an 80 megabyte disc unit plus four extra VDUs, is already available. The additional video-terminals are less elaborate and costly than the two Lynwood VDUs currently used for inputting and editing catalogue data. A disc file has been created using the paper tape produced under the Flexowriter regime, which contains all additions to the Library catalogue since 1971. When added to the MOLARS file proper, it will give a data base of up to 100 000 records. When made available to on-line queries this should be adequate for 70–80 per cent of all searches. When this part of MOLARS goes live the Library will cease adding new cards to the catalogue and this in itself will be a considerable boon, since in recent years the catalogue has been growing in size alarmingly and taking up space that could be used more usefully for other purposes. If time permits, the Library may weed out cards for items within the on-line system, thus reducing the card catalogue to more manageable proportions.

In the longer term, the Library is considering a serials control system, which would also be able to monitor the more than 1000 exchange arrangements in which the Library participates. A statistical and management subsystem may also eventually be grafted on to MOLARS, but the Library intends to continue its steady one-step-at-a-time approach which gives the best guarantee of maintaining a consistent level of service to its customers.

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Memoirs of an Army Meteorologist

By H. Cotton, M.B.E., D.Sc.

Part 4

(Continued from the November 1979 issue)

'What do you intend to do this evening? It is such a beautiful evening that it is a shame to waste it.' This was Corporal George speaking. I had intended to swot some new German after the 6 p.m. balloon ascent was finished. To a scientist and an engineer German is a very important language and I was not all that good at it.

'Have you something in mind?' I asked.

'Yes, I thought we might go sketching. There must be some interesting material in these towns', and he pointed to Marchélepot and Briost on the map.

'There are at least two hours of daylight left, so I shall have time to make one or two watercolour sketches. There are some ruined houses at Marchélepot which will just suit you with your liking for fine detail, although I wish you wouldn't niggle so much.'

I found a convenient seat on a fallen tree and made a sketch of a ruined house at Marchélepot. I then went to find Corporal George who was making a very attractive painting of a very large barn at Briost, a village on a slope just above the river. The barn was severely damaged by shell-fire and all the more interesting because of it. As the painting was not quite finished I decided to make a sketch of my own. I wondered what he would say—I felt rather proud of my two sketches.

'Your drawing of Marchélepot is quite good, although you still don't let yourself go. The same with the barn. I think you ought to try charcoal for a change. You won't be able to get in so much detail, but your drawings will have more character.'

He pointed to two lines I had drawn across the sky on my sketch of the barn.

'Whatever are these?'

'Cloud of course.'

'Oh, what kind? There isn't any cloud anyway.'

'It's supposed to be a band of cirrostratus.'

'I've never seen cirrostratus looking like that.'

'Well I have.'

'But there isn't any cloud. Put in what you see, not what you don't see and then your drawings will be more convincing and more honest. You can leave things out for the purpose of composition and if they will be a distraction from the main subject, but that is not the same thing as putting in things that aren't there.'

Early in July 1917 we learned that 4th Army H.Q. was to move to Bray Dunes on the Channel Coast. I was sorry in a way to leave the quiet of Villers Carbonnel, but a spell 'by the seaside' was exciting. The pleasure was tempered by the certainty that such a move, from the very south of the Army to the extreme north, could only mean one thing. There was to be another offensive before winter set in. By now the vital importance to the Army Commanders of reliable meteorological information covering all aspects of operations was fully realized: one no longer received the jibe about one's cushy job. With the abandonment of that unreliable weapon chlorine gas supplied from gas cylinders, the necessity for the early gas alerts and warnings no longer applied. But more and more the Commanders relied on accurate weather forecasts—and considering the then scarcity of information in comparison with today's plethora, the forecasts were remarkably accurate. Corrections for the artillery were also of progressively increasing importance, as I was soon to find out.

The lorry containing all our equipment belonged to the Army Service Corps and so did the driver. I travelled with him in the cab but the others went by car so as to be ready for us as soon as we arrived. We took two days over the journey, and very pleasant they were, as the route was through undevastated countryside. We stayed for the night at the little town of Pernes, at a hotel in one corner of the Grand' Place. I sensed that there was something wrong with the place and realized what it was as I was sitting at a little table on the pavement in front of the hotel; the driver had gone off on his own somewhere and I had a feeling that he had been here before. The trouble with the town was its unexpected quietness, there being few people about. Then it dawned on me: no men, and no-one came for a drink; in fact, I believe that the two of us were the only guests in the hotel. As soon as I finished my drink I decided to go for a walk. I should have enjoyed it, as it was pleasant enough, but I could not get rid of the sadness of the place.

As I had a separate bedroom I had no idea whether the driver stayed the night at the hotel. I had a feeling that he did not, but he was there for breakfast. Our schedule was to arrive at the Kursaal at Bray Dunes not later than 5.30 p.m. so as to give time to set up the theodolite and be in good time for the 6 p.m. balloon ascent, an important ascent because of the delay occasioned by the move, because the Belgians who had previously manned the sector adjacent to the sea had not made upper-air observations, and because of the effect of land- and sea-breezes which sometimes resulted in a surface wind being almost diametrically opposite in direction to the wind in the upper air.

The driver took the longest route, which was not scheduled and could have been avoided, although the alternative route was not so good. He drove the lorry to a large shed somewhere in the middle of Dunkirk, jumped down, said 'See you in the morning' and began to walk away.

'Where do you think you are going?' I said, 'this isn't a pleasure trip; we have to be at Bray Dunes by five-thirty.'

'Well we won't will we.'

'Why not?'

'Because I've got a girl in Dunkirk.'

'Look here' I said, 'you can't do that. I order you to take me to Bray Dunes now!'

'Who the bloody hell do you think you are? I take my orders from my officer and from nobody else' and he went off to his girl; I couldn't prevent him from doing that. But my presence of mind deserted me and I accepted the position and did nothing. Bray Dunes was only seven or eight miles away and I could easily have walked there, informed Meteor of the situation and possibly have arranged for another A.S.C. driver to bring in the lorry. I tried to find an M.D., although by then it wouldn't have been of much use, but I couldn't find one and concluded that they must have had girl friends in Dunkirk as well.

The driver turned up next morning at about half past eight, so I had missed not only the 6 p.m. observations of the previous day but the 1 a.m. and 7 a.m. as well. There would be hell to pay, and there was. The artillery in the coast sector had been supplied with wind corrections by the Second Army, further south and where there was no modification due to the proximity of the sea. For the shorter ranges the corrections were entirely wrong and it was our own men who had been shelled. I explained the situation and then set up the theodolite just where we were, opposite the Kursaal, and the telegrams were sent first priority. What happened to the driver I didn't enquire, as I was kept busy helping to prepare the station for normal working.

To anyone who has made measurements of the surface winds only, in areas where the wind is influenced by the sea, but not of the winds at higher altitudes, the results of such observations can be quite surprising. There can be occasions when the surface wind is almost diametrically opposite to the wind at high altitudes, the gradient wind, and it is then necessary to change the orientation of the theodolite telescope quite rapidly in order to keep the balloon in the field of view. Since the observer has to take his eye from the eyepiece in order to read the verniers and call the readings to the recorder there is always the possibility at such times that the balloon might have moved out of the field of view, finding it again sometimes being very difficult and resulting in a loss of time, a serious matter because of the limited time interval between successive readings. From the observational point of view it is therefore fortunate that the sea- and land-breezes do not extend to a very great height, sometimes to no more than a few hundred feet; the finding of the balloon, if momentarily lost, is therefore facilitated by its nearness and consequently comparatively large size in the field of view. Above the sea winds are the gradient winds, as given by the direction and spacing of the isobars. With large differences in the directions of the winds at the surface and at high altitudes it is not uncommon for the corrected winds for small calibre guns to be almost opposite to those for higher calibres. It was this which caused the shelling of our own areas when corrected winds for an area not influenced by the sea were used by the artillery near the coast.

The observational difficulty caused by rapid changes in orientation does not arise at places away from the coast. There, the wind is normally a gradient wind at all heights, and the changes in orientation are so small that the balloon is lost not through wandering out of the field of view but through entering cloud or becoming visually so tiny that it can no longer be seen.

The promenade at Bray Dunes ends at the eastern end at a very high sand dune and east of that, close to the sea, is a line of lower dunes, behind which the land is flat. There are no sand dunes the whole length of the promenade, but firm sands, not quite covered at high tide. Built into the dunes east of the high isolated dune was a small fort manned by French soldiers. I never saw it in action except on one night when they shot down one of our pilot balloons by machine-gun fire. The light, steadily rising into the sky, was clearly something new to them, and they had to be informed the next morning. Our hut was placed on the flat land at the foot of the high dune, and on the top of this was a wooden platform for the theodolite.

The weather was fine and warm on the whole, and in between observations we could enjoy sea bathing. I learned for the first time the danger of the undertow. The waves of the sea are circularly polarized, that is to say the water particles, instead of moving up and down, move in circles, the direction of the wave-front being at right angles to the plane of these circles. At the top of the crest the water motion is forward, but in the long trough the direction is out to sea. If the waves are high enough the velocity of the undertow can be surprisingly high, and it is augmented when the tide is ebbing (because of the gravitational pull of the moon.) One afternoon at a time of ebb tide I was bathing by myself and unwisely went beyond the breakers. On the shore side of the breakers there is no danger because friction reduces the undertow, but beyond these there is no such effect. The current was so strong that I realized I could not get back. Fortunately there were rows of groynes running out to sea; I managed to work my way to one of them and literally pulled myself hand over hand to the shore. A more amusing incident was when Banaghan and I had just finished bathing and were walking across the beach, stark naked, when General Rawlinson rode by. Banaghan stood stiffly to attention and saluted. I did nothing, remembering that one should not salute if not wearing a cap. As far as I know the rule said nothing about the rest of one's clothes.

The Meteor office was a good-sized room on the first floor of the Kursaal, no doubt previously used as a bedroom. A few yards away at the side of the road was the Post Office, housed in a large Nissen hut, and opposite to it a large car park for staff cars. One day I was just about to leave after enquiring about mail when there was a series of loud explosions, very close. Like everyone else I threw myself flat on the floor and hoped for the best. Everybody knew that there was an offensive in the offing and it looked as though the agreement regarding the shelling of Army and Divisional Headquarters no longer existed. The bombs, for that is what they were, were obviously intended for the Fourth Army H.Q. but, luckily, they only killed one man and a cage-full of carrier pigeons. The man was given a full military funeral, and, never having seen one before, I felt shocked when, on the return, the band played a jolly marching tune.

Besides the R.F.C. there was a squadron of the R.N.A.S. operating in the area. I had occasionally seen a young man in an immaculate blue uniform lolling in the back seat of a Lancia saloon, and two ratings in the front, one the driver and the other no doubt to open doors. I was surprised when he turned up one day just as we were about to make the 1 p.m. balloon ascent. By that time we were rather scruffy, with worn, not very smart uniforms, and somehow I resented the arrival of this beautiful apparition. He explained that he had noticed our balloons from time to time and guessed what we were doing. Would we mind if he watched, he asked, and of course we said no. I did the recording and manipulation of the slide rule and I could sense his astonishment when he realized that I was working out the results in the one-minute intervals between the readings. It was a good ascent, to 15 000 feet as far as I can remember, and it was only a matter of a few minutes before I had completed the computations, made out the telegrams—I knew the codes by heart—and sent Banaghan off to Signals. I made a copy of the data of wind direction and velocity versus height and gave it to him. He was quite unnecessarily grateful and I learned the reason why. As he left with his driver the other rating lagged behind and whispered that he only made one ascent per day, in the morning, and that it took him all day to work it out. I only hoped that the R.N.A.S. pilots didn't mind if they encountered a wind entirely different from that predicted for them. The world was an unjust place, I mused. Here was I, university man with a first-class honours degree, a mere Corporal dressed in a scruffy uniform, and there was he, obviously incompetent for the job somebody had wangled for him, dressed in a beautiful blue uniform and driven about in a dream of a car.

A pilot lives with the weather; from his point of view it can be his friend or it can be his enemy and it is the function of his meteorological advisers to tell him which to expect. This applies even today, but far more so in the days of the First World War, with gimcrack planes, to fly which at all was a miracle. 'Jobs for the boys' is, unfortunately, an inevitable characteristic of business and politics, but it is wholly reprehensible when the fate of a nation and the freedom of its people is at stake. I could never understand why, with competent Meteor observers on the spot, the R.N.A.S. did not ask for the complete information which only Meteor could supply, instead of relying on a man who, however admirable as a person, was obviously not competent to hold such a responsible position.

I found a bookshop in Rosendael, a walk of about four miles, and bought a copy of Alphonse Daudet's delightful *Lettres de mon moulin*. It was a pleasant change from the German texts I had been reading. He had a name of his own for all the bright stars. '*Voici le Râteau ou les Trois rois* (Orion). *Un peu plus bas brille Jean de Milan, le flambeau des astres* (Sirius). *Sur cette étoile là, voici ce que les bergers racontent. Il paraît qu'une nuit Jean de Milan avec les Trois rois et la Poussinière* (the Pleiades) *furent invités à la noce d'une étoile de leurs amies.*' These delightful imaginings seemed to be centuries away from the times in which I was then living. A beautiful land of make-believe which can exist only in a happy mind.

Apart from sea-bathing, an occasional cinema show, or a visit to Dunkirk, the work at Meteor Fourth

Army was exactly the same as at the other Army Headquarters. A change from routine was afforded by a request to assist at artillery ranging tests at Coxyde, some miles east of Bray Dunes. I was detailed to do this. A pilot-balloon ascent was made immediately before I started, so that the only equipment I had to take with me was the portable anemometer and a stop-watch. I went by coast road, called by the Army the Aeolian Road, on the motor bike and found the artillery testing station near the coast, with the guns, of various calibres, all pointing out to sea. I explained the pilot-balloon results to the officer in charge and worked out the corrected winds for the times of flight to be used during the tests. I also determined the surface wind just prior to each firing, it being relevant to short ranges, but of no importance at long ranges for which the shell spent a negligible amount of time in the lowest levels. It was interesting to stand directly beind the gun and watch the shell, like a black ball with a fuzzy edge, no doubt due to the rotation.

The Germans had perfect observation along the Aeolian Road because of the flat terrain and their artillery occasionally indulged in a strafe, which may have been a scheduled operation, or even pot shots at anything observed. Actually the road was used very little and, as far as I remember, I did not meet a single vehicle or party of men all the way to Coxyde. On the way back they started shelling the road about a mile ahead of me, and I flattered myself that, having seen me, they put on a show for my benefit. All I could do was to sit by the roadside, smoke a cigarette or two, and wait until they decided to stop.

During the First World War there was published a journal called *Blighty* which was circulated to the troops in France. Obviously it was by no means highbrow, but consisted of light reading and illustrations, all pen-and-ink drawings. In one issue there was a competition open only to members of the Armed Forces. As I still had my monster revolver I regarded myself as eligible. They were offering two prizes, one of one pound, the other of ten shillings, for the two best drawings which would be published in *Blighty*. I decided to have a go. At the entrance to the farm at Le Touret there were, on either side, two trees whose overhanging branches would have produced a conventional heart-shaped space in between if the bases of the trunks had been much closer together. I therefore made a drawing of the trees, modified in this way, and in the space between drew a silhouette of a soldier saying 'good-bye' to his girl. I did not suggest a title, but it was published with the caption 'Hearts are Trumps'. I obtained the second prize of ten shillings, a useful addition to a Corporal's pay, and a few weeks later I received an upside-down pipe. That, I think, is the best description. It looked like an ordinary pipe, but the opening of the bowl was at the bottom, the top being closed. There must have been a duct leading from the top of the bowl, through the briar to the stem. As I didn't smoke a pipe I gave it away. It must have been a pig to clean. I also received an offer of marriage from a girl in Wisbech.

A little while after the war I was in Liverpool Lime Street Station and as I had some time to spare I looked at the books and things on the bookstall. I was surprised to find my drawing of 'Hearts are Trumps' in the form of a picture postcard, and this time coloured, blue and pink as far as I remember.

(To be continued.)

Review

Climatic change, agriculture and settlement, by M. L. Parry (in the series *Studies in Historical Geography*). 225 mm × 135 mm, pp. 214, *illus.* Dawson Publishing, Folkestone; Archon Books, Hamden, Connecticut, 1978. Price £9.00.

This book provides what is on the whole a useful conspectus of the influence of climatic change on the cultivation of certain crops and hence on the productivity of farming and the consequential changes in population levels and patterns of settlement. Attention is focused chiefly on north-west Europe, but examples are drawn from all over the world including ancient Mediterranean civilization and the American Great Plains in modern and prehistoric times. It is not free from faults, however, and one of the most serious and fundamental is the lack at the outset of any adequate discussion of the meaning of 'climate' and hence of 'climatic change'. Under 'Climate, definition of' the index directs us to p. 25 where all that we find is the following:

'The term climate usually brings to mind the idea of an average regime of weather; 'weather' refers to the condition of the atmosphere at a particular place and time. It is useful to view climate as a system comprising properties and processes which are responsible for its many types of variation, from yearly fluctuations to changes on a millenial time-scale. The most important influence on climatic change is the circulation of the atmosphere.'

This will not do. We all have a vague feeling that we know what climate is, and that, for example, the climates of Manchester, Moscow and Madras are today very different from each other, and that the climate of Manchester today is very different from what it was 20 000 years ago. Such vague feelings can be and have been systematized: an excellent discussion is given in the National Academy of Sciences publication 'Understanding Climatic Change' (Washington, 1975) in Chapter 3. Dr Parry brings out more than once in passing that there is more to climate and the way in which it influences crop yields than simple annual averages of temperature and rainfall, and that the distributions of weather elements within the year and their mutual correlations are very important; such matters should have been analysed thoroughly at the very beginning.

Dr Parry rightly concentrates his attention on areas that have marginal agricultural climates; changes of climate have much more dramatic effects in such areas than in others. He has made a particular study of the Lammermuir Hills and applies the results obtained to the whole of north-west Europe in a very plausible fashion by showing how isopleths of measures of insolation, exposure and summer wetness reveal the patterns of cultivation limits and frequency of crop failure. (It is perhaps worth remarking that the idea of a definite 'growth threshold' for accumulated temperature, whether put at 6 °C or 4·4 °C, has been superseded by recent work which has shown that growth continues, albeit at reduced rates, at temperatures only a little above freezing; however, the patterns of useful growth derived using fixed thresholds are not likely to be altered in their general aspect by such considerations.) Dr Parry's idea of an end of summer 'potential water surplus'—i.e. the excess of a middle and late summer surplus of rainfall minus evapotranspiration—is a useful one for consideration of the effect on harvests of excessive soil wetness; this effect is particularly marked in marginal upland areas. It is, however, *actual* evapotranspiration that should be considered, not *potential*, otherwise in dry sunny summers (e.g. 1976) absurd results would be obtained. Again, soil wetness as such may be of much less importance at harvest time than untimely rain and strong winds that produce 'lodging' and sprouting of grain in the ear. Dr Parry also has a grossly over-optimistic view of the accuracy of evaporation estimates (p. 78): ±20 mm is nearer the mark than ± 5 mm!

The book contains a large number of references to the work of other researchers—climatologists, agricultural economists, geographers, botanists and historians. The conclusions of some climatologists are sometimes quoted rather uncritically, and several diagrams showing 'running means' are reproduced with no comment on the fallacious and misleading impression conveyed to the innocent reader by this regrettable practice. The style is resolutely undogmatic, however, and a high proportion of sentences contain phrases such as 'seem to bear this out', 'may have occurred', 'probably became', 'suggests an effect consistent with', and so on. The author nevertheless castigates some medieval historians for relying on accounts of climatic change that have long been superseded, and some others for ignoring the subject completely.

The book is written in a clear and attractive manner; it is, however, sad to see the author adopting the barbaric misuse of 'anthropogenic' to mean 'man-made'.

R. P. W. Lewis

Die Wissenschaft vom Wetter (*Verständliche Wissenschaft Band 94*), by H. Reuter. 185 mm × 115 mm, pp. viii + 146, *illus.* Springer-Verlag, Berlin, Heidelberg, New York, 1978 (second edition). Price DM 12, US $6.00.

When the first edition of this book was reviewed in the *Meteorological Magazine* in 1969 amost the only adverse comment made was that the methods of numerical forecasting then in use in several countries were inadequately covered. This edition devotes seven pages to the topic but it must be admitted that this is still a somewhat sketchy account, though probably all that is warranted in an elementary text.

I agree with the reviewer of the first edition that the book otherwise gives 'a very readable non-mathematical account of many aspects of meteorology'. The author discusses most topics in a very open and frank way, not pretending that there are no outstanding difficulties in explaining atmospheric phenomena. This leads him at times into some deep waters where he offers the following piece of metaphysics: Upward motion (of air) is a consequence of cyclonic development but downward motion is a cause of anticyclonic development. After a discussion of several aspects of anticyclonic structure he concludes 'it must be admitted that certain details of the formation of anticyclones require further elucidation.' I personally think that such a frank avowal is to be welcomed even (and perhaps especially) in an elementary text for everyman.

The diagrams and illustrations are with two exceptions (clouds reproduced from WMO Cloud Atlas) clear and the printing is admirable.

M. K. Miles

Notes and news

Investiture of Mr C. Kyriacou with the B.E.M.

At a ceremony at Air House, Episkopi on 3 September 1979, Mr Charalambos Kyriacou, supervisor of the meteorological communication centre at RAF Akrotiri, was invested with the B.E.M. by Major-General W. R. Taylor, Administrator of the British Sovereign Base Areas in Cyprus.

Charlie Kyriacou is very well known to the many members of the Meteorological Office staff who have served in Cyprus. Although the 'Met Comcen', previously associated with the Main Meteorological Office at Episkopi and now integrated with the Akrotiri office, is an RAF unit, Charlie and his staff have always seen themselves as, and have been accepted as, part of the Meteorological Office community in Cyprus.

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NOTICES

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