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The Synoptic Data Bank

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Summary

The last 15 years have seen major changes not only in forecast models but also in the technology able to support them. Over this period the Synoptic Data Bank has kept pace, developing from a very simple system to a complex collection of software and data sets able to receive a wide assortment of data on a continuous basis, making it available to an ever-increasing and increasingly demanding range of users. From its original concept as a source of data for the forecast models it has developed into a major service, and this development seems likely to continue.

Introduction

In 1970, the decision that the Meteorological Office should extend its work in numerical forecasting required the creation of a data base to provide quality-controlled data in real time. This data base, now known as the Synoptic Data Bank (SDB), was designed to form a bridge between the data flow on the Global Telecommunication System (GTS) and the numerical weather prediction model.

Before the formation of the SDB, data from the GTS were transferred to five-hole paper tape and sent to the computer room for reading by slow paper-tape readers. The data requirement of the earlier numerical models was much lower than nowadays so that data consisted mainly of land and sea observations coded as SYNOPs (surface observations on land), SHIPs (surface observations at sea) and TEMPs (upper-air data). However, since the late 1970s the availability of satellite data and the collection of more reports from the southern hemisphere have led to vastly increased amounts of data in the SDB. When, in 1982, the forecast model was extended to become global the SDB was able to provide the required data. The need to achieve this without any major change in the design of the SDB has created many problems, but the system is now relatively stable and this is a convenient time to present an account of the SDB and its expanding role in the Meteorological Office.

Report types

The original SDB was set up to collect synoptic and upper-air reports for the numerical forecast model and for a limited number of other users. The design, a simple indexed structure, has been essentially retained despite the subsequent growth in the variety of data. Commercial software packages for handling data bases were not available when the SDB was developed and are not yet employed.

The growth of the SDB has been dominated by a continual demand for more, higher-quality data with a wider coverage for projects such as the GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment (GATE) and the First GARP Global Experiment (FGGE), and, more recently, to meet the needs of a global analysis system for the larger forecast model. The number of report types has grown and now exceeds 50, consisting of surface, upper-air, satellite, and GRID (numerical output) codes, and TBUS data (satellite prediction information). Each new code often involves additional problems of storage, archiving, retrieval and error checking and so over the years has taken the SDB far beyond its original design.

As shown in Table I, the SDB still consists mainly of SYNOPs and SHIPs (now combined in code FM 12/13–VII) together with radiosonde information. However, the reason for the growing need for more data will be seen from Figs 1–4 which show the global distribution of reports. By far the greatest coverage is in the northern hemisphere, with only a small number of reports from land stations and a few ships in the southern hemisphere.

This distribution was satisfactory for a short-term forecast (1 to 3 days) confined to the northern hemisphere but for medium-range global forecasts the coverage of upper air data is insufficient, especially in the southern hemisphere. Even aircraft reports (AIREPs) of temperature and wind values at the aircraft's flight level tend to be infrequent and confined, like ship reports, to specific lanes.

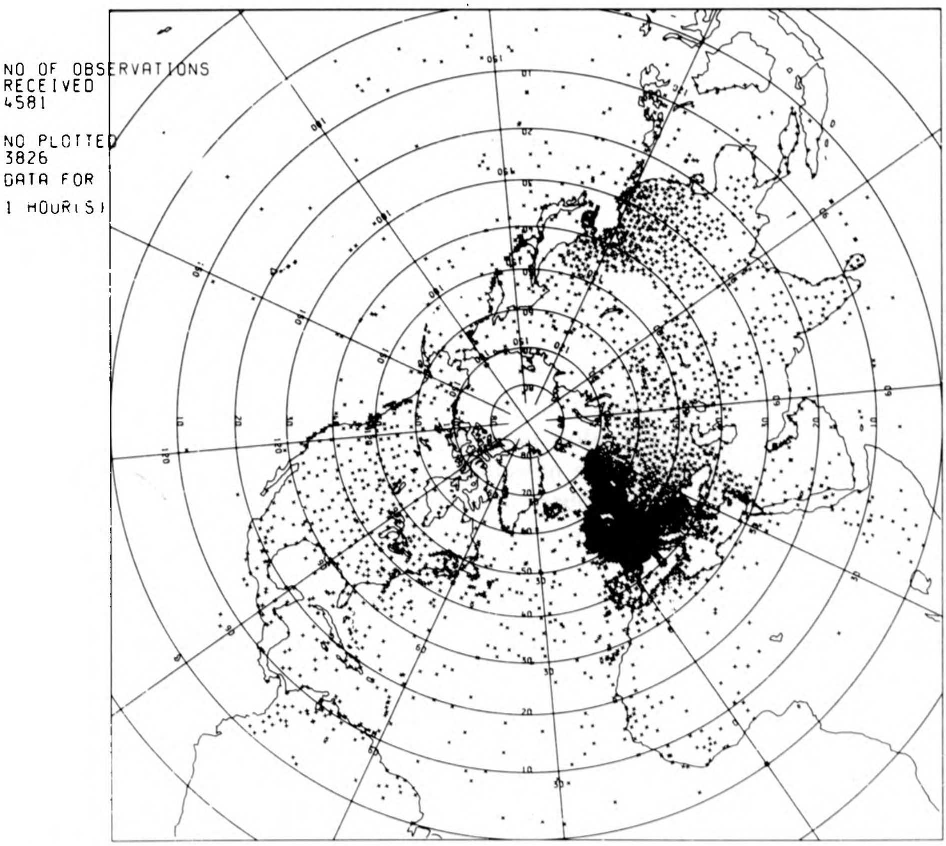

Figure 1. Surface observations (SYNOPs) in the northern hemisphere for 1200 GMT on 10 September 1985.

Table I. *The contents of one data bank, showing the main types of data stored in the data banks every 12 hours. Approximately 5 × 10⁶ characters are processed every 12 hours.*

Type	No. of reports
SYNOPs	14 673
SHIPs	2 026
TEMPs (land and ships)	2 176
PILOTs (land and ships)	935
AIREPs	1 753
BATHY (bathythermal observation), TESAC (temperature, salinity and current report) etc.	772
NCM	126
METARs (aviation routine reports)	600
SATEMs[1]	4 350
SATOBs[1]	894
HERMES[1]	6 000
GRID[2]	155

Note [1] Stored in satellite banks
[2] Stored in GRID code banks

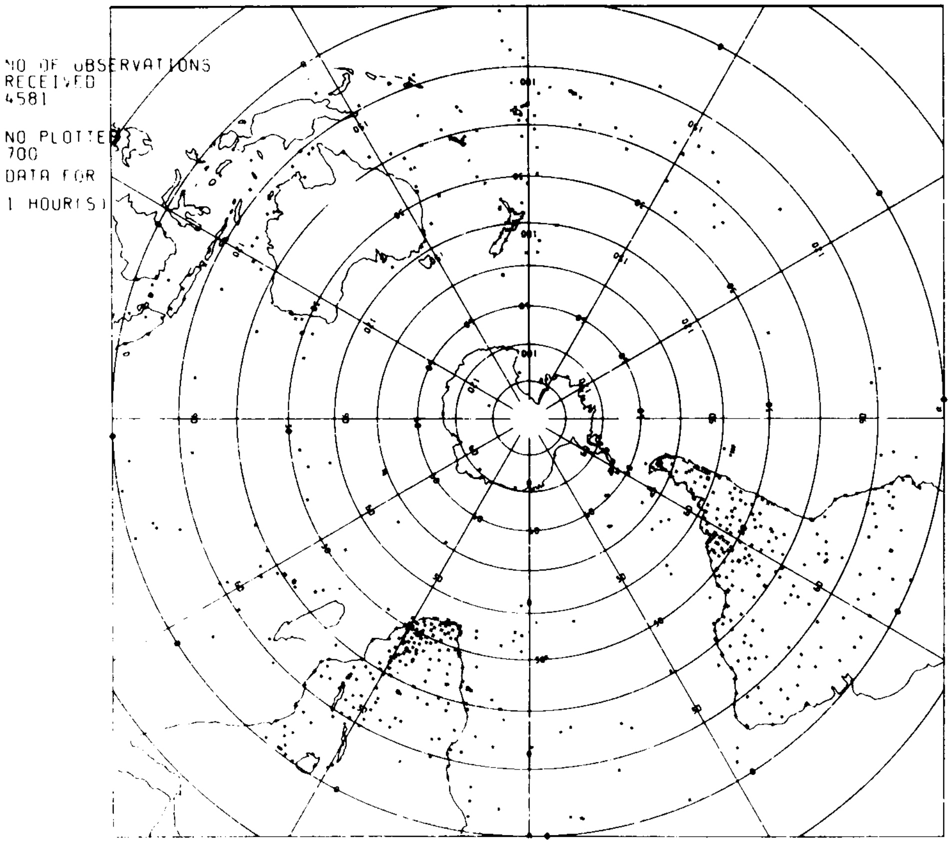

Figure 2. As for Fig. 1, but for the southern hemisphere.

In recent years, however, the imbalance between the coverage of data in the northern and southern hemispheres has been redressed by the availability of satellite reports. The series of geostationary satellites give SATOB reports of winds and temperatures, and the NOAA polar-orbiting satellites provide SATEM reports at about 500 km intervals of cloud cover, thickness of defined layers in the atmosphere, and water vapour. These reports are not yet accurate enough to replace other types of data but they provide very valuable additional information where other, conventional, types of data are sparse or non-existent.

The first major departure from the original SDB design occurred when it was realized that the large and growing number of satellite reports threatened to swamp the SDB. Since 1976, therefore, they have been stored in a separate set of Satellite Data Banks, designed with the same simple index structure as the SDB, capable of being increased in size, as necessary, without affecting any other data.

A similar policy was subsequently adopted with the GRID code reports from other Meteorological Centres. These data, consisting of heights, temperatures and wind vectors for standard pressure levels at fixed grid positions over the entire globe, are used by the researchers and, in plotted form, by the Central Forecasting Office (CFO). GRID data require a potentially large amount of on-line storage but have no archive value and so a third set of data banks was set up.

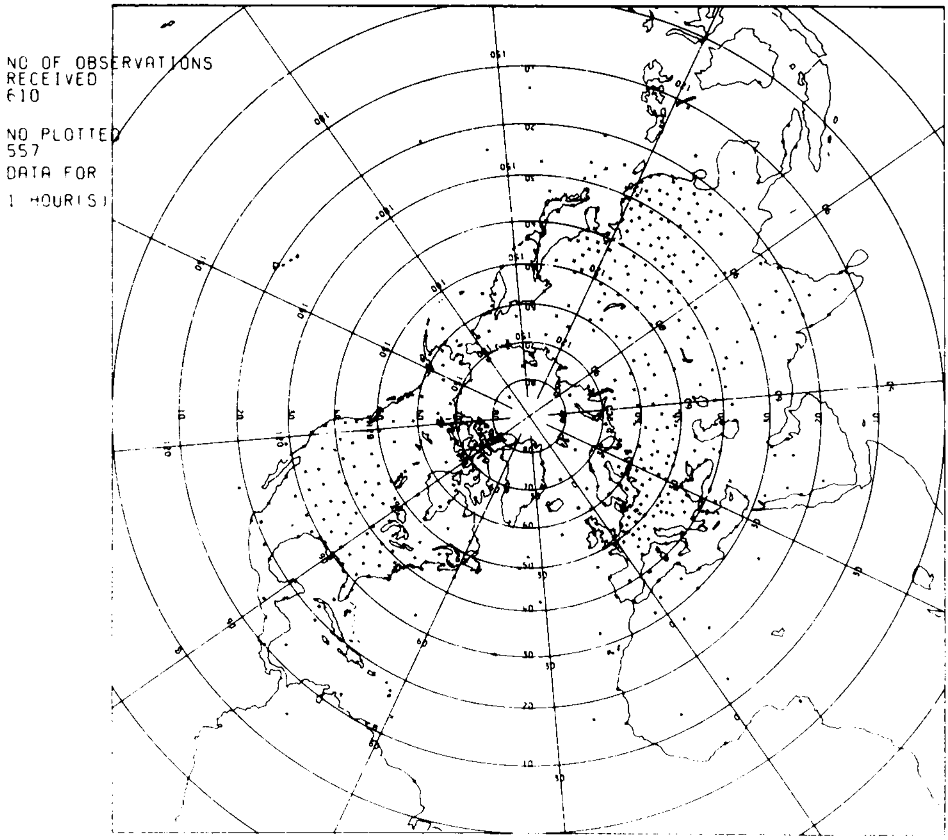

Figure 3. Upper-air soundings (TEMPs) in the northern hemisphere for 1200 GMT on 10 September 1985.

Data storage

Almost all the data stored in the SDB are received over the GTS via the Regional Telecommunication Hub (AUTOCOM) at Bracknell but, in addition, there are now also processed satellite data from the HERMES (High-resolution Evaluation of Radiances from Meteorological Satellites) minicomputer. The GTS data are passed via a Ferranti Argus system (Fig. 5) to the Meteorological Office central computer system (COSMOS) and processed by the permanently resident SDB software. These programs read and identify the data and, after checking and quality controlling, store the reports in the appropriate data banks.

The SDB programs must be sufficiently flexible to cope with large amounts of data at peak periods (bursts of around 1000 characters per second) while remaining inactive for periods when few data are arriving. The data flow (Fig. 6) determines optimum cut-off times for chart plotting. Information on the real-time flow of data is sent to World Weather Watch for forward planning of the GTS circuit.

The continuous availability of the SDB is of vital importance to the forecast so, in order to reduce the probability of loss, a dual system has been created in which two identical copies of the SDB are kept on separate discs and updated simultaneously. One set of banks is allocated for operational work and the parallel set for other users. When either disc is unavailable, all users are automatically switched to the

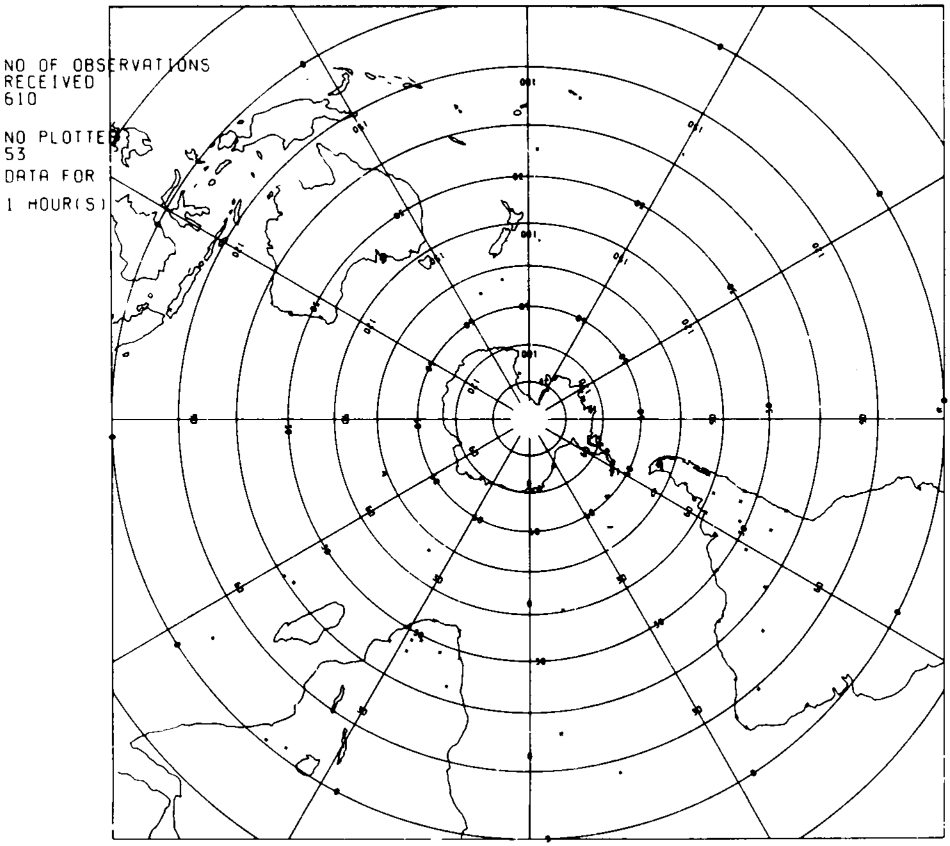

Figure 4. As for Fig. 2, but for the southern hemisphere.

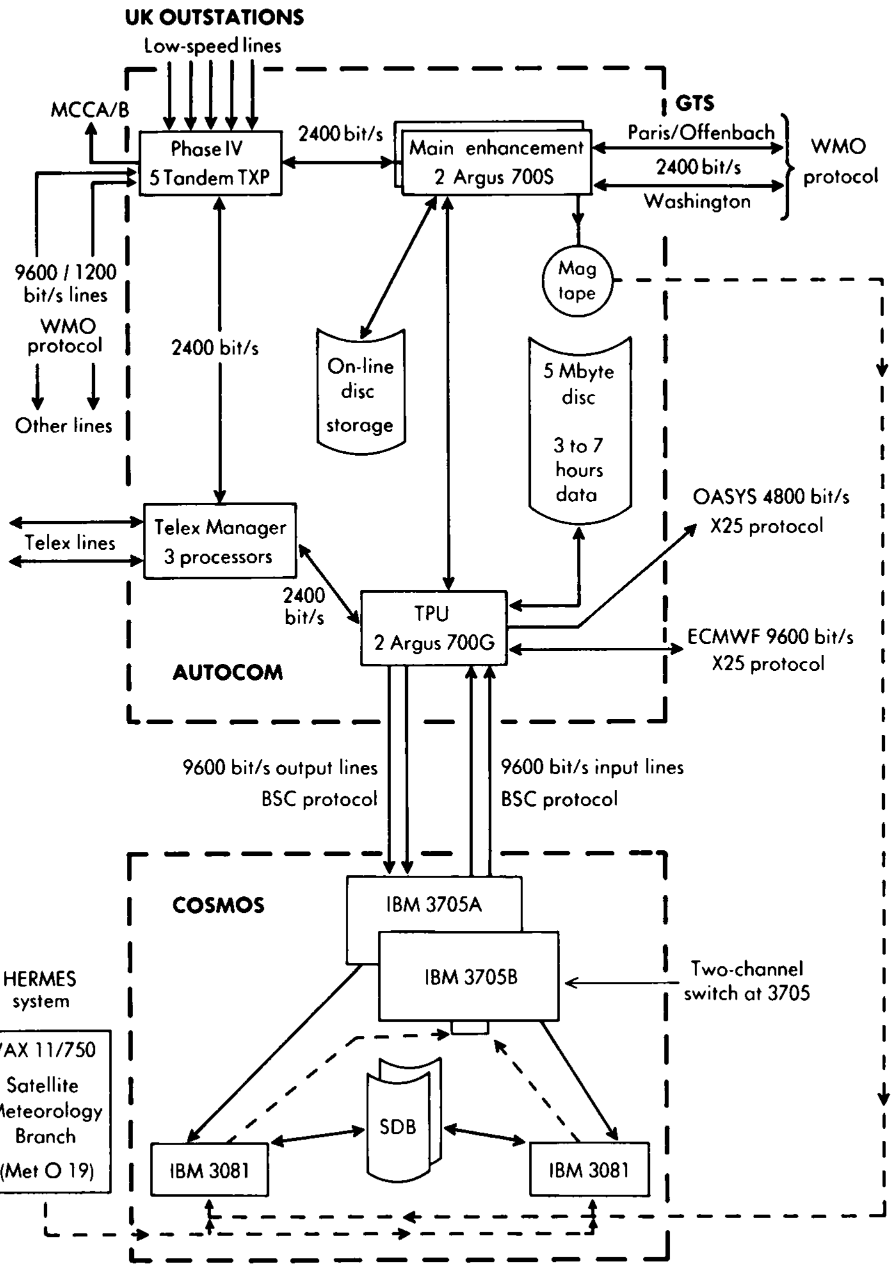

Figure 5. The international and UK data flow into the Bracknell Regional Telecommunication Hub and are then continuously passed to the Synoptic Data Bank. Processed satellite data from the HERMES system are passed to the Synoptic Data Bank shortly after the pass of the polar-orbiting satellite over the eastern Atlantic and western Europe. Line speeds given are in bits per second (bit/s); one byte is eight bits.

other which continues to accept and store data from the GTS. When the disabled disc is again available its data banks are automatically updated and dual storage is restored. This automatic switching is achieved, without programmer action, through the use of a 'housekeeping' data set which holds information about the data banks.

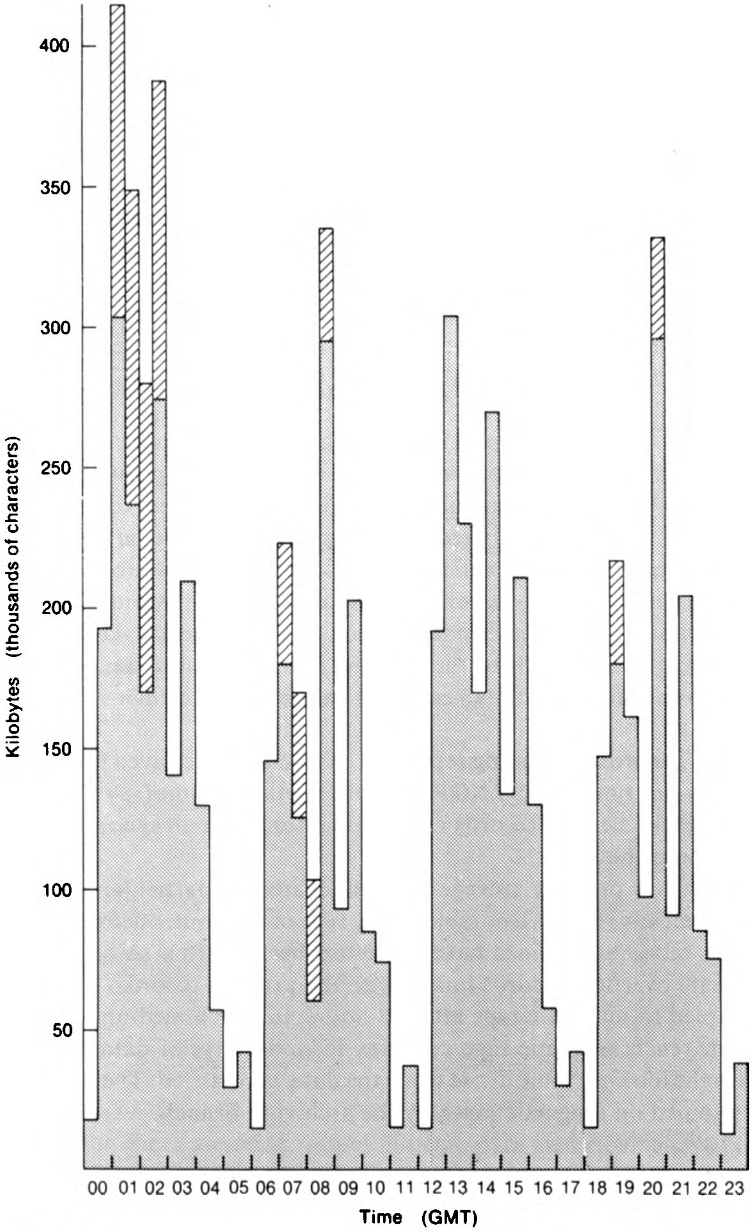

Figure 6. The peaks and troughs of data stored in the Synoptic Data Bank in a typical 24-hour period. The stippled histogram denotes the number of characters of surface, upper-air and satellite reports stored in the Synoptic Data Bank within each 30-minute period. The hatched areas at the top of the columns show the number of characters of GRID code data, received mainly from Washington and the European Centre for Medium Range Weather Forecasts, stored in the Synoptic Data Bank.

If the COSMOS system is unable to take data for short periods, the GTS data are held on a disc in AUTOCOM until the SDB is re-started. When there is a longer breakdown in communication, the data which are continuously written to a series of magnetic tapes by AUTOCOM are subsequently transferred to COSMOS for reading into the SDB, simulating the AUTOCOM–COSMOS link. The amount of data held on the tape will depend on the operational requirements at the time but tapes would usually be called for every 30 minutes.

In cases of a major breakdown in the system, AUTOCOM can store up to 6 hours of GTS data on disc and this, in conjunction with the GTS data from magnetic tape, can be read simultaneously into the banks when COSMOS becomes operational again.

Synoptic Data Bank data sets

The phrase Synoptic Data Bank is often used to refer to the 200 or so programs handling the storage and retrieval of the data. But, to be strictly accurate, the term SDB should only be applied to the data sets storing the data and a few others fundamental to the operation of the suite.

These comprise:

(a) The ten Synoptic and ten Satellite Data Banks. Each data bank stores meteorological reports for a 12-hour period (i.e. 0000 GMT to 1159 GMT or 1200 GMT to 2359 GMT), storage being by validity time rather than by time of receipt.

(b) The look-up table — a fairly complex index using the station number (or, for a ship, latitude and longitude), and the time and type of the observation, to determine the position for storage in the bank. This table has a particularly important function in that it enables changes to be made in the SDB layout without affecting the user. Any changes in record position, for example, are handled by changes in the look-up table. For this reason a current version of the look-up table is archived with each SDB.

(c) The abbreviated station index — a complete list of World Meteorological Organization (WMO) stations and some relevant details of each station, such as station height, latitude and longitude.

(d) Two housekeeping data sets storing the date and time of the latest data banks created. These two small data sets also provide the current names of the data banks and their location and availability.

Each SDB consists of records containing reports in characters as received from the GTS. Each record contains reports of only one type (e.g. SYNOPs) for one particular time (say 0500 GMT) and for one or more WMO block numbers. Several records are required for the main synoptic hours and very few for the intermediate and minor hours.

The first 800 records are primary storage areas allocated to particular types of data. These are accompanied by 220 overflow records available to any type of data but, once used, linked to the relevant primary records. The retrieval routines have therefore been written so as to search automatically through the appropriate overflow records linked with the primary records.

Data banks are copied to magnetic tape after 48 hours, in which medium they are retained for five years. When complete, each magnetic tape contains 15 or 16 days of data banks (depending on the month) together with the look-up table in use when the data were stored. The permanent Synoptic Data Bank archives are retained on magnetic tapes by the archiving Branch.

Bulletin recognition

When bulletins are received the first job of the software is to recognize the type of data by examination of the bulletin headings and allocate the appropriate Data Processing Branch (Met O 12) code type for future processing. For example, AAXX would indicate a land station SYNOP, and TTAA a TEMP part A. (If, however, the heading or content of a bulletin is unrecognizable it is stored in the 'dregs' records of the SDBs. These may be dealt with manually but this is a facility not readily available to users.) After the bulletin has been recognized the software then 'cleans up' the reports, removing all telecommunication characters, and investigates non-five figure groups for surface and upper-air reports. Groups with fewer than five characters are sometimes padded with slashes or re-formed if a space is in the wrong place; groups with more than five characters are split up and padded if necessary. The date and time are extracted from the bulletin heading and inserted in an information header preceding the bulletin contents. The bulletin heading is then discarded and the contents separated into individual reports which are then subjected to the quality-control routines.

Quality-control routines

These routines subject each observation (now that its format has been checked and standardized) to extensive tests on the data content. When an error is detected a quality-control 'flag' (a marker on the data set record) is set for that element. Tables II and III list quality-control tests for surface observations and upper-air data. These tests have been developed keeping in mind the main purpose of the SDB which is to provide a suitable source of data for the numerical forecast model in real time; hence a fully comprehensive set of tests is not possible at this stage of processing.

Table II. *Quality-control checks carried out at storage time.*

Code type		Valid Date/ time	WMO block and station no.	Position groups lat./long. Marsden sq.	850 mb and 700 mb initial digit check	Max wind at standard levels	Wind shear check	Full hydrostatic check
TEMP	A	✓	✓	—	✓	✓	✓	✓
	B	✓	✓	—	—	✓	—	—
	C	✓	✓	—	✓	✓	✓	✓
	D	✓	✓	—	—	✓	—	—
TEMP SHIP	A	✓	—	✓	✓	✓	✓	✓
	B	✓	—	✓	—	✓	—	—
	C	✓	—	✓	✓	✓	✓	✓
	D	✓	—	✓	—	✓	—	—
PILOT	A	✓	✓	—	—	✓	✓	—
	B	✓	✓	—	—	✓	—	—
	C	✓	✓	—	—	✓	✓	—
	D	✓	✓	—	—	✓	—	—
PILOT SHIP	A	✓	—	✓	—	✓	✓	—
	B	✓	—	✓	—	✓	—	—
	C	✓	—	✓	—	✓	✓	—
	D	✓	—	✓	—	✓	—	—

The basic idea is that the checks applied should indicate data elements believed to be suspect when tested against some set of acceptable criteria — for example, an assumption that the atmosphere is approximately in a state of hydrostatic equilibrium. A flag does not necessarily indicate that the data are wrong, only that the allowed limits set in the SDB software have been exceeded or that consistency checks have failed. The basic philosophy adopted when the bank was established was that it was not the responsibility of the SDB to reject any meteorological information. Thus, if any element of a report is modified by the quality-control routines (for example as a result of the hydrostatic checks) the original data are stored in the 'quality control' records of the SDB, and may be retrieved by those who wish to make their own decisions about the questions raised by the flags. No quality-control flags are set when the hydrostatic equation shows a temperature or height error, and a new value has been substituted. However, a substitution flag is set in the information header and the user can decide if the original observation is to be seen.

Table III. *Some of the 250 quality-control checks carried out on a SYNOP. Internal consistency checks account for a large number of the quality-control checks.*

Check	SHIP	SYNOP
Valid date and time	✓	✓
WMO block no. and station no.	—	✓
Ocean Weather Ship position check	✓	—
Internal consistency	✓	✓
Background field pressure comparison	✓	✓
Pressure group checked for high-altitude station	—	✓
Movement check	✓	—
Pressure tendency sequence check	✓	✓
Temperature − dew-point consistency	✓	✓
Land or sea position	✓	—

Associated with every report with quality-control queries is a record of all the quality-control flags, corresponding to the data elements within the report; these indicate whether the data elements in question have been flagged.

In some cases reported values may be replaced by calculated values, for example:

(a) Marsden square/latitude, longitude/quadrant values are checked.

(b) Standard pressure level indicators in parts A and C of TEMP messages are corrected provided the indicator for the next level can be recognized. For example 70 05 40 becomes 70 50 40.

(c) Hydrostatic check for TEMPs part A and C ('standard levels' data up to 100 mb and above 100 mb, respectively).

The hydrostatic check is applied to all TEMPs part A and C. It is an extensive test of the temperatures and geopotentials of the standard pressure levels and is based on the hydrostatic equation which may be written thus, assuming the temperature varies linearly with pressure within each layer:

$$\text{Thickness} \simeq \frac{R}{2g}\left[\log_e P_N - \log_e P_{(N+1)}\right]\left[T_N + T_{(N+1)}\right]$$

If the difference between the thickness of each layer calculated in this manner and the thickness calculated from the reported geopotentials is less than 30 gpm for all layers the check is regarded as complete. If the discrepancy is larger than 30 gpm then further tests are performed to try to find the source of the error. A common source of error has been found to be an incorrect sign to a temperature value, and thus when errors are detected the first test entails reversing the temperature sign at the top of each layer and recalculating the thickness difference. (Surface pressure checks are used to check the lowest level, usually the 1000 mb geopotential). If the error persists further tests are made based on consideration of various lapse rates in successive layers. The whole series of these tests is worked through and elements are either corrected and substituted or, if a reasonable value cannot be found, then the suspect element is flagged.

Extensive internal consistency checks, about 250 in all, are made on surface reports.

If, during the passage through quality-control routines, some part of the observation is suspect, a flag is set in the information header attached to the beginning of every observation in the data bank. After quality control, the report, the information header and the quality-control record (if any) are finally stored.

Since the four parts of TEMP and PILOT (upper wind) reports do not usually arrive at the same time, full quality control on storage is not performed. Users are, however, provided with the option of using a second-level quality-control package on retrieval. This additional software combines all the available parts of the ascents, and, using some of the first-level quality control, can carry out additional detailed checks.

Retrieval

An important feature of the SDB is that any computer user may have easy access to the data whether either synoptic or satellite data are required.

A subroutine is therefore provided which acts as an interface between the users and the data sets without the user having to know where the data are stored. The user has to specify up to eight parameters to the subroutine and the correct routines are automatically loaded from the SDB libraries to search the data sets for the required information and supply them to the user. Retrieval routines may be called from FORTRAN or Assembler programs. The eight parameters, chosen to define fully the data and format required, are as follows:

1. Date and time of the reports to be retrieved.
2. Type of observation.
3. List of stations required.
4. The name of the user's retrieval area in which the retrieved data are placed.
5. Code type combination.
6. Element retrieval. To return only specified parts of an observation.
7. Option word. Type of retrieval: i.e. character, half-word integers etc.
8. Time slice: for data received within a time window.

The use of parameters 5, 6, 7 and 8 is optional. Quality-control information can be retrieved if required but it should be noted that only the preferred report is returned when using normal retrieval routines. On the GTS an observation can be received several times, not always in identical form, and hence the SDB software has to decide upon the best report available. Other versions are not rejected nor, in the past, have they been made available through normal retrieval software; however, during 1985 a further option was provided enabling all versions to be retrieved.

To decide upon the preferred report the following points are considered:

(a) Are the observations in question identical? If there are no differences detected the newest observation is not stored.

(b) Are the observations of the same length? If the new report is identical with the original as far as the original goes but the new report is longer, then the new report becomes the preferred report.

(c) A correction (CC or COR) report will always replace an old one independent of the data content.

(d) Two reports not identical are both stored but the preferred one is the longer or the one with the fewest quality-control flags raised.

Fig. 7 shows the three stages of a SYNOP through the SDB, ending with the final character retrieval of the observation displayed on a computer terminal.

DATA ON GTS:

↓ZCZCΩ
↓SMUKΩEGRRΩ↑110900<<≡
↓AAXXΩ↑11094<<≡
03318Ω41465Ω82435Ω11093Ω20085Ω49897Ω56057<<≡
77562Ω88511Ω333Ω82615Ω88622Ω90998Ω91149<<≡
91235Ω555Ω1//49=↓<<≡≡≡≡≡≡

CLEANED UP:

83	EGRR	541	0	4	0	83

11-byte information header
(as yet incomplete)

03318414658243511093200854989
75605777562885113333338261588
62290998911499123555555 1//49

PASSED TO QC ROUTINE — ERRORS FLAGGED:

VV and ww
TTT and $T_dT_dT_d$
4 added to 'L' as quality-control record is added to the end of the report

CHARACTER FORMAT RETRIEVAL:

87 ** EGRR ** 541 ** 00101001 ** 4 ** 00000000 ** 83
03318 41465 82435 11093 20085 49897 56057 77562 88511 33333 82615
88622 90998 91149 91235 55555 1//49
00000110 01000001 00000000 00000000 00000000 00000000

Figure 7. An example of a surface observation received from the Bracknell Regional Telecommunication Hub. The observation is recognized by the Synoptic Data Bank software as a SYNOP, quality controlled, and then stored in the data bank. When the SYNOP is retrieved in character format the user has available the 11-byte information header, the SYNOP WMO code, and any quality-control bits which are set during the quality-control process.

Data monitoring

Another operational use of the SDB is real-time data monitoring for three applications. First, telecommunication staff need to monitor the flow of data through the automated system to ensure that data for their area of responsibility are not corrupt and are transmitted correctly at the scheduled times.

The second need for real-time data monitoring is for the intervention team in CFO to be able to monitor reports used as input to the numerical forecast suite.

Third, an essential requirement of any data base is to monitor the volume of data received. In a system such as the GTS varies the number of reports received for any type of data varies from day to day. Even within each data type there can be fluctuations because the number of reports varies from hour to hour and even at the same hour from day to day from the same country.

Gross increases or decreases of any type of data can be noted. Synoptic and upper-air statistics are printed out for the whole twelve-hour period for the WMO blocks with a deficiency of 20% or more during any hour that they are expected to report. From this information it is possible, with the help of the Telecommunication Branch, to detect where international links have been cut for a period, and even where alternative links have the wrong bulletin routeing lists. In cases where this has occurred it is possible for telecommunication staff to request a recall of lost GTS data from other Regional Meteorological Centre data bases.

New applications

The Advisory Services Branch is now dependent on retrieving SYNOPs and National Climate Messages (NCMs) from the SDB for archival purposes and also for the preparation of daily plant disease and warning messages for farmers. Examples of these are potato blight, apple-scab and barley mildew warnings. The Meteorological Office Rainfall and Evaporation Calculation Service (MORECS) and other routine services also take and process data direct from the SDB.

To help achieve as complete a set of synoptic and climatological data as possible a monitoring program driven by a list of expected UK synoptic stations supplied by the Advisory Services Branch compiles bulletins of missing or flagged SYNOP reports every hour at HH+30 and at 1130 GMT and 2330 GMT for the 0900 GMT or 2100 GMT NCM reports respectively. These bulletins are sent to all outstations on the MCCA facsimile broadcast requesting them to send or repeat the missing report, or correct the flagged report. Generally it is expected that all missing reports will be re-transmitted within the 24 hours and stored in the current banks, but when this is not practicable the reports can be sent to the SDB up to the last day of the current month, and stored in a 'late' data set for direct accession by the Advisory Services Branch.

This monitoring is vital both to achieve, efficiently, completeness of the archive data banks and for the routine time-critical services to farmers and others.

The archiving staff have less pressing time-scales for their operations and can do considerably more detailed quality-control checks than can be done in the very short time available to the SDB. However, the continuous data flow means that time is not inexhaustible and there are real pressures to complete the archiving and quality-control process quickly.

New types of data

Much more difficult have been recent departures from the original system of transmitting data in character format over the GTS. HERMES satellite data, for example, providing a fine network of thickness and thermal wind information over the eastern Atlantic and western Europe are transferred to COSMOS by a smaller VAX minicomputer within the Meteorological Office. The SDB software operates a 'sideways' transfer from disc for storage in the SDBs.

Another radical departure is the use of a compressed code for SATEMs. These are of considerable importance because they provide a four-fold increase in the number of reports, giving improved coverage in both northern and southern hemispheres. In order to achieve the necessary compression the data are encoded in a complex way quite different from the standard character format.

An expanding service

Finally, there are plans to make the SDB part of a much wider system. Information on present weather conditions in the United Kingdom and Europe, together with gale warnings and reports of coastal and skiing conditions could be made widely available via Prestel and other videotext systems. It is also possible that with increasing automation the SDB could be used to provide global information to the Weather Centres for answering enquiries with little or no delay.

Acknowledgements

My thanks are due to Dr G.W. Bryant, Mr B. Edkins, Mr C. Long and Mrs A. Jackson for their valuable assistance in producing this article.

Appendix — A short glossary of computing terms used

Data set	An organized collection of records. Known as a file in many other computer installations.
Data base	A data set, or several data sets, which is not designed to satisfy a specific, limited application.
Subroutine	A logically subordinate routine that is arranged so that control can be passed between it and the master routine.
Half-word integer	An integer value contained in a two-byte area on the IBM system.

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Transatlantic flight incident

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Pan American flight PA125, London to San Francisco, experienced severe turbulence, and shot up 1000 feet, over Greenland just before 1700 GMT on 22 January 1985. Several passengers were injured.

The incident occurred as the aircraft was approaching the west coast of Greenland, close to 62° N 48° W. Just before the incident the aircraft measured a wind of 180° / 10 knots, and immediately after the incident the wind was 100° / 100 knots. The aircraft was cruising at 33 000 feet when it suddenly ascended to 34 000 feet, at which point the pilot assumed manual control, then dropped to 32 400 feet and subsequently recovered to 33 000 feet. The turbulence lasted for about 2 minutes.

From the appropriate 12 GMT and 00 GMT Central Forecasting Office 250 mb analyses (Figs 1 and 2) an interpolation was made to assess the likely situation at 18 GMT. This interpolated analysis has been transferred to the two charts containing plotted aircraft reports (Figs 3 and 4). The evidence indicates that the jet on the western side of the ridge, which extended to Greenland, is bifurcated near the area where the incident occurred.

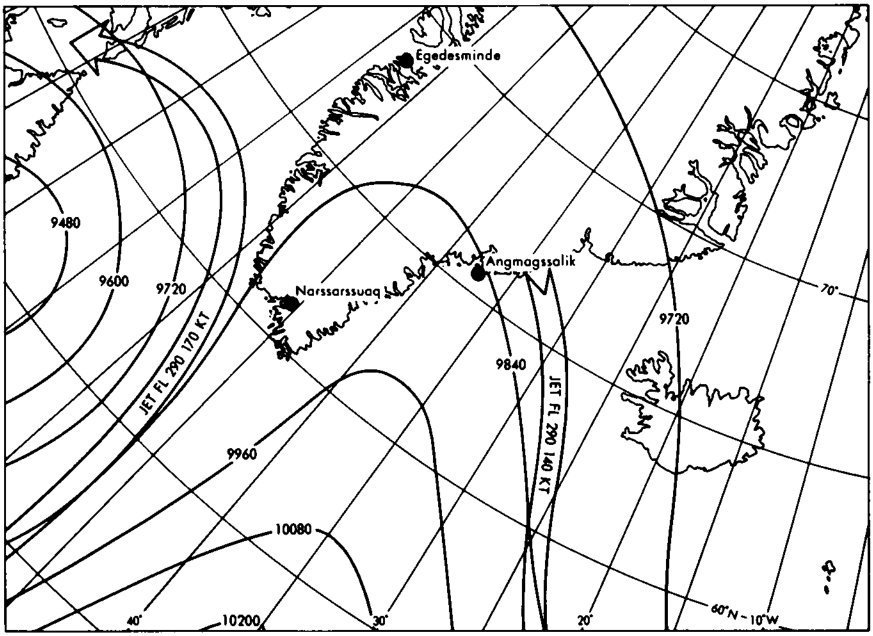


Figure 1. 250 mb analysis chart for 12 GMT on 22 January 1985. Contour values in geopotential metres. (Note: the terms KT for knots and FL for flight level are standard usage in aviation meteorology.)

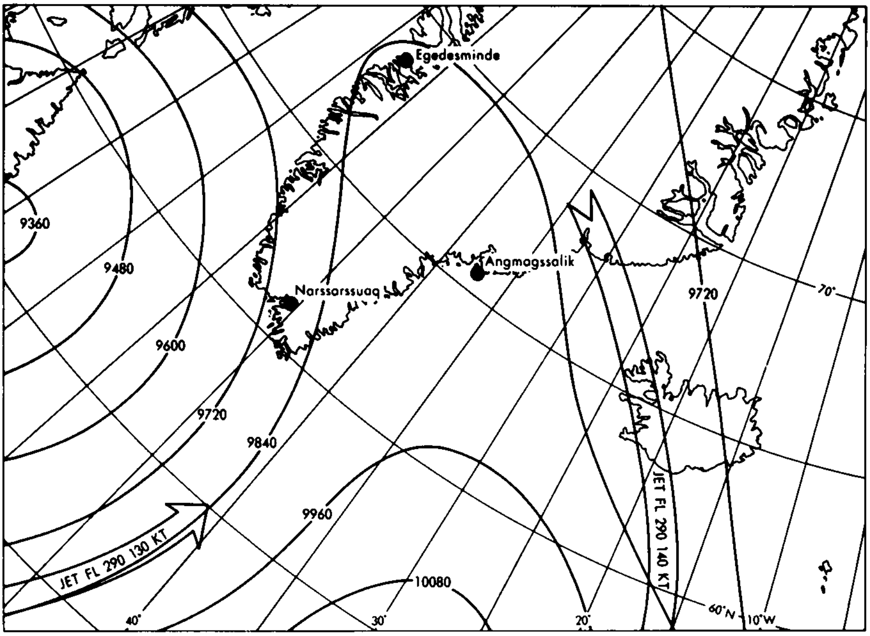


Figure 2. As Fig. 1 but for 00 GMT on 23 January 1985.

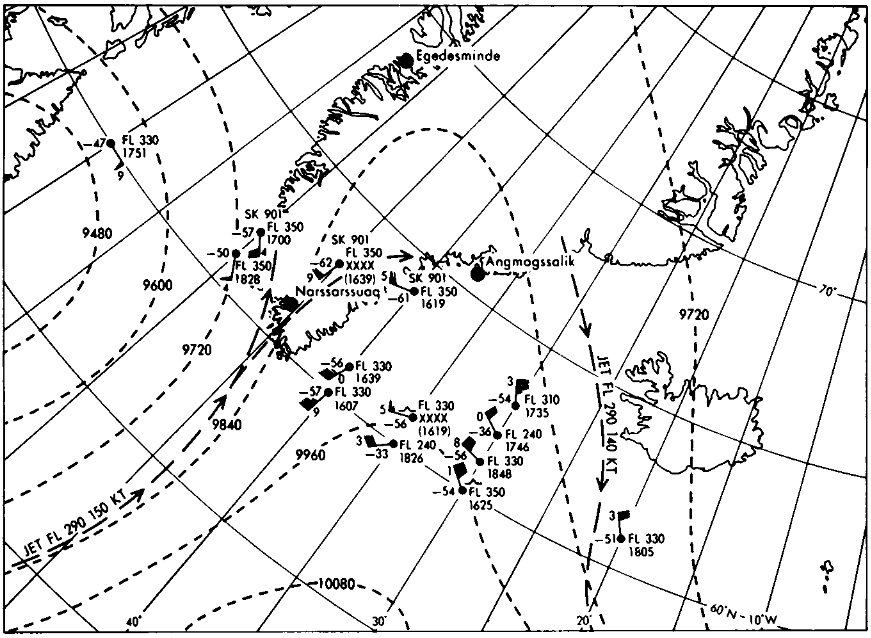


Figure 3. 250 mb contour chart for 18 GMT on 22 January 1985 interpolated from Figs 1 and 2. Aircraft reports are included giving flight level (FL), time of report (GMT), temperature (° C), and wind direction (tens figure is plotted beside the arrow) and speed (knots: long feather — 10, solid triangle — 50). The symbol ⌒ indicates moderate turbulence at time of report. (Note: Where the exact time of report is not known XXXX is plotted with the time of receipt in brackets below.)

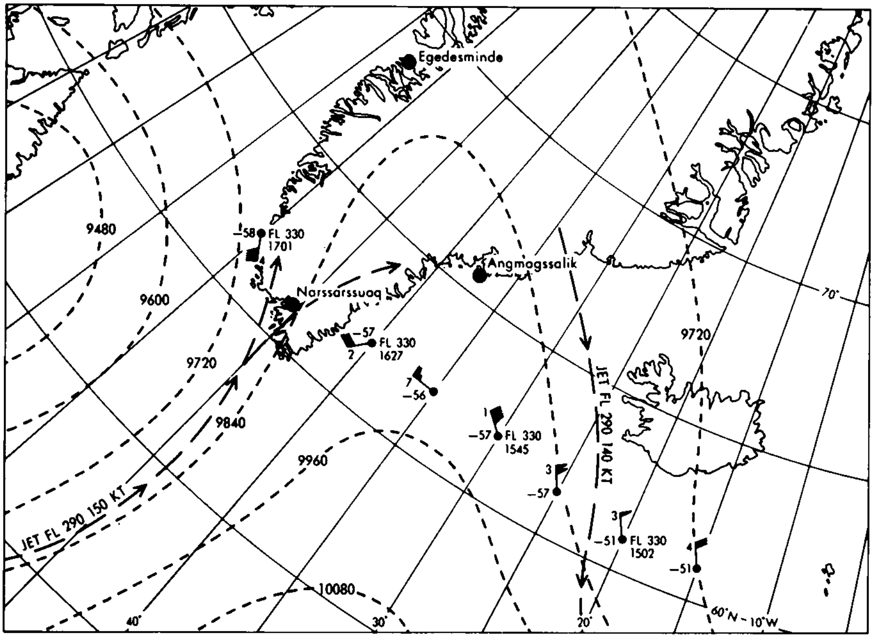


Figure 4. As for Fig. 3 but all aircraft reports are for Pan American flight PA125.

The computer Clear Air Turbulence forecast chart (Fig. 5) shows an area of 4% and 6% probability associated with the jet over south-west Greenland, and indeed the bifurcation can be seen quite clearly on this chart.

It is clear from the available aircraft reports and from the analysed charts, that the aircraft travelled from the eastern branch of the bifurcated jet through a zone of relatively light winds into the western branch of the jet. Thus it is not surprising that turbulence was encountered. Indeed this is a classic situation for the formation of clear air turbulence (Roach 1969). Moreover the tropopause was at about 260 mb and this may have intensified the vertical shear of the jet, thus increasing the chance of severe turbulence.

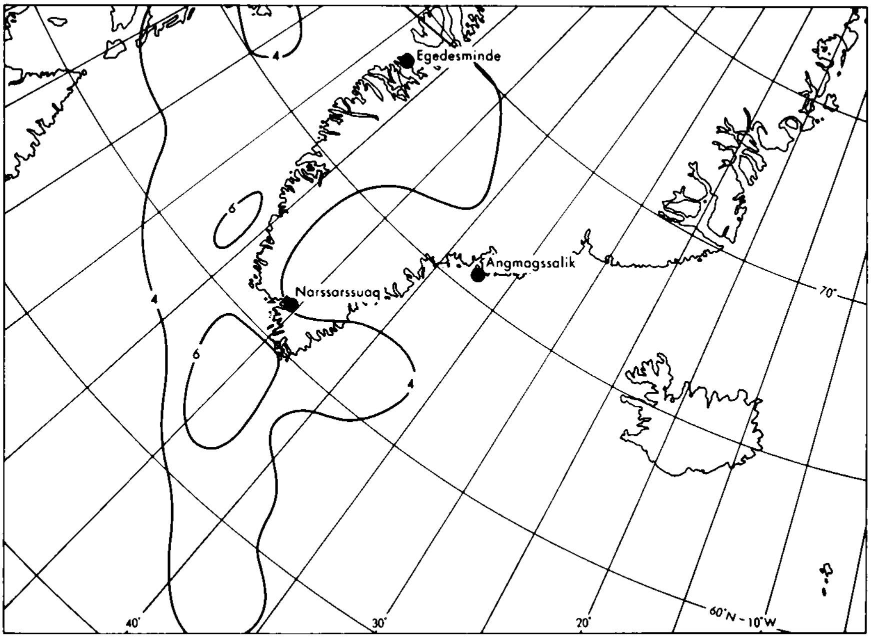


Figure 5. Computer 18-hour Clear Air Turbulence (CAT) forecast chart for 18 GMT on 22 January 1985 showing probability (%) of moderate or severe CAT at 250 mb.

Concerning the possibility of mountain waves, unfortunately ascents from the nearby upper-air station (Narssarssuaq) are not available for the day in question. The nearest ascents (Egedesminde and Angmagssalik) are to the north and not felt to be representative of the area in question. However, both these ascents do show some evidence of the possibility of mountain waves (stable layers with winds increasing with height). The available surface observations contain no firm evidence of cloud associated with mountain waves. However, although the presence of mountain waves cannot be discounted, it is felt that the incident can be explained satisfactorily without them.

Reference

Roach, W.T. 1969 Some aircraft reports of high-level turbulence. *Meteorol Mag*, **98**, 65–78.

551.509.52:551.509.53

Improved accuracy of international aviation forecasts of winds and temperatures

By N.D. Gordon
(New Zealand Meteorological Service)

In September 1980, a computer system providing forecasts of upper-level winds and temperatures for international aviation over the south-west Pacific was made fully operational in Wellington. This replaced a manual system where forecasts were produced for mid-latitudes in Auckland, and for the tropics in Nandi.

The manual and computer systems had been run in parallel for several months earlier so that their accuracy could be compared. As reported in Gordon and Purnell (1982), the root-mean-square (r.m.s.) vector-wind errors of the computer-derived forecasts at 250 hPa were reduced to about two-thirds of the errors of the manual forecasts. The computer and manual temperature forecasts were of comparable accuracy.

This computer system ran with little modification until the end of July 1985 when the new World Aviation Forecast System (WAFS) was implemented in New Zealand. Under this system, forecasts for the entire globe are produced in two World Area Forecast Centres (WAFCs) — Washington in the United States and Bracknell in England — and provided to Regional Area Forecast Centres (RAFCs) around the world. The Wellington RAFC receives data over most of the globe from the Bracknell WAFC, then distributes it in appropriate form to users.

For the month of August 1985, the old New Zealand computer system was kept in operation, without issuing any forecasts based on it, so that comparative verifications could be done. These verifications were against observations, as described in Gordon and Purnell (1982), with forecasts bilinearly interpolated from the centres of the four surrounding five-degree 'squares'. (This is the resolution on which the old forecasts were issued.) The WAFS forecasts are issued on a different grid of generally higher resolution, but for verification purposes have been bicubicly interpolated to the same points as the old system. The WAFS errors would probably be a little lower if the interpolation were from the original WAFS grid.

Verifications were done separately for the tropical south-west Pacific (north of 25° S from 145° E to 145° W), and for a mid-latitude area that corresponds to the old Auckland manual-forecast area — essentially from 25° S to 45° S and from 150° E to 160° W. Although five levels were verified at the four standard synoptic hours, for brevity Table I gives just two levels for 12-hour and 24-hour forecasts verifying at 00 GMT, the time of the most complete data coverage.

It should first be noted that, probably owing to the influence of the subtropical jet at this time of year, wind and temperature errors typically peak around August. Therefore, worst case errors are being considered here.

The table shows that the errors from the old system for August 1985 are almost all lower than the August average for the preceding five years. None the less, all the WAFS forecasts improve on the old system.

For winds, the percentage improvements are generally larger in mid-latitudes than in the tropics, larger at the higher level of 250 hPa, and larger for the longer-range forecasts of 24 hours. The best improvement is a reduction of 34% (from 28.7 to 19.0 kn) for 24-hour 250 hPa forecasts in mid-latitudes. Day by day values of the 250 hPa r.m.s. wind errors show that the WAFS forecasts have consistently lower errors than the old system, being bettered by it on only one day (August 29) in the entire month.

Table I. *Root-mean-square errors for 12-hour and 24-hour forecasts verifying at 00 GMT for winds (kn) and temperatures (°C) at two levels together with the percentage improvement of the WAFS forecasts over the old system for August 1985*

12-hour forecasts

	Tropics				Mid-latitudes			
	500 hPa		250 hPa		500 hPa		250 hPa	
	kn	°C	kn	°C	kn	°C	kn	°C
Original (unmodified) (Average for Augusts 1980–84)	14.6	2.05	19 5	2.34	17.2	2.37	27.7	3.70
Old system (August 1985)	12.4	1.60	17.9	1.91	15.7	3.11	25.1	3.74
WAFS 1985	11.6	1.47	16.4	1.75	14.7	2.68	18.6	3.13
Improvement (%)	6	8	16	8	6	14	26	16

24-hour forecasts

	Tropics				Mid-latitudes			
	500 hPa		250 hPa		500 hPa		250 hPa	
	kn	°C	kn	°C	kn	°C	kn	°C
Original (unmodified) (Average for Augusts 1980–84)	16.4	2.14	23.0	2.17	19.0	2.61	33.1	3.66
Old system (August 1985)	13.9	1.62	20.9	1.71	17.6	3.11	28.7	3.48
WAFS 1985	11.8	1.54	16.5	1.69	15.5	2.57	19.0	3.34
Improvement (%)	15	5	21	1	12	17	34	4

The percentage improvement of the WAFS temperature forecasts over the old system is generally smaller in the tropics and, if anything, decreases a little for the longer forecast period. This could be because the temperature errors for the old system were dominated by the statistical uncertainty of deriving temperatures from forecast height fields, with no systematic increase from 12-hour to 24-hour.

In conclusion, the wind and temperature forecasts based on data from the WAFC in Bracknell are an improvement over the previous computer system in New Zealand, with the largest increase in accuracy — 34% — coming in 24-hour forecasts of high-level mid-latitude winds. The old computer system was discontinued in early September.

Reference

Gordon, N.D. and Purnell, D.K. 1982 The aviation grid wind and temperature system. *Tech Note* No. 249. New Zealand Meteorological Service.

Notes and news

A Summer School on 'Mesoscale meteorology'

A residential Summer School is a new occurrence in this country. The first one ever to have been organized was held at the Meteorological Office College at Shinfield Park, Reading, during the week from 8 to 12 July 1985. The subject was 'Mesoscale meteorology' and over 75 people attended. They came from a variety of backgrounds, with the Meteorological Office and the Universities, notably Reading, providing equal inputs into the venture. In the planning, lecturing and in the numbers of participants involved, this was a new, combined operation, which it is hoped will be the forerunner of similar ventures in the future.

Many of the Office staff who attended were research workers, but there was also a significant contingent of active, operational forecasters. These were drawn from both the Central Forecasting Office at Bracknell and from the outfield, and others involved in the School had had similar experience in the past, so that the available forecasting expertise was quite large.

The University participants came from a dozen different Institutions. The University of Reading was well represented, as was Imperial College, and an international flavour was provided by a group of six from various centres in France. All of these were involved in mesoscale research in universities at some level, either in the forefront of scientific developments in the subject or as students doing advanced projects leading towards higher degrees.

There was therefore a numerical preponderance of research workers, but the presence of the practising forecasters was an element that was essential to the purpose and the character of the School. One of its central objectives was indeed the creation of an environment in which leading experts from both the theoretical and practical ways of meteorology could meet and talk together for an extended period, and enlarge each other's understanding. It is on this aspect, as seen from the forecaster's viewpoint, that this review concentrates.

Participants at the Summer School on 'Mesoscale meteorology' held at Shinfield Park, July 1985.

Sitting at the right-hand end of the front row are the Organizing committee (from the right: Dr K.A. Browning, Dr C.J. Readings, Prof. B.J. Hoskins, Dr B.W. Golding).

The daily timetable was straightforward. Lectures in the morning were followed by practical, mesoscale analyses of relevant case-studies in the afternoon. The lectures were delivered by acknowledged experts of whom it must suffice to mention a small number from the Meteorological Office (Dr K.A. Browning, Dr B.W. Golding and Dr M.J.P. Cullen) and the Universities (Prof. B.J. Hoskins, Dr A.J. Thorpe, Dr M.W. Moncrieff and Dr M. Miller). The lectures were good — authoritative and well-presented — and provoked some informed and interesting discussion. They formed a coherent series during the week; starting with Dr Browning's initial overview, and going on to cover the two broad areas of 'frontal mesoscale phenomena' and 'mesoscale organization of convection', which were the main topics of the School.

Individually, the lectures made varying demands on the audience. From the forecasters' point of view the straightforward ones were those which described observed phenomena, or models (either conceptual or numerical). Much of the material covered in this area has already been published (see Browning (1985), Golding (1984)). Even so there was great value in hearing it described by the authors and discussed by others at first hand. Much more demanding were those lectures which took us from the observations (the daily currency of forecasters) to physical understanding (the realm of theoreticians). Though the organizers of the School had imposed a moratorium on over-much mathematics, some inevitably crept in. This had predictable consequences for those who are not paid to spend their working lives using such concepts directly, but on the whole the cries of the drowning were relatively infrequent and resuscitation was available to all who needed it.

Certainly it was no easy matter to assimilate lectures which presented, perhaps for the first time, such heirarchies of ideas as 'vorticity — potential vorticity — isentropic potential vorticity'; or 'upright instability (CAPE) — slantwise instability (SCAPE)'. For many it was in something of an intellectual daze that concepts such as Q-vectors, density currents, Lagrangrian equations and much else came floating up from the front of the lecture theatre and over their heads. Looking back at the Summer School now, a need for improved preparatory literature can be seen. The *Lecture abstracts* which were available at the start of the School were not too helpful, in as much as they were concerned with generalizations rather than the particular concepts which became important in relation to the practical project work. It would have been helpful to many to have had some better record of these concepts.

But certainly it had been clearly recognized by the organizers that it would be hard work absorbing new ideas in the relatively short time available in the lecture periods. Complementary practical work was therefore carried out in the afternoons, in seven parallel groups. Each group was a carefully arranged mix of people drawn from a variety of backgrounds. In practice it took a day or two for the individuals within each group to learn to work and talk freely to each other, as there were considerable differences in both thinking patterns and working patterns between the forecasters and the researchers in each group. But it was in these groups that the meeting of minds slowly took place, catalysed and fertilized by the lecturers and other staff who were constantly available to encourage and discuss the work of individuals in each group.

To what extent the School succeeded in bringing the forecasters and the theoreticians together in any permanent sense is hard to say. The week passed all too quickly and just as it felt that real progress was starting to be made, it was time to disperse. It is hoped that no narrow assessment of its value will be made, for the School was a totally new venture and surely a very valuable one which should be repeated. It must be good for research workers to expose their ideas to the test of routine observations, and for forecasters (that most conservative group of people) to assimilate theoretically sound ideas into their pragmatic working routine. It is greatly to be hoped that Summer Schools of this kind become a regular occurrence, bringing the operational and research wings of meteorology in this country into close, regular contact.

P.G. Wickham

References

Browning, K.A. 1985 Conceptual models of precipitation systems. *Meteorol Mag*, **114**, 293–319.

Golding, B.W. 1984 The Meteorological Office mesoscale model: its current status. *Meteorol Mag*, **113**, 288–302.

Reviews

World-wide weather, edited by K. Takahashi. 160 mm × 242 mm, pp. xv + 252, *illus*. A.A. Balkema, Rotterdam, 1985. Price £17.50.

World-wide weather is a recently published translation of a Japanese text first published in 1975. It consists of a collection of 30 essays by 20 authors on various topics, ranging from the general circulation to ice-floes and icebergs. With such a diversity it is little surprise that each topic is treated superficially.

The book is neatly divided into three parts. The first sets the scene and deals with climatic change, solar energy and water. The next describes the meteorological characteristics of various regions and the last section briefly looks at the relationship of weather and human activity. The intention of the editors is to introduce to the general reader various world-wide weather phenomena of current interest and in this they have, by and large, succeeded. However, for today's reader, the ten years that have elapsed since first publication mean that the current problems of the sub-Sahara do not receive sufficient attention. It is good to see a chapter devoted to the widening of deserts but ideas on controlling and even making deserts fruitful are made to sound very simplistic.

Having been written for a Japanese readership many of the topics are concerned with meteorological phenomena of south-east Asia. The rest of the world, however, is not forgotten and there is, for example, a simple but good description of El Niño. Even so we are reminded that the 1972 occurrence eventually led to an astronomic rise in the cost of soya bean cheese in Japan! Several of the essays have been written from personal experience and reminiscences. Occasionally, this seems out of keeping in such a book when, for example, the author on tropical cold waves writes in a style more akin to travel journalism.

The editors, in their preface, state that there are some unresolved differences of opinion. One presumes they must be referring to some of the misleading statments such as 'big cities like Tokyo no longer have cold winters because of heat produced by human activities' or '... a computer can now (1975) forecast the occurrence of a tornado'. Unfortunately, an otherwise admirable book is spoilt by a number of minor errors and omissions. Too many of the diagrams are difficult to interpret because of their size and the one showing annual wind roses for a number of places in the British Isles has several errors. There are no photographs and in places, in the reviewer's copy, the printing is poor. Even in these days of high prices one would have expected rather better value for money.

This is certainly a book for the general reader and it brings together descriptions of a number of global weather features. However, even the most casual reader will probably be left at times wanting to know more and unfortunately the bibliography is poor — apparently because of the limited number of standard works translated into Japanese. As it stands, it is difficult to see this book finding a place on many western bookshelves.

C.H. Kensett

Climate and history, edited by T.M.L. Wigley, M.J. Ingram and G. Farmer. 150 mm × 230 mm, pp. xii + 530, *illus*. Cambridge University Press, 1985. Price £15.00, US $24.95.

It is good to see that this volume, which arose from a conference on 'Climate and History' held at the University of East Anglia in 1979, is now available in paperback at half the price of the hardback edition of 1981. It is not just a symposium volume; the editors have gone to a good deal of trouble to select the most important contributions to the conference and the result is a volume of immense value to those actively engaged in a wide range of related scientific disciplines.

The first part is a lengthy but excellent introduction which is very well balanced. The editors do not assume that climate has determined history to any great extent; indeed they emphasize the many pitfalls in any such assumption. Human communities vary considerably in how they adapt to environmental changes. For instance, the Norse colonization of Greenland which failed around AD 1500 was probably only subjected to a small deterioration of climate which did not greatly bother Eskimos living in the same area. Even the abandonment of marginal land may be due to changes in agricultural methods, prices or other social or economic changes rather than to changes of climate.

The second part of the book consists of nine chapters, six of which outline the various methods now used to reconstruct past climates. There are comprehensive chapters on: 'the use of stable isotope data','glaciological evidence', 'pollen analysis', 'tree rings', 'archaeological evidence' and 'documentary sources'. It becomes clear that all these methods face considerable difficulties in attempting to reconstruct past climates; it is essential to try to integrate the results from several methods before reasonably reliable conclusions can be reached.

The last three chapters of this section are specific examples of what can be achieved. The reconstruction of the Little Ice Age climate of Switzerland by Pfister forms an outstanding chapter while the other two chapters on 'the historical climatology of Africa' and 'droughts and floods in China (from 1470)' are interesting but of a somewhat lesser calibre.

The next five chapters form a section entitled 'towards a theory of climate–history relations'. There are contributions from H.H. Lamb and H. Flöhn who stresses the importance of short-term climatic fluctuations such as three successive cold winters. Flöhn also makes the point that persistent anomalies in one region will normally be accompanied by anomalous periods in other widely separated regions. The best contribution in this section is that by M.L. Parry who attempts to put matters on a scientific framework. He suggests, for example, that the relationship between the present yield of oats and climatic parameters can be used to estimate the climate when the crop failed in the past.

The fourth section of the book contains five so-called case studies of climate–history interactions. These make interesting reading but do not entirely support the idea of a strong connection between climate and history. Shaw, for instance, suggests that the decline of north African population since Roman times may be partly due to man's destruction of the forests and animals, while McGovern alleges that the decline of the Norse population in Greenland mentioned previously was caused primarily by a lack of adaptation to a small shift of climate. Sutherland shows that in Brittany during the period 1780–89 peasants were able to adapt to a run of poor harvests owing to bad weather although children suffered. In Maine, decline in agriculture between 1785 and 1885 seems to have been primarily due to movement of the population to better land elsewhere. Mooley and Pant follow with an interesting study of droughts in India over the last 200 years and conclude that they are random occurrences. The last chapter considers the effect of climatic fluctuations on human populations. It discusses population changes in the Tigris–Euphrates Valley from 6000 BP, the Sahel 1910–74 and the US Great Plains 1880–1979. It is suggested that populations can adapt to climatic events which occur more often than once in 100 years but rarer events may result in a catastrophe. The causes of the huge population changes (from less than 100 000 to about 2 million) which have taken place in the Tigris–Euphrates area over the last 8000 years remain uncertain but climate appears to have played a rather small part.

This excellent book is very readable, and the new cheaper paperback version should encourage those working in the many scientific disciplines concerned with climate and history to purchase their own copy. The delay of six years since the original conference has not made the volume out of date to any noticeable extent.

R.A.S. Ratcliffe

Books received

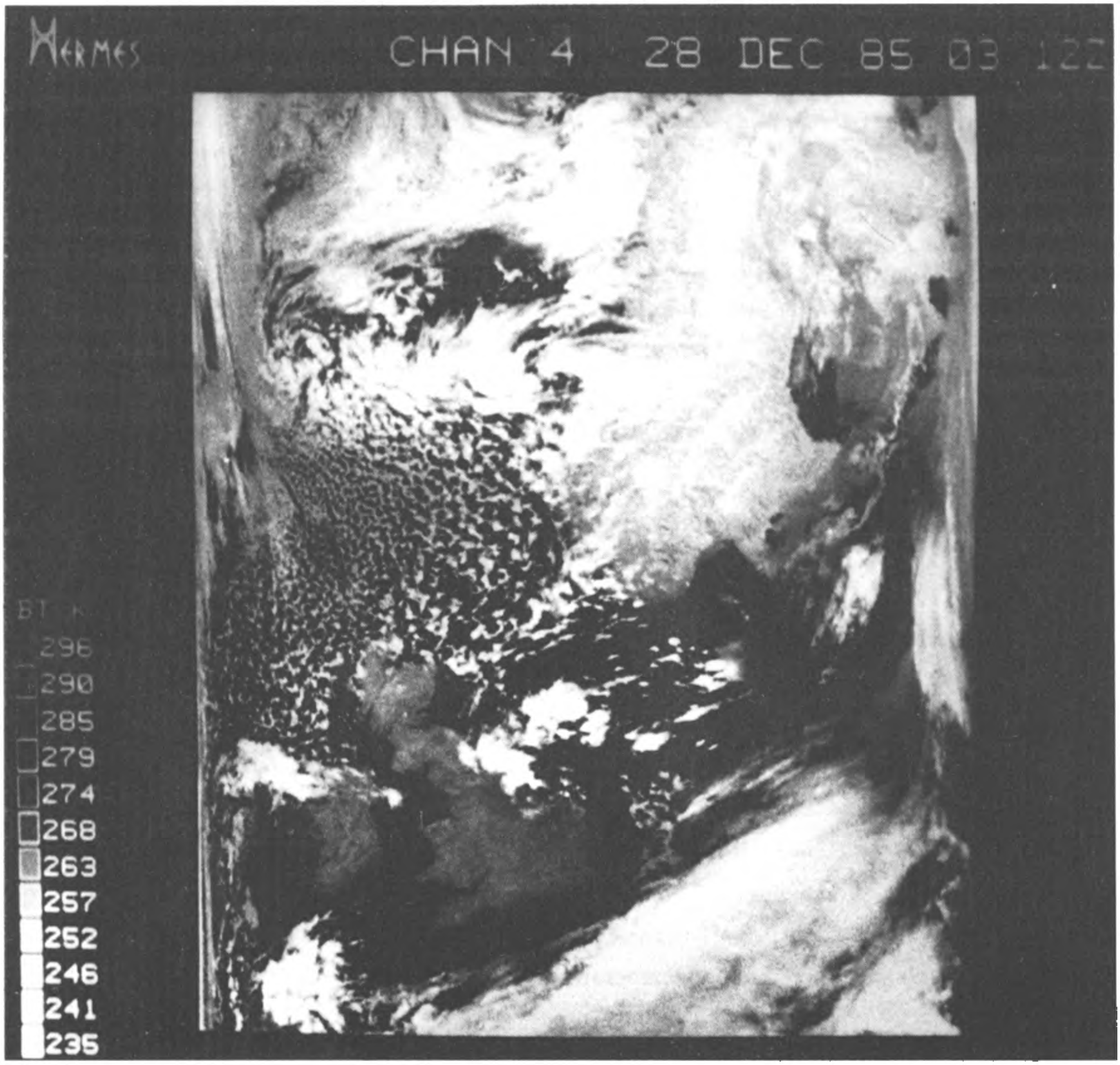
The listing of books under this heading does not preclude a review in the Meteorological Magazine at a later date.

Climate and history, edited by T.M.L. Wigley, M.J. Ingram and G. Farmer (Cambridge University Press, 1985. £15.00) now published in paperback, is a collection of 20 papers including discussions of the climatic information obtainab le from the study of chemical isotopes, glaciers, pollen remains, tree rings, archaeological materials and documentary sources. Later chapters analyse the theoretical and methodological problems involved in assessing the impact of climate and climatic change on past societies, and then provide a series of case studies arguing for or against the importance of climatic factors in human affairs in specific economic, social and cultural contexts.

Intrinsic geodesy, by Antonio Marussi; translated from the Italian by W.I. Reilly (Berlin, Heidelberg, New York, Tokyo, Springer-Verlag, 1985. DM 160) is a collection of articles embodying Antonio Marussi's principal contributions to geodetic theory between 1950 and 1981, many translated into English for the first time. His objective was to turn geodetic theory away from its preoccupation with two-dimensional (spheroidal) geometry and to redirect it to the consideration of three-dimensional space. This change, made necessary by the coming of EDM and satellite techniques, was achieved by applying Gauss's differential geometry to the description of the earth's gravity field in terms of elements that are both intrinsic to the field and directly observable. The method was applied to both actual and normal gravity fields, and was extended to the study of the conformal representations between their respective equipotential surfaces, and further to the analogous problem of the propagation of light in a refracting medium.

Tornado! Proceedings of the first conference on tornadoes, waterspouts, wind-devils and severe storm phenomena, Oxford Polytechnic 29 June 1985, edited by G.T. Meaden and D.M. Elsom (Artetech Publishing Co. (54 Frome Road, Bradford-on-Avon, Wiltshire BA15 1LD), 1985. £10.00 hardcover, £3.00 softcover.) As the title indicates, this volume presents the proceedings of Britain's first national conference on tornadoes and other severe storm phenomena, held at Oxford Polytechnic on 29 June 1985. There are chapters on the Tornado and Storm Research Organization (TORRO) — by whom the conference was sponsored — and on the work of its divisions (Tornado, Thunderstorm and Hailstorm). There are other chapters on whirlwind types, the incidence of tornadoes in Britain together with accounts of the most damaging tornadoes known to have occurred, tornado damage to buildings, the spatial and temporal distribution of British thunderstorms, and ball lightning. The book concludes with several case studies of recent tornadic phenomena, including photographs and eye-witness accounts. This volume summarizes over a decade of painstaking and detailed research by TORRO into the distribution of tornadoes and allied phenomena in Britain, and contains much valuable information to workers in the field of severe convection studies.

Satellite photograph — 28 December 1985 at 0312 GMT



The satellite picture is an infra-red image from the NOAA-9 polar-orbiting satellite at 0312 GMT on 28 December 1985. The image has been processed on the HERMES computer system.

On 26 December the British Isles experienced a change of airstream from the mild west or south-westerly type which prevailed for much of December to a northerly type and this lasted for three days. The surface analysis for 0600 GMT (Fig. 1) shows the main synoptic features a little after the time of the satellite picture. There was a deep depression near the North Cape, Norway and a ridge of high pressure extended south-eastwards across Iceland towards southern Britain. The northerly flow between Iceland and Norway was very unstable to relatively high surface temperatures over the sea. Near the Norwegian coast, the cells had an open structure characteristic of deep convection whilst further to the west the cells were elongated owing to the stronger flow. A trough at about 65° N appeared to have circulations near the Norwegian coast and between 5° W and 10° W. The latter was probably a polar low and its circulation was still identifiable in the Irish Sea some 24 hours later.

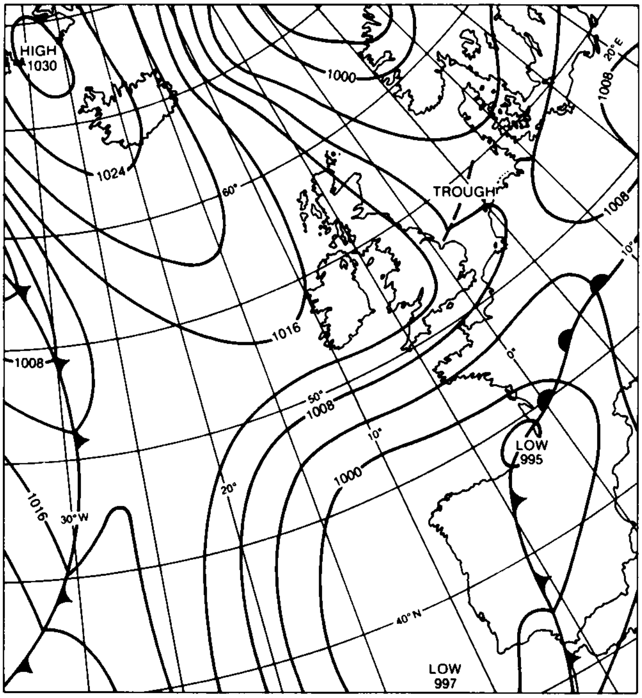


Figure 1. Synoptic situation at 0600 GMT 28 December 1985.

It was a very cold night with minimum temperatures in the range −5 to −10° C over many areas and as a result the British Isles contrast well with the relatively warm sea temperatures of around 7 to 11° C.

The trough approaching East Anglia was more active when it was over the north of Scotland early on 27 December although even here snowfall was variable, Invergordon reporting 35 cm of snow but Aviemore only 1 cm. The higher sea surface temperatures were required to maintain convection, and it was most intense just behind the surface trough. Sheltered areas to the north therefore remained dry whereas the north-east coastal strip of England experienced heavy snow showers. RAF Boulmer near Alnwick in Northumberland accumulated 21 cm of snow and the town of Whitby was reported to be cut off for a time. The satellite picture shows shallower cloud associated with the trough over and just to the east of Lincolnshire. The trough weakened further as it moved southwards but still gave light snow showers in East Anglia and parts of the south-east. Coastal regions on the western side of the country remained free of snow showers as convection was suppressed by the ridge of high pressure.

The following night the ridge had declined and the trough near 65° N brought snow showers to areas exposed to the northerly airstream, in the west as well as the east.

Letter to the Editor

Odd snowfall at Royal Air Force, Valley

Browning *et al.* in a paper *The use of satellite and radar imagery to identify persistent shower bands downwind of the North Channel (Meteorol Mag*, **114**, 325–331, 1985) state in the second sentence of their *Conclusions*: 'They can give rise to persistently adverse weather over rather narrow but well-defined paths when most other areas are enjoying relatively good weather'.

The forecaster on duty at Valley on the afternoon of 28 November 1969 would certainly agree with this statement! On that date an arctic air mass with record low thickness values moved southward over the British Isles. The gradient wind was from 350 degrees, the direction for 'North Channel showers at Valley'. The first showers of soft hail commenced at Valley around noon but the forecaster was not unduly concerned since records for the Holyhead area going back nearly 100 years gave no indication of lying snow in November. By midnight on that day a succession of heavy showers had deposited 10 cm of snow on the airfield! The snow cover ceased abruptly east of a north–south line on Anglesey about 10 miles east of the airfield. The occasion becomes all the more remarkable when it is realized that the fall on that date remains the record depth of snow recorded at Valley for *any* month during the last 25 years.

A.K. Kemp
(Senior Meteorological Officer)

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Mr T.L. Hunt

It is with regret that we record the death on 25 October 1985 of Mr T.L. Hunt who had been the chief weather presenter at Anglia Television in Norwich for 22 years, until he retired in 1984.

Mr Hunt, who was usually known as 'Michael' or 'Mike', worked in the Meteorological Office from January 1939 to August 1961 when he resigned from his post as a Senior Experimental Officer at RAF Dishforth to begin a new career as a professional meteorologist presenting weather forecasts on commercial television.

He was immensely popular with his viewers for his cheerful, humorous and direct style. On going to Anglia TV he immediately began to set up his own network of 'weather correspondents' in the region, a network that was much denser than the official one, so that he could always give a truly 'up to the minute' report on the progress and development of rain, snow, or fog. In 1983 the Royal Meteorological Society awarded him a share of the FitzRoy prize for his work in applied meteorology. Mike Hunt was always a good friend to, and ambassador for, the Office, and his help in promoting awareness of the Norwich Weather Centre among the people of East Anglia was much appreciated.

Obituaries

Mr A.C. Nicholson

We regret to record the death on 30 October 1985 of Mr A.C. Nicholson, Scientific Officer, who was stationed at RAE Bedford.

'Nick' Nicholson joined the Office as a Scientific Assistant in 1947, and over the next two decades worked at several forecasting outstations including Manchester, Birmingham and London/Heathrow Airports; he was promoted to Senior Scientific Assistant in 1960. In 1969 he joined the staff of the Training School (as the Meteorological Office College was then known) to give instruction to the Assistant Courses on instruments. While there, he met Miss M.D. Pritchard, an Assistant Scientific Officer normally stationed at Gloucester, whom he married in 1979. From the College, he was posted in 1978 to RAF Cardington, moving to RAE Bedford in 1980.

Mr Nicholson enjoyed boating; while at Manchester he had a boat which he used on the canals, and later on he had one on the Thames. He was also keen on motor-cycling, and regularly took leave for the TT races. He was an amiable man, well liked by his colleagues.

Mr M.H. Lloyd

We regret to record the death on 24 November 1985 of Mr M.H. Lloyd, Senior Scientific Officer, of the Main Meteorological Office (MMO), RAF Upavon.

Max Lloyd joined the Office in 1953 as a Scientific Assistant; a period of national service in the RAF soon followed during which he was for a time stationed at Bahrain. From 1956 to 1964 he worked at South Cerney and Colerne; he then obtained promotion to Assistant Experimental Officer and began his career as a forecaster with a posting to Chivenor. Further promotion followed during the next few years, during which he had a tour of duty at Singapore, and in 1978 he was appointed Senior Meteorologial Officer at RAF Brize Norton.

In July 1983, Max Lloyd was appointed Officer Commanding (OC) the Mobile Meteorological Unit (MMU). On return from his first detachment to Ascension Island in December 1983, he was promoted to Wing Commander, OC MMU, and undertook three detachments to the Falkland Islands between February 1984 and September 1985; in addition, he moved to MMO Upavon in 1984 where he became deputy Principal Meteorological Officer.

Max Lloyd will be remembered for his amiable and practical approach to his work and also for his consideration for the staff under his command. His career within the Defences Service Branch brought him into regular contact with the Armed Forces who much appreciated his co-operation and enthusiasm as regards provision of meteorological support. His interests outside the Office were mainly concerned with sport. Indoors he enjoyed darts and snooker. Outdoors he played cricket to Minor Counties standard in the 1950s and more recently his golfing ability won him many friends whilst representing the Office and the Royal Air Force at station level.

His sudden death at the age of 49 came as a great shock to all who knew him.

Meteorological Magazine

GUIDE TO AUTHORS

Content

Articles on all aspects of meteorology are welcomed, particularly those which describe the results of research in applied meteorology or the development of practical forecasting techniques.

Preparation and submission of articles

Articles for publication and all other communications for the Editor should be addressed to the Director-General, Meteorological Office, London Road, Bracknell, Berkshire RG12 2SZ and marked 'For *Meteorological Magazine*'.

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Spelling should conform to the preferred spelling in the *Concise Oxford Dictionary*.

References should be made using the Harvard system (author, date) and full details should be given at the end of the text. If a document referred to is unpublished, details must be given of the library where it may be seen. Documents which are not available to enquirers must not be referred to.

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