European Centre for Medium Range Weather Forecasts

ECMWF NEWSLETTER

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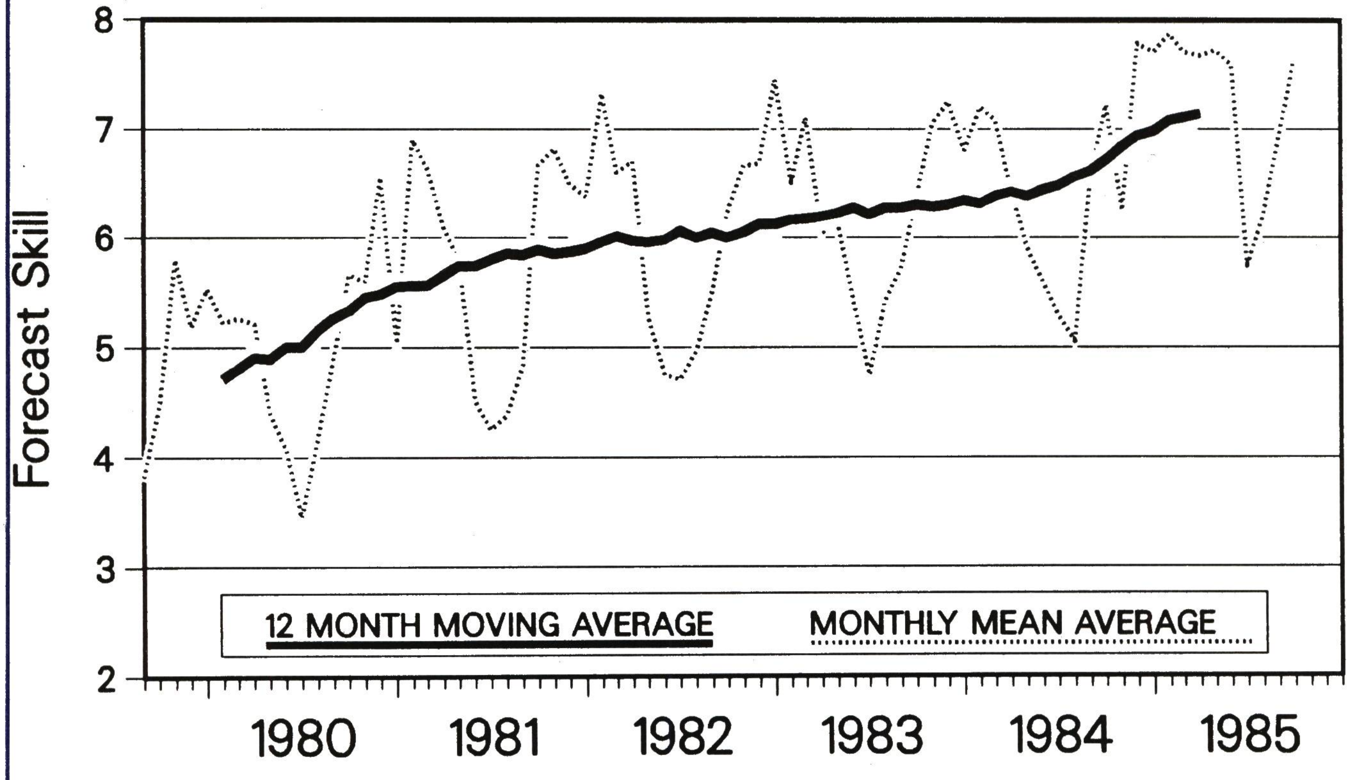
ECMWF FORECAST SKILL
September 79 - September 85



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GENERAL

COVER: A measure of the skill of ECMWF Northern Hemisphere forecasts, derived from monthly means of daily averages of the anomaly correlations and standard deviation of the errors of geopotential height and temperature forecasts for levels 1000 to 200 mb (height) and 850 to 200 mb (temperature).

This Newsletter is edited and produced by User Support.

The next issue will appear in March 1986.

This issue appears shortly after the Centre celebrated its 10 year anniversary on 22 November 1985. The celebration has provided an opportunity for taking stock of the Centre's achievements during that time.

The Centre began operational forecasting 5 days per week on 1 August 1979 and extended to 7 days per week one year later. The first operational model was a grid point model with a 1.875° latitude-longitude grid and 15 levels in the vertical. On 21 April 1983, the grid point model was replaced by a model using a spectral representation in the horizontal with triangular truncation at wavenumber 63. At the same time, the number of vertical levels was increased to sixteen. An enhanced orography, incorporating the blocking effect of sub-grid-scale topographical obstacles was also introduced. Finally, on 1 May 1985, a very high resolution model, with spectral truncation extended to wavenumber 106, was introduced. (This is approximately equivalent to the resolution of a grid point model of 100 km resolution). A considerable improvement in forecasting skill has been achieved since 1979; as can be seen in the cover illustration, useful predictive skill has improved by somewhat over 2 days.

The Centre's computing capacity has grown to support the needs of research developments. When operational forecasting commenced, the Centre had a Cray 1-A 'number cruncher' with a Cyber 175 as its front-end and sufficient room in the computer hall for a game of football (this space was never utilised!). The Cyber 175 was joined by another Cyber (a model 835) to increase front-end capacity, and the model 175 was later replaced by the slightly more powerful Cyber 855, which also had the advantage of being fully compatible with the model 835. In 1983 the Cray 1-A was replaced by a Cray X-MP/22 dual processor including a separate Input/Output Subsystem and Solid State Storage Device (SSD). This, in turn, will shortly be replaced by a Cray X-MP/48, a four processor model. Various subsystems have also been developed: a comprehensive archival and retrieval system based on an IBM 4341/M12 data handling machine and an IBM 3850 mass storage device (see page 15 of this issue) and a graphics subsystem based on a VAX 11/750. All the mainframes of the Centre are now connected by a high speed data highway. The Centre produces its own alphanumeric microfiches, by means of an Autocom IV system and has acquired high quality printers and plotters to aid in the production of publication quality material. All of this additional equipment has resulted in the once spacious computer hall now appearing rather cramped, but ensures adequate computing capability for the immediate future.

In telecommunications too, considerable progress has been made. When the dissemination of operational forecasts began, only seven Member States had telecommunication links to the Centre, of which six were low speed (50 or 100 bps) and only one was medium-speed (2400/4800 bps). Since then, Member States have gradually implemented connections, so that currently all Member States are connected to the Centre and only three by low speed lines. The present Network Front-End Processor is in the process of being replaced by a new telecommunications system based on a cluster of VAX machines, which will provide considerably enhanced facilities for the Member States.

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ECMWF - THE NEXT TEN YEARS

The following article contains a summary of Dr. Bengtsson's presentation during the ECMWF 10 year celebration seminar on 22 November 1985. A proceedings of the seminar, containing this and all the papers presented, will be published in due course.

By improving the accuracy of the way in which the forecasting model represents the atmosphere and by utilising ever more power computers to increase the resolution of the model, the Centre has achieved a considerable and continuing increase in the skill of the forecasts it produces; the present four day error is approximately equivalent to the error seen a year ago for three day forecasts. However, studies have shown that the theoretical predictability of the atmosphere is greater than the present predictive skill of the Centre's model and so give justification and incentive for continued research. Below, a short summary of the Centre's plans for the future is given.

Observations

One fundamental element upon which accurate forecasts depend is the availability of sufficient and accurate observations, with a better coverage of currently data sparse areas, for instance, the oceans, the polar regions and the Tropics. Studies have suggested that if observational error were reduced by half, a gain of two days' predictability could be achieved over a ten day forecast period. To this end, the Centre will continue to monitor observations in order to identify and correct systematic errors. The Centre will also be attempting to increase the amount of observational data it receives, such as data from vertical atmospheric sounders on board polar orbiting satellites.

Model improvement

The Centre has developed a four-dimensional data assimilation system in order that observations from previous analyses can be taken into account at the analysis of the initial state of the forecast. In particular, this method allows efficient use to be made of temperature and moisture soundings from polar orbiting satellites and of wind observations from the geostationary satellite platforms. The accurate carrying forward of 'old' observations depends upon a very accurate model reproduction of the atmosphere.

The accuracy of the model's depiction of the atmosphere can be improved in some obvious ways. Numerical errors, caused by the fact that the equations used are only an approximation of reality, can be reduced by increasing the resolution of the model. A doubling of resolution would result in four times more grid points. However, with more dense grid points, the time taken for the atmospheric flow to move from one grid point to the next decreases, and therefore necessitates an increase in the frequency of the forecast time steps. If timesteps were reduced by half, this this would result in a total of eight times more calculations. Consequently, such improvements are to a great extent dependent upon the availability of adequate computing power, though judging by current computer developments this should present no problem in the future.

However, increases in resolution do not necessarily lead to improvements to the forecast in the medium range, the description of the physical processes involved must also be enhanced and the interaction of individual processes carefully considered in order that the hydrological balance is maintained.

Reliability studies

The quality of the forecasts currently produced varies considerably for different areas and times; some forecasts are accurate for only a few days, some remain accurate beyond three weeks. So far, this phenomenon remains unexplained. The Centre intends to carry out substantial research in this area with the intention of eventually being able to provide Member States with indications of reliability for individual forecasts.

The Centre intends to achieve these aims by continued high level research and in close co-operation with Member States to maintain a steady flow of new ideas. The Centre also hopes to stimulate universities to work on particular problems. In the operational sphere, the Centre will maintain the separation between its responsibility for the large-scale flow and the medium range, and the Member States' concern with the short range and interpretation of the Centre's products to provide useful local weather forecasts. The Centre's achievements so far have been considerable, nevertheless, there still remains a great deal to be achieved. Now, as we stand at the threshold of a most exciting period for forecasting, the Centre's Meteorologists look forward to the challenge presented to them with anticipation.

- Pam Prior

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CHANGES TO THE ECMWF OPERATIONAL FORECASTING SYSTEM

Recent changes

During the last three months, September to November, a number of minor modifications in the analysis were implemented which had no significant impact on the overall performance of the analysis and forecast system. They are listed below.

(i) The number of thickness layers used from the SATEM observations (data at 500 and 250 km horizontal resolution from the vertical atmospheric sounder instruments on board polar orbiting satellites) was reduced from 14 to 11 without any loss of information. The vertical structure of the atmosphere as it can be resolved by atmospheric sounding from satellites is overdetermined in the SATEM code.

(ii) A further modification in the interpolation of the sea surface temperature from the 5 degree NMC grid to the ECMWF analysis grid was made.

(iii) Modifications to the Hough functions used in the stratospheric analysis were introduced, giving a smoother height and wind analysis.

Planned changes

No major changes are planned for this coming quarter.

- Horst Böttger

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ECMWF HUMIDITY ANALYSIS AND TIROS-N PRECIPITABLE WATER CONTENT DATA

In recent years much emphasis has been placed on the representation of dynamical processes in the tropics in general circulation models because of possible coupling between the tropics and middle latitudes.

The humidity variable is particularly important in the tropics, more so than in mid-latitudes, because as the equator is approached, the geostrophic adjustment time scales become longer. For example, the relaxation time for vertical motion and hence humidity and rainfall fields is of the order of three days in the tropics. It is important, therefore, to ensure that the humidity data are introduced into the tropics with some care so that the analysis/initialisation procedure does not interrupt the dynamical evolution of the tropical atmosphere. The quality of the humidity analysis is thus an important component, particularly in the tropics.

Recently we have been studying the performance of the humidity analysis produced by the ECMWF data assimilation system during the FGGE period and assessing the quality of satellite precipitable water content data and their impact on the humidity analysis.

Satellite precipitable water content (pwc) data are not at present used in our analysis procedure but we have shown that they are of comparable quality to the pwc derived from radiosondes and the first-guess; furthermore, the inclusion of satellite pwc has a beneficial impact on the analysis.

A collocation study

Fig. 1 gives a vivid impression of the density of data coverage obtained from TIROS-N during FGGE (12 June 1979). It is clear that satellite data have extensive spatial and temporal coverage. However, the data are deficient in resolving the vertical structure, and cloud contamination, even in partly cloudy areas, can be very severe. Perhaps because of these limitations, little effort has been put into an evaluation of satellite derived moisture data or their use in the analysis.

In an attempt to evaluate the quality of TIROS-N pwc data during FGGE, a collocation study with radiosondes was carried out for a period during June 1979. Fig. 2 shows the standard deviation of the difference between satellite and radiosonde data expressed in relative humidity both for the northern hemisphere and for the tropics. These curves are a measure of the total error due to both satellite and radiosondes:

$$\text{STD (SAT-RAD)} = \sqrt{E_{sat}^2 + E_{rad}^2}$$

where according to the manufacturer E_{rad} is 10% for normal conditions and 20% for very dry or very cold conditions. From Fig. 2 it is clear that the quality of satellite data is at least comparable to that of the radiosondes. In the tropics the satellite error varies between 15% and 20%. However, in the northern hemisphere it varies from 15% in the lower troposphere to 35% in the upper troposphere, where it is difficult to sample moisture because of very dry and cold conditions.

Generally, we have concluded that the satellite data are of comparable quality to radiosonde data and are able to measure the total moisture in a layer without a large bias.

<u>Impact of satellite data in assimilation experiments</u>

A 3½ day data assimilation experiment, from 8 June 00 GMT to 11 June 12 GMT 1979, has been carried out to evaluate the impact of satellite data. Based on our statistical study of satellite data, the observational error ascribed to TIROS-N data has been chosen to be 20%, slightly more than the radiosonde error (10%), while the prediction error is chosen to be 10% in the extratropics and 15% in the tropics.

The satellite data have quite a large impact on the humidity analysis, affecting mainly data sparse areas over the oceans. At the surface they tend to moisten the oceanic region with differences in the southern oceans up to 50%. In the middle troposphere (500 mb) they dry some regions and moisten others. However, overall the satellite data tend to moisten the tropics and subtropics by about 20% in relative humidity.

It is of course difficult to assess whether these changes improve the description of the moisture field in the assimilation. One way to assess the quality of the humidity analysis is to compare derived quantities which should be highly dependent on moisture. The most obvious choice is the 6-hour precipitation, since we expect changes in the precipitation field to contain a signature reflecting the impact of changes in the humidity analysis. Figs. 3 and 4 show the 6-hour precipitation from the experiment without satellite (NO SAT) and the experiment with satellite (SAT). These should be compared with Fig. 5, which show a satellite derived index of convective activity for the same period, derived from the Infrared sensor on GMS satellite. Values of 4 or greater denote very active convection and significant rainfall. The difference between the rainfall from the NOSAT assimilation (Fig. 3) and the SAT assimilation (Fig. 4), although small, appears to be meaningful when compared to the observed convective activity (Fig. 5). By incorporating satellite data, more realistic rainfall features are obtained in some areas; for example the rainfall over Thailand (15N, 100E) has been reduced in agreement with observations, as has the rainfall over Indonesia (5N, 125E); the rainfall centred at (10N, 140E), as well as the maxima at (5S, 85E), have been intensified by incorporating satellite data, in agreement with the observed convective activity.

We conclude that satellite precipitable water content data derived from TIROS-N are of reasonable quality (compared to radiosondes) and have a beneficial impact in data assimilation experiments. It is planned to introduce them operationally.

- Lodovica Illari

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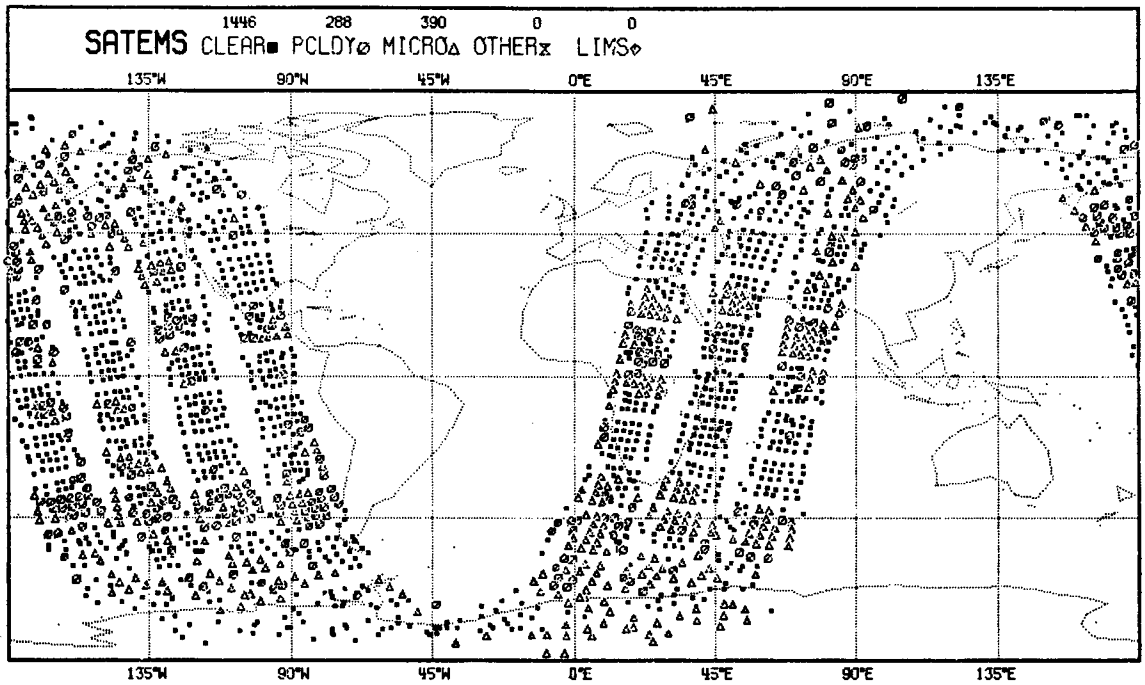

Fig. 1 The coverage of TIROS-N satellite on 12 June 1979, 00GMT (FGGE IIb data)

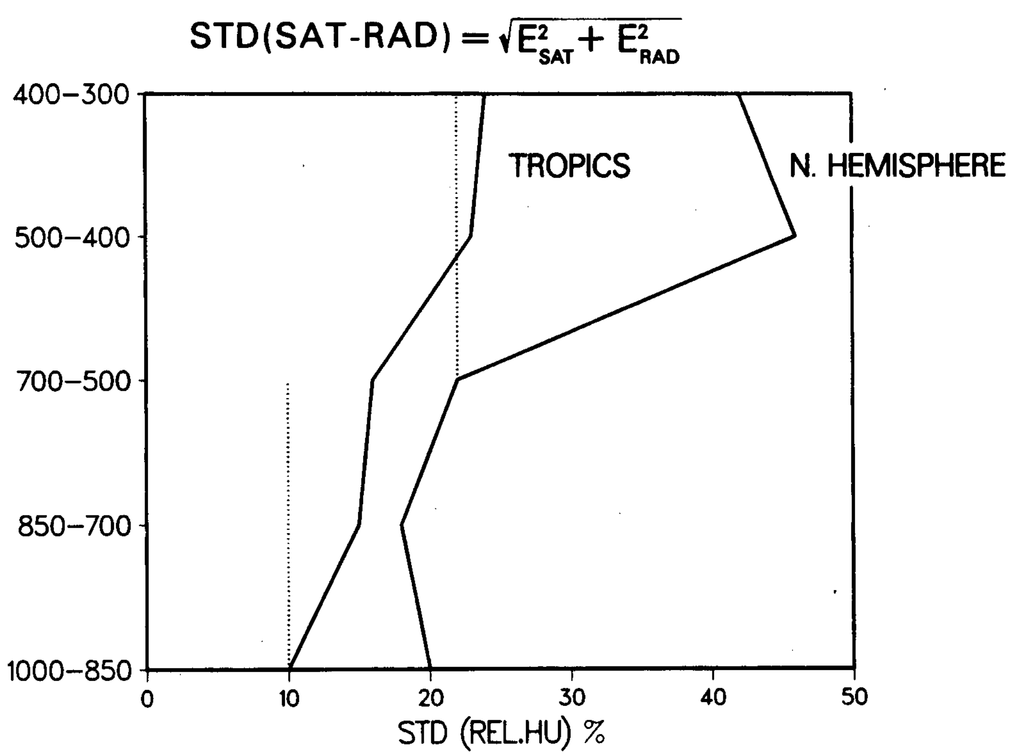

Fig. 2 Standard deviation of the difference between satellite and radiosonde in relative humidity (continuous line) and the radiosonde observational error (dashed line)

NO SAT

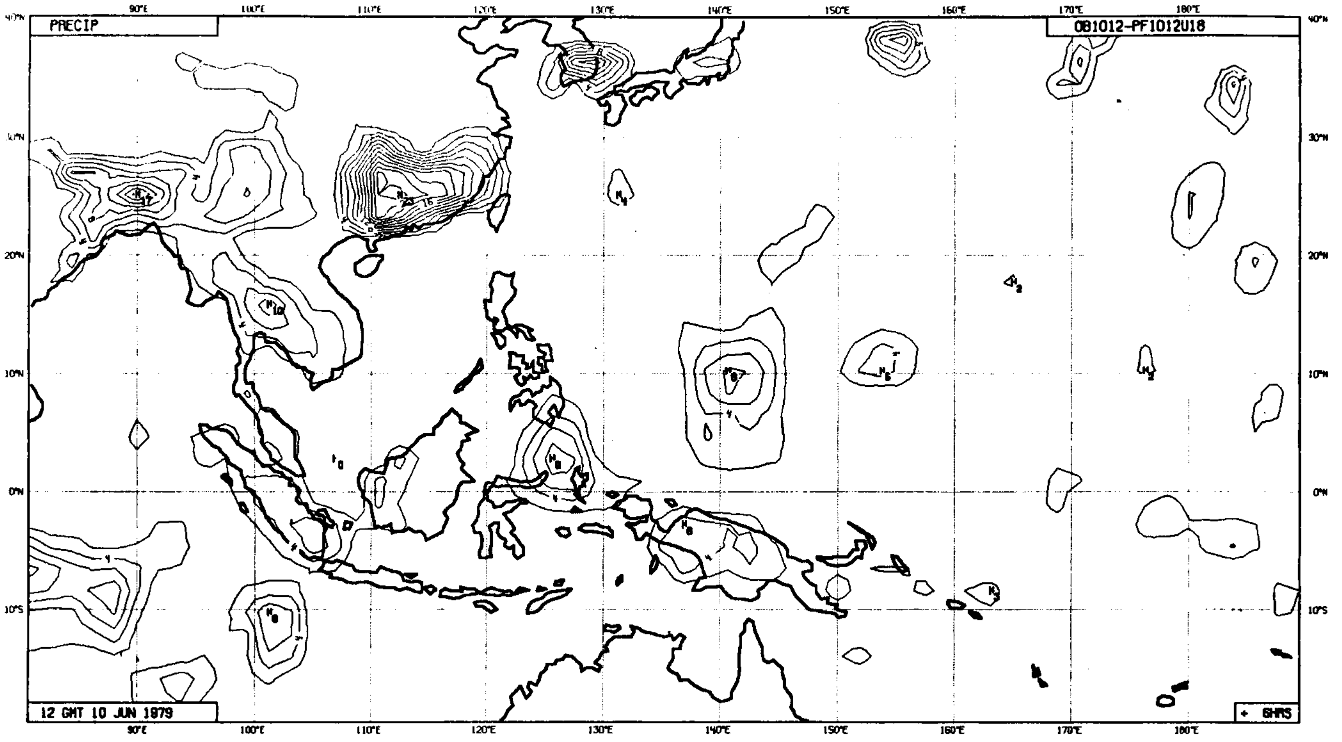

Fig. 3 Accumulated precipitation for the 6-hour period ending 12GMT 10 June 1979 from the "NO SAT" experiment. Contour interval 2mm

SAT

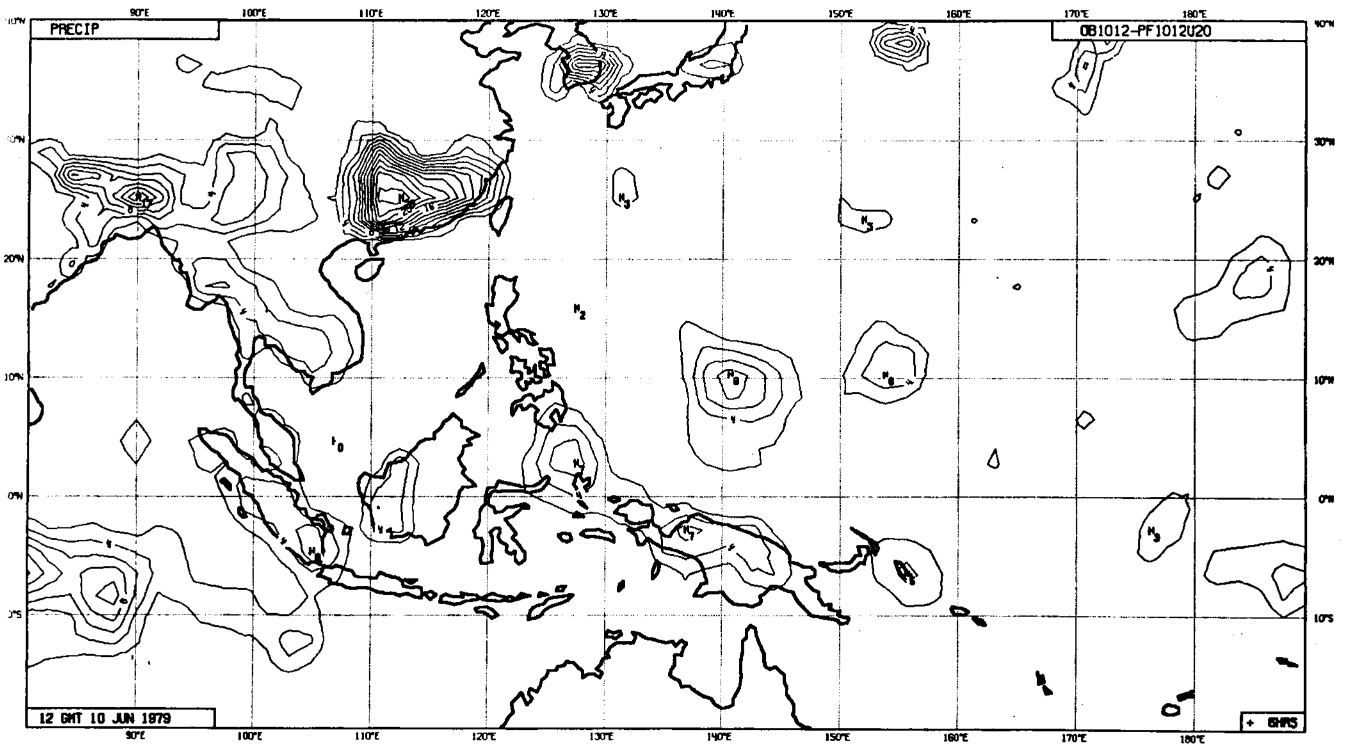

Fig. 4 As in Fig. 3 but for the "SAT" experiment

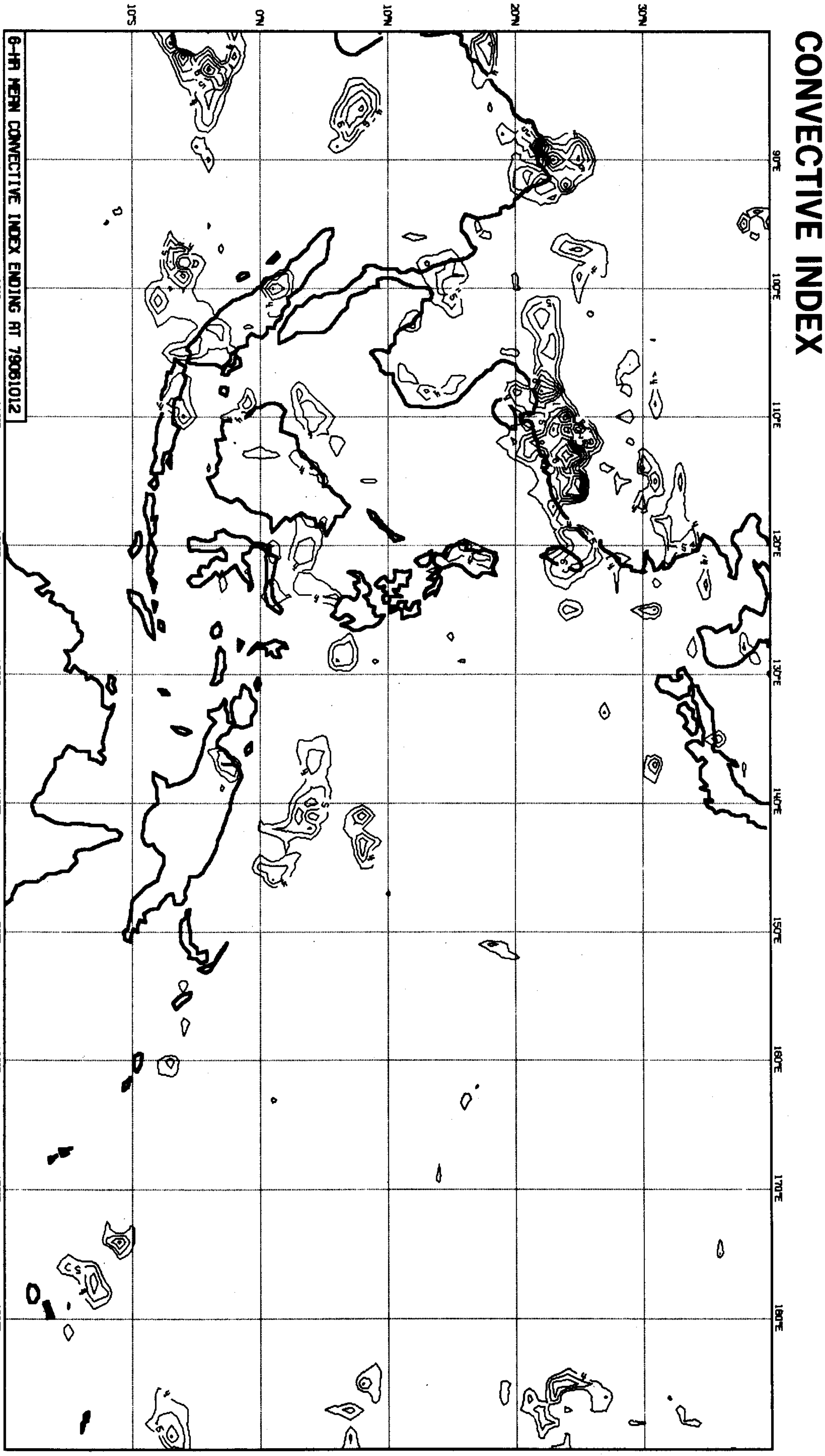

Fig. 5 The field of convective activity index for the 6 hour period ending 12GMT, 10 June 1979 derived by Murakami (1985). More than 5 units implies vigorous convective activity.

METEOROLOGICAL SUPPORT FOR A TRANSATLANTIC BALLOON FLIGHT

At 05.17 UTC (01.47 local time) on 25 August 1985, an 8000 cubic metre helium hot air balloon manned by three Dutchmen lifted off from St. John's, Newfoundland, for an expected record-breaking flight to the European continent.

Doubtless such an endeavour, facing some 2000 nautical miles of ocean, would have been much like Columbus' travel to the edge of the world, if modern meteorological support had not been available. Thanks to the output of ECMWF, we were able to supply just that.

Except for Anderson and Abruzzo's flight in 1978 and that of soloist Kittinger in 1984 all other attempts to cross the Atlantic failed, some for unknown reasons, some certainly on account of the weather. In 1976 the American Yost was forced to ditch because he got caught up in the circulation around the Azores high. In 1977 Anderson and Abruzzo, in their first trial, ended up in the cold waters off Iceland because of unfavourable winds and weather. The Englishmen Cameron and Davies almost made it, but they decided to land in the Gulf of Biscay as they had thunderstorms in front (1978).

Evidently, apart from technical perfection of the balloon, high forecasting skill on the short and medium range is essential. So here is what we were in for: alert the crew 48 hours in advance, when the weather during filling and launching of the balloon (some six hours altogether) will be good, i.e. dry, little or no cloud and especially little or no wind in the lower 50 m; when the upper winds will be right to carry the balloon to Europe in about three days; when the flight conditions can be expected to be reasonable (preferably no icing, no thunderstorms) and when the weather conditions at the projected landing site ensure a safe landing. In summary: give an alert on a 48-hour basis that anticyclones are expected over Newfoundland and over Europe with a strong westerly current in between and no weather to speak of.

As KNMI routinely receives 500 hPa heights with vertical motions and 1000 hPa heights with 850 hPa isotherms out to +144 hours, the general weather patterns can fairly easily be followed, but to do this particular job properly we needed more data. Obviously we had to make use of the KNMI trajectory model that can be run on the Cyber at ECMWF. Therefore daily a number of extra windfields were set apart for us in the ECMWF data dissemination base. That enabled us to run the trajectory model almost interactively.

During the flight we would need actual wind data. These are hard to come by over the observation-sparse ocean, so we decided to use +12, +24 and +36 forecast upper air maps instead. These were also provided by ECMWF. Crew and balloon were ready to go on 48-hours' notice as from 17 July 1985.

After two attempts that were aborted for non-meteorological reasons, on Friday morning, 23 August, the situation seemed to be developing into a promising one again. Ex-tropical storm Danny was going to cross Newfoundland the coming night and a high pressure area was slowly drifting east in its wake. Furthermore, the model promised an anticyclone over southwest Europe in a few days' time and the winds aloft looked good. A 48-hour alert was issued.

Next day, early Saturday morning 24 August, the three of us came together at Schiphol Met. Office to discuss the latest ECMWF products. The surface chart for Sunday, 25 August, 0000 UTC (+36) showed a beautiful slack gradient over the Newfoundland area (Fig. 1). Our Canadian colleagues agreed that tonight would be the night. The trajectories for a supposed launch on Sunday 0200 UTC looked even better than the day before (Fig. 2) and ECMWF kept its promise about the anti-cyclone over southwest Europe (Fig. 3). So unanimously we decided to signal GO.

Then the whole machinery started rolling. In the course of the day the Flight Control Centre was manned (flight control officer, radio officers, public-relations people, secretaries) and we began monitoring the weather over Newfoundland. Naturally from then on we used conventional material also, since launch time was less than 24 hours away. Satellite pictures (GOES) clearly showed that Danny and its associated cloud band had moved away and only broken stratocumulus would be present. Our main attention was focused on the surface wind at Newfoundland. Local wind effects are notorious there and as the wind remained around 15 kt all through the afternoon we got a little nervous, but towards dawn it started behaving as it should and died out completely.

Launch was scheduled for Sunday morning, August 25, at 0400 UTC, which gave us the opportunity to run the trajectory model on the new output. The trajectories, not very different from yesterday's, still looked favourable indeed, the more so because the natural behaviour of the balloon would be to ascend to 18,000 ft or more in course of the flight.

Launch eventually took place at 05.17 UTC (01.47 local time) under excellent conditions. From then on the flight proceeded smoothly. The balloon deviated slightly to the right of the projected path and it moved a bit slower than anticipated, but in no way alarmingly so (Fig. 4). It was expected to catch up with Danny's cold front somewhere over the eastern part of the Atlantic. The front was quite inactive, however, and anyway, the balloon would have been high enough to overfly it. But before that could happen, fate took control. Through some - as yet unknown - technical failure, after about 31 hours of undisturbed flight, the balloon suddenly lost height and despite the crew's frantic efforts to stop the descent by throwing away ballast and turning on the propane heaters, the balloon crash-landed shortly after 1200 UTC on Monday 26. Fortunately nobody was hurt.

Notwithstanding the untimely end of the trip, in at least one way it was record-breaking after all: never did transatlantic balloonists know they would have the right winds all the way. These did.

We wish to thank everyone at ECMWF and at KNMI who made it possible for us to do this job.

- Roel Blokzijl, Jules Roodenburg, Arie Steenhuisen
Royal National Meteorological Institute,
Ae de Bilt, Netherlands

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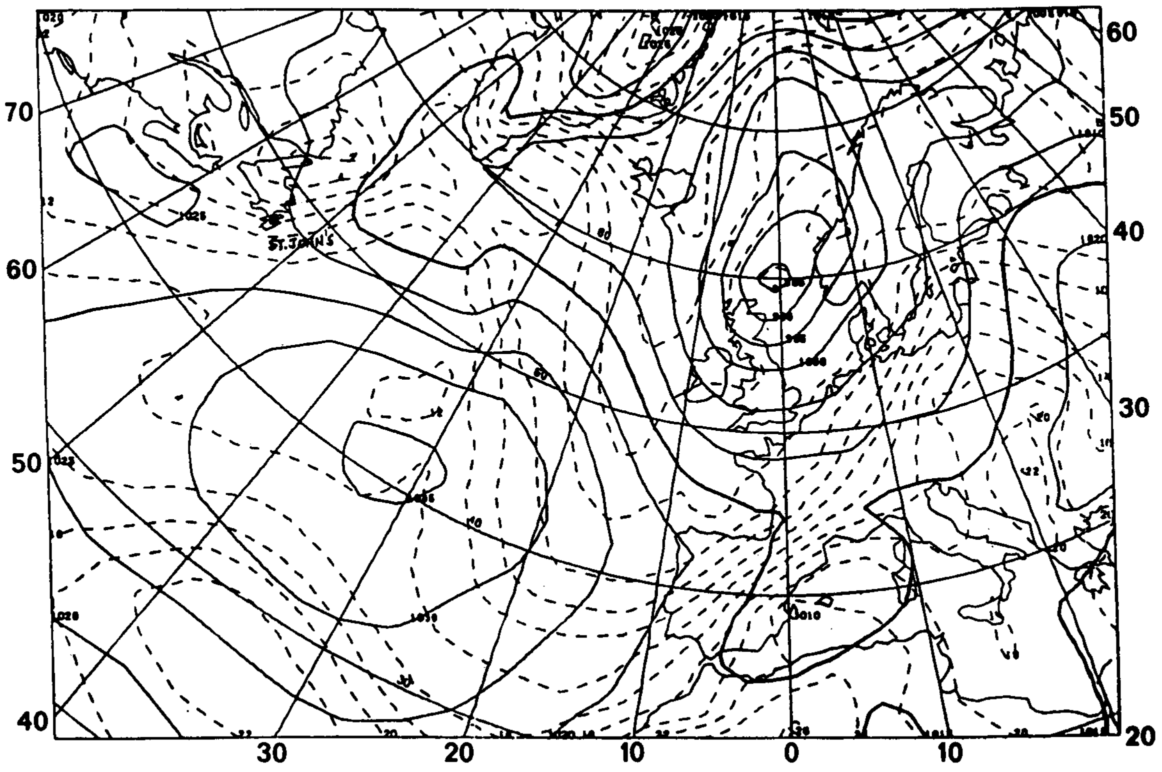

Fig. 1: Surface pressure + Temp 850 hPa valid for Sunday 25 August 0000, based on Friday 23 August 1200.

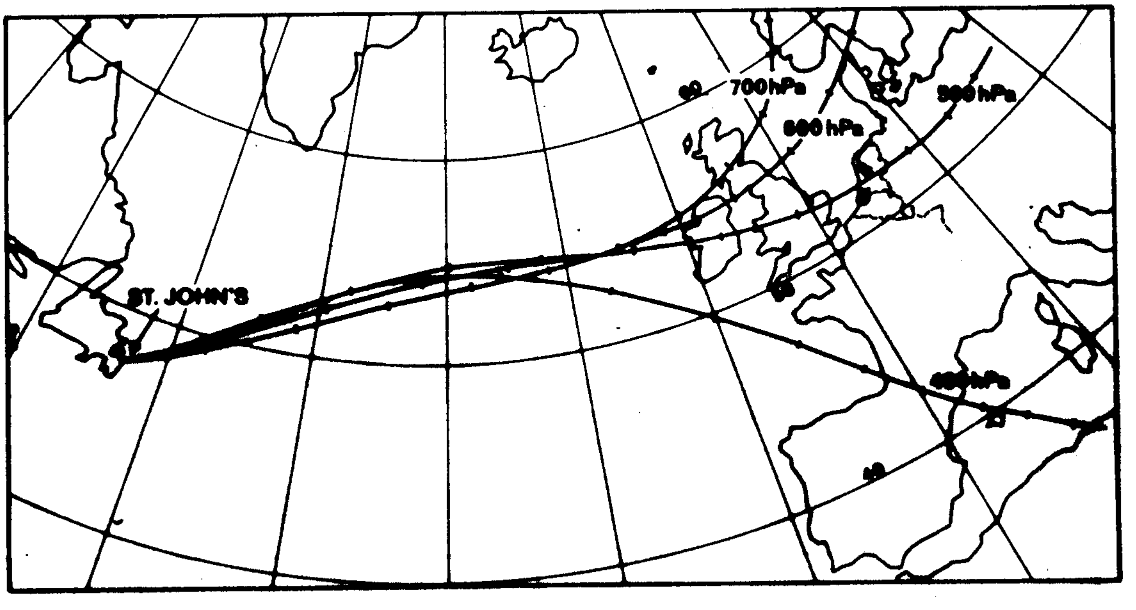

Fig. 2: Trajectories at 700, 600, 500 and 400 hPa starting from St. John's Sunday August 25 at 0000. Six-hourly intervals.

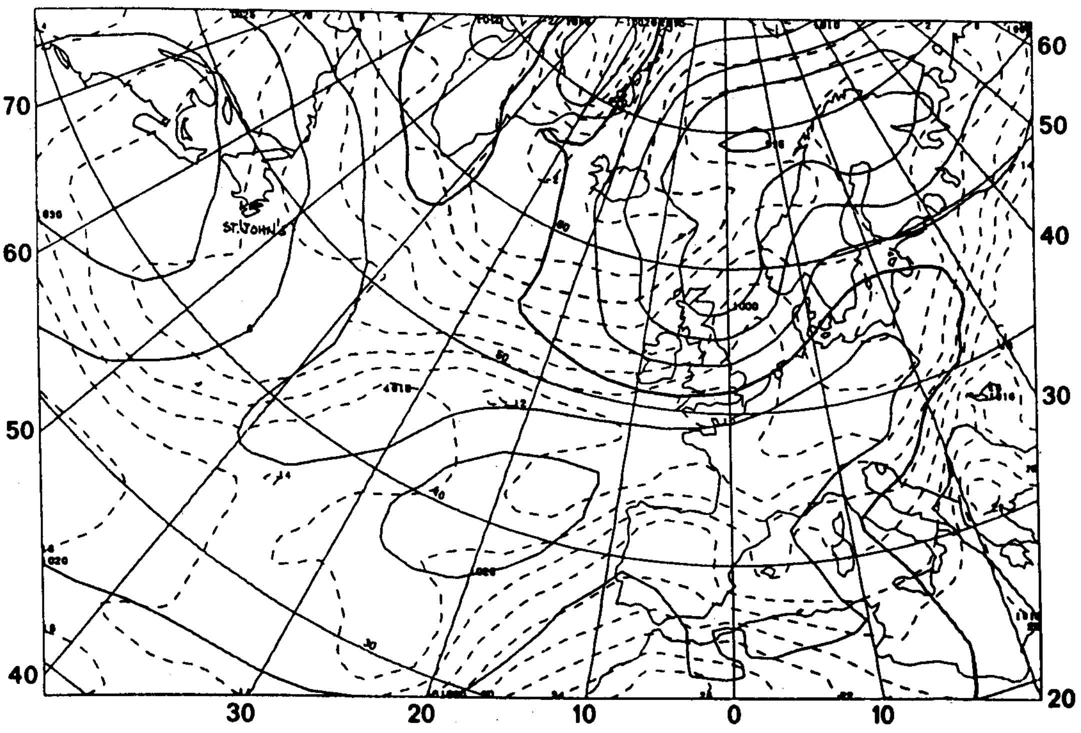

Fig. 3: As Fig. 1., but valid for Tuesday 27 August at 1200.

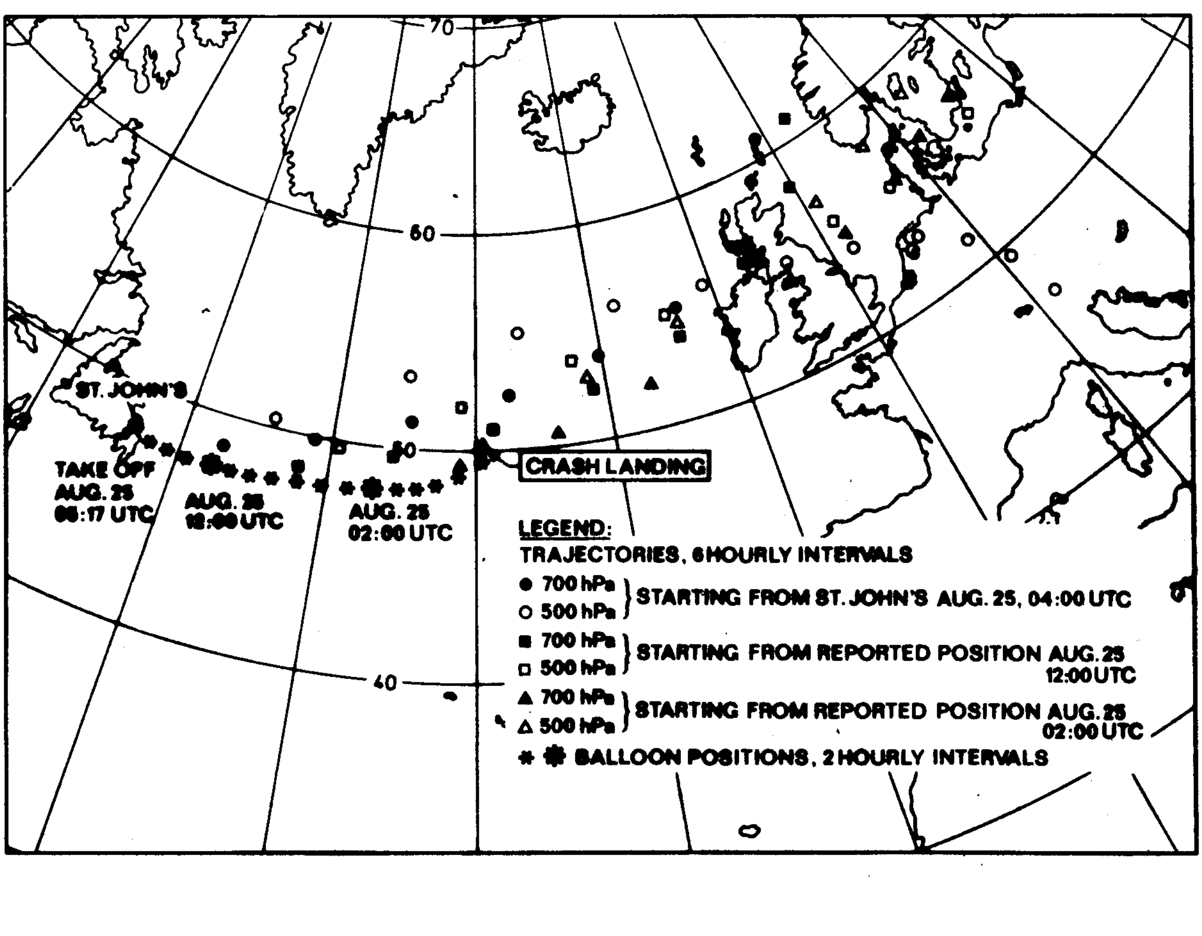

Fig. 4 Projected and actual positions.

WORKSHOP ON HIGH RESOLUTION ANALYSIS
24-26 JUNE 1985

ECMWF has, over the years, organised and benefitted from a series of workshops covering a variety of aspects of its operational and research activities. The discussions during these workshops have had a substantial effect on the activity of ECMWF in many of the areas which have been taken as topics. This is readily apparent in even a casual comparison of workshop proceedings with forecasting system changes; the best correlation is found with a lag of three years, or thereabouts.

The topic for this workshop, high resolution analysis, was chosen because of likely developments in the area of analysis and assimilation resulting from the more powerful computers that will be available towards the end of the decade. Increased computational power will enable the exploitation of ideas that have been pipe-dreams up to now. In addition, some radically new approaches to the analysis/assimilation problem are currently being developed.

Because of the time scales on which the computer developments will occur, we have considered likely developments for the analysis/assimilation problem on a wide range of spatial scales. The discussions have therefore benefitted from a wide range of viewpoints.

The three working groups at the workshop considered:

- use of satellite data
- short term developments
- development of new techniques

The first two working groups made specific recommendations about how to improve the use of satellite data and analysis techniques in the short term, whereas the third group concentrated on giving an overview of the new analysis techniques being developed, which will bear fruit in the long term.

It is hoped that the proceedings of the workshop will be published early in 1986. They will contain reports of the working groups and all the papers presented at the workshop.

\- Anthony Hollingsworth

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MARS - THE ECMWF METEOROLOGICAL ARCHIVAL AND RETRIEVAL SYSTEM

The first of two articles describing the ECMWF MARS. The second, giving more detail of the system, will appear in the February 1986 issue of the Newsletter.

The new Meteorological Archival and Retrieval System (MARS) has been designed to provide an efficient, machine independent system, based on a dedicated data handling machine connected to the other computers at the Centre via a local area network. Facilities provided enable the archival, retrieval and management of data in a linked computer environment. In particular, data can be archived from any machine, and retrieved and used on any machine. Storing data in machine independent formats ensures long-term compatibility and ease of support for the archives, enabling retrieved data to be used easily on any computer system.

The system is not restricted to ECMWF's operational archives - observation, analyses and ten day forecasts - but is designed to embrace all the data stored at the Centre; results of experiments, FGGE and ALPEX data and WMO/CAS NWP datasets.

As well as keeping the data machine independent, every effort has been made to keep the software as independent as possible as well. All MARS modules on all worker machines at the Centre are written, as far as possible, in standard ANSI 77 Fortran.

This article gives a general description of the system and will be followed later by one dealing in more detail with the various subsystems.

System Overview

An illustration of the ECMWF linked computer system is shown in Figure 1.

The data handling machine is an IBM 4341/M12, with 8 megabytes of memory and six channels. Its storage devices provide online capacity of 12.5 gigabytes on disk and 105 gigabytes on cartridges of an IBM 3851 mass storage device. There are six tape drives capable of handling 6250 bpi tapes. The IBM machine is connected to the other machines via Control Data's Loosely Coupled Network (LCN).

The files of MARS archive data are managed by the Common File System (CFS), developed by Los Alamos National Laboratory. CFS is responsible for handling the storage, retrieval and backup of files in an integrated system covering all the various storage media available to the IBM 4341. These devices are used in an hierarchical manner by CFS, which moves files between the different media, with the aim of having the files most frequently accessed immediately available from disk or mass storage and those least frequently used stored on tape. Related files are grouped together within families and kept together when written to tape.

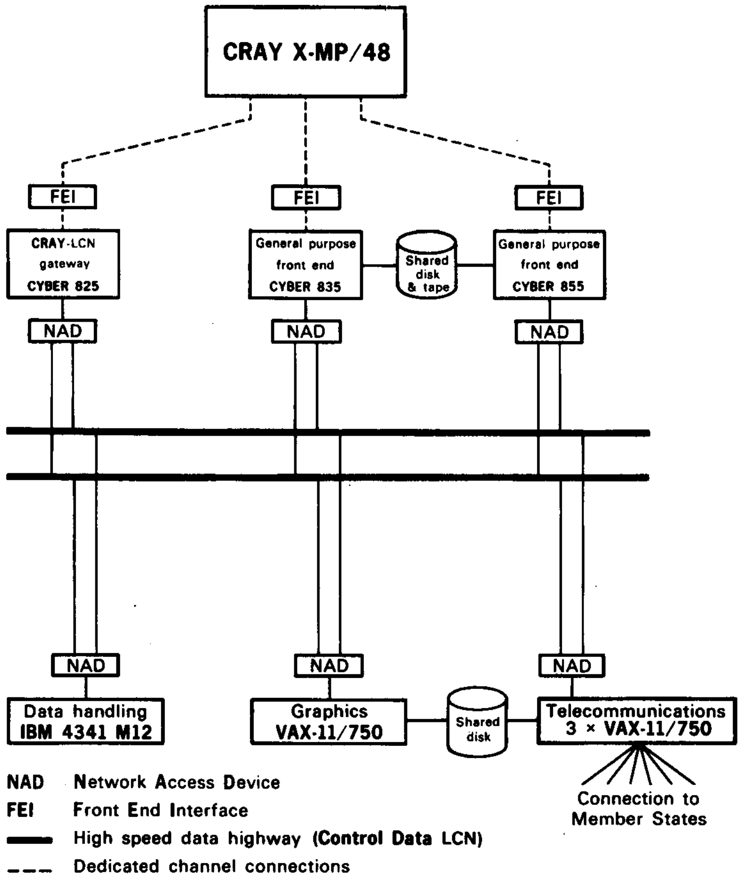

Fig. 1: ECMWF's computer system.

Facilities to archive and retrieve data and to manage the database are provided by the MARS application software package which consists of a central component resident on the IBM server machine and a component on each of the other, worker machines. When a user invokes the system on a worker machine, a network connection is made with the central MARS component on the IBM. Figure 2 (overleaf) shows the principal modules of these various components.

Archive Data

Meteorological data is stored to enable:

monitoring of the performance of the operational forecast and data assimilation;

diagnostic studies of the behaviour of the atmosphere, the data assimilation and forecast;

the results of forecasts and analyses to be retained and subsequently used for scientific investigation;

the extraction of starting points for numerical experiments, and storage of the results of such experiments;

a data service to be provided for Member States and external bodies;

model and analysis climatologies to be accumulated.

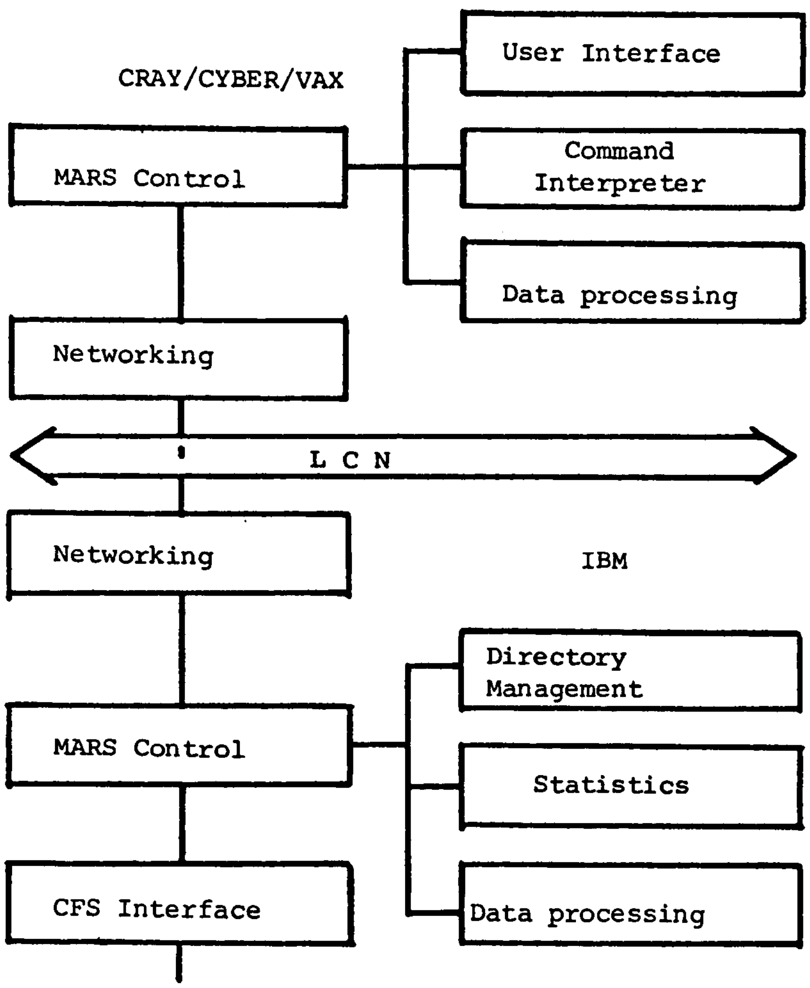

Fig. 2: Principal MARS modules.

These needs involve the short term retention of a large volume of data, representing as complete a description as possible of the generating models, coupled with a long term retention of less detailed data in the form of time series.

It is also necessary to retain observational data, in both raw and processed form, retaining important enhancements to that data such as substituted values, flags and bias information.

<u>Archive Contents</u>

In summary, the data to be archived includes

a Daily Archive, containing data at forecast model resolution, augmented by additional grid-point data to simplify processing;

a Time Series Archive, containing data at a lower resolution, extracted with the minimum of interpolation, and stored in families designed to permit 3 months data to reside on one magnetic tape;

an Archive of Monthly Means of model variables at model resolution;

an Observational Archive, containing raw data, decoded and substituted values, quality control and analysis flags, and bias information returned by the data assimilation system;

Research Department Archives of results of numerical experiments;

other datasets, to support a general data service.

Data Storage

All data are stored as series of CFS files, grouped into families to comprise archive streams. Some files are copied,or modified and copied, into more than one family, to improve the efficiency of different retrieval combinations, as ease of retrieval is of paramount importance. This will, in particular, enable access to time series data across a more suitable combination of files than that suited for retrieving daily data. Some data will be stored additionally at much reduced resolution, again to optimise access for certain applications. For long term retention, only data in time series form will be retained, probably at some reduced resolution.

In general, where interpolation, resolution, reduction, etc. is required, attention is given to avoiding undue data pollution. Thus archived data is often represented on model grids, rather than regular grids, and on model levels, in addition to pressure levels. Despite these considerations, a sub-set of archived data will be kept on a 2.5 degree regular grid as an aid to the distribution of data required for less sophisticated uses.

Analysis and forecast data can be considered as sets of fields, each field representing one parameter at one time for one level. The number of fields to be stored is very large, and they are gathered into sets as files, to prevent the CFS file directory becoming overloaded.

Observational data will be stored in data structures, representing a number of observations within a specific geographical area. Such structures will bear some similarity to fields of analysis and forecast data, and will be treated in a similar manner with respect to file structure.

The central MARS module on the IBM maintains an archive directory, which contains information on the content and structure of all the archive files in the different archive streams. This directory provides sufficient information to establish where data should be archived, whether requested data is archived, and the location of fields within files of analysis and forecast data. Thus users need only specify requests in terms of the data, with MARS doing the necessary mapping to CFS files and to the location of fields within files. Since the extent of observational data is subject to considerable variation, the location of segments within observations files will be contained in the appropriate MARS directory entry.

Data Formats

ECMWF has always archived data in binary form, and has always made its products available in a binary grid representation for dissemination to the Member States. However, the archive format and the real-time transmission format were different and both were unique to the Centre. The obvious advantages to be gained by having one machine independent and universally accepted standard for representing data in field form encouraged ECMWF to give substantial support to WMO in defining the GRIB code for binary representation of field data. All MARS field data is stored in GRIB format, with the additional constraint that the length of each GRIB coded field is rounded to the nearest 120 octets. This results in each field of a series of retrieved fields starting on a word boundary on any of the Centre's machines, which have different word lengths of 16, 32, 60 and 64 bits. Thus, GRIB code, which is now a WMO standard form and is machine independent, provides one common format for data, whether for real-time transmission on the GTS, for archives or for data exchange via magnetic tape.

Other numeric data are stored in machine independent forms also. These forms have the same block structure and data representation formats as GRIB. The characters GRIB are replaced by four other ASCII characters. The meaning of the data definition and description blocks varies and depends on the four identifying characters of the first block.

What has been done in standardising binary representation for data in field form must be followed as soon as possible by a comparable standard for observational data. Here again, ECMWF has a vested interest in the quick emergence of a standard, as the archiving of observational data has not yet been implemented in MARS. Designs for the binary representation have been made, and the design papers submitted to WMO. These ideas have been taken up and have resulted in a proposal for BUFR (Binary Universal Form for Records) code for binary representation of observations. WMO have taken the necessary steps to ensure further development.

With machine independent, standard representation of data in binary form, the ECMWF archives will remain easily accessible and become increasingly valuable, especially as all previous archives will be converted to the standard formats.

- John Hennessy

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TELECOMMUNICATIONS SCHEDULE

At its twenty second session (20-21 November 1985) Council approved a revised implementation schedule for the 3 medium speed circuits remaining to be implemented, as shown below:

Member State	Speed (bps)	Line to be set up
Italy	4800	February 1986
Turkey	2400	April 1986
Yugoslavia	2400	April 1986

COMPUTER RESOURCE ALLOCATION TO MEMBER STATES IN 1986

At its twenty second session Council also approved the allocation of computer resources to Member States for 1985 as shown below. These allocations will come into effect on Monday, 30 December 1985.

Details of how a unit is constructed are given in ECMWF Computer Bulletin B1.2/1. For guidance, note that for the "average" job:

- 1500 Cray units equals approximately 1 CP hour
- 1650 Cyber units equals approximately 1 CP hour.

	Cray (Kunits)	Cyber (Kunits)	On-line Mass Storage (Mwords)
Belgium	50	5	0.5
Denmark	243	25	1.9
Germany	1247	130	9.6
Spain	445	46	3.4
France	1053	109	8.1
Greece	214	22	1.6
Ireland	100	19	1.4
Italy	150	40	5.0
Yugoslavia	260	27	2.0
Netherlands	350	46	2.9
Austria	260	27	2.0
Portugal	150	20	1.4
Switzerland	309	32	2.4
Finland	220	20	1.7
Sweden	400	45	2.5
Turkey	200	20	1.5
UK	918	95	7.0
TOTAL	6569	728	54.9
Special Projects*	337	82	6.1
OVERALL TOTAL	6906	810	61.0

Note:
* This allocation is distributed between Special Projects as shown in the table overleaf.

SPECIAL PROJECTS 1986

Member State(s)	Institution undertaking the project	Project Title	1986 Resources requested			Future Cray resources	
			Cray Kunits	Cyber Kunits	On-line storage Mwords	1987 Kunits	1988 Kunits
Continuation Projects							
Germany							
	Institute for Geophysics and Meteorology, Cologne	Interpretation and calculation of energy budgets	7	17	0.2	7	7
	Max Planck Institute for Meteorology, Hamburg	Third generation global wave model	20	5	0.3	20	20
France	Laboratory of Atmospheric Optics, University of Science & Technology, Lille	Climatic impact of aerosols	10	3	0.3	-	-
	Fundamental Physics, University of Science & Technology, Lille	Intercomparison of radiation codes in the ECMWF model	30	6	0.3	-	-
United Kingdom	Meteorological Office	Model Intercomparison project	20	4	0.5	-	-
	University of Reading	Normal modes of a 3-D atmosphere flow	20	5	0.5	-	-
New Projects							
Germany	Max-Planck-Institute for Chemistry, Mainz	Container Project	5	2	0.5	5	5
Netherlands	KNMI	Testing and evaluation of a third generation ocean wave model	150	15	3.2	150	-
United Kingdom	Imperial College of Science & Technology, London	A North Atlantic Ocean Circulation Model for WOCE Observing System Simulation Studies	75	25	0.3	-	-
		TOTAL REQUESTED	337	82	6.1	182	32
		AMOUNT AVAILABLE	750	82	6.1		

COS 1.14 and CFT 1.14

COS 1.14 has been in use on the CRAY X-MP/22 since 23 October 1985. Some minor problems have been corrected since then, and the system now appears to be very reliable. This system change was essential in order to prepare for the CRAY X-MP/48, since COS 1.13 is unable to run on the X-MP/48.

The COS 1.14 manuals and change packets have been distributed; they contain full details of the new features described below.

Currently, the default version of CFT for normal use (i.e. non-multitasking) is still CFT 1.13 Bugfix 2. However, we hope to make CFT 1.14 Bugfix 3 the default version later this year. This version is available for testing and may be accessed using the NEXT control statement:

```
NEXT(PROD=CFT).
```

If you find any problems with this latest version of the CFT compiler, please report them to the User Support Section.

New features in COS 1.14

COS 1.14 contains many new features as well as corrections to problems in the operating system (e.g. the problem with double ACQUIREs has been fixed). The new features most relevant to users at ECMWF are described below.

1. Support for the X-MP/48 (to allow use of 4 CPUs and 8 MW of memory).

2. Support for the Hardware Performance Monitor. This will allow us more easily to measure the machine performance (e.g. number of MFLOPs/second) and improve the utilisation of the system.

3. Contiguous Disk Space - it is possible to use ASSIGN to request contiguous disk space, by use of the C parameter. For full details consult the COS Reference Manual.

4. DEBUG has been enhanced to produce Managed Memory (HEAP) and STACK statistics, and for multi-tasking jobs,information about the current state of each active task.

5. DUMP has been enhanced to allow memory to be dumped in CAL format using the instructions mnemonics.

6. DSDUMP - the contents of the dataset may be printed in Hexadecimal instead of octal.

7. AUDPL - this is a new utility which provides information about CRAY UPDATE Program Libraries. It may be used to list specified decks, common decks etc., reconstruct modification sets applied to a PL, list the history of the PL etc. See the CRAY UPDATE Reference Manual for full details.

8. FTREF - this is a new utility which provides information about a FORTRAN program. FTREF will give a cross reference of Common Block variables, a static calling tree and, for multitasking programs, information whether a common variable or a subroutine is locked when it is referenced or redefined. Full details may be found in the COS Reference Manual.

9. SKIPU - this may be used to skip sectors in an unblocked dataset; it is the equivalent of SKIPR/SKIPF/SKIPD.

10. SEGLDR has an additional control statement parameter 'DIR' which allows directives to be specified on the control statement. See the SEGLDR Reference Manual.

New features in CFT 1.14

CFT 1.14 contains a number of new features, as follows:

1. Utilisation of hardware gather/scatter and compressed index instructions on machines where they are available. They are not available on the X-MP/22, but will be available on the X-MP/48.

2. Improved code for exponentiation.

3. Improved code for DO-loops (including two version loops - the compiler will generate both vector and scalar code for certain loops and then test the loop trip count at run time to determine which version to use). This is controlled by the CVL/NOCVL options and compiler directives.

4. Do-loop Unrolling - the CFT control statement parameter UNROLL=r will unroll any DO-loop with a constant trip count 'r' or less. The maximum value of 'r' is 9, the default is 3. The ROLL/UNROLL compiler directives may also be used to enable/disable DO-loop unrolling.

5. If ANSI is specified on the CFT control statement, then any non-ANSI FORTRAN 77 code will be flagged, the warning messages having the prefix NON-ANSI.

6. The maximum length of character variables is increased from 504 to 16,383 characters.

7. Recursion is permitted - subroutines and functions may call themselves both directly and indirectly (ALLOC=STACK must be used to compile recursive code).

8. A new kind of common - TASK COMMON - is provided for use with multitasking programs. Each task will have its own copy of such common blocks.

\- Richard Fisker

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STILL VALID NEWS SHEETS

Below is a list of News Sheets that still contain some valid information which has not been incorporated into the Bulletin set (up to News Sheet 181). All other News Sheets are redundant and can be thrown away.

No.	Still Valid Article
16	Checkpointing and program termination
19	CRAY UPDATE (temporary datasets used)
56	DISP
67	Attention Cyber BUFFER IN users
73	Minimum Cyber field length
89	Minimum field length for Cray jobs
93	Stranger tapes
118	Terminal timeout
120	Non-permanent ACQUIRE to the Cray
121	Cyber job class structure
122	Mixing FTN4 and FTN5 compiled routines
127	(25.1.82) IMSL Library
130	Contouring package: addition of highs and lows
135	Local print file size limitations
136	Care of terminals in offices
140	PURGE policy change
141	AUTOLOGOUT - time limit increases
144	DISSPLA FTN5 version
152	Job information card
158	Change of behaviour of EDIT features SAVE, SAVEX.
	Reduction in maximum print size for AB and AC
164	CFT New Calling Sequence on the Cray X-MP
165	Maximum memory size for Cray jobs
166	Corrections to the Contouring Package
167	CFT 1.13 improvements
170	NOS/BE level 604
171	" " "
172	" " "
	Change to CFT Compiler default parameter (ON=A)
174	Warning against mixing FTN4 and FTN5 compiled routines.
176	Archival of Cyber permanent files onto IBM mass storage
177	RETURNX, REWINDX
178	TIDs on Cray include 2 chara. TID plus 3 chara source computer ID.
	Caution with ACQUIRE on RERUN jobs

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THE METEOROLOGICAL TRAINING COURSE - 28 APRIL - 20 JUNE 1986

The objective of the training course is to assist Member States in advanced training in the field of numerical weather forecasting. Participants should have a good meteorological background. Some practical experience of numerical weather prediction is an advantage.

The course is divided into four modules:

- M1: Dynamical meteorology and numerical methods (28 April - 9 May)
- M2: Numerical weather prediction - analysis, initialisation and adiabatic formulation (12 - 22 May)
- M3: Numerical weather prediction - diabatic processes and the representation of orography (27 May - 6 June)
- M4: Use and interpretation of ECMWF products (9 - 20 June).

Modules M1, M2 and M3 will be of most interest to scientists who are involved in the development of numerical models for operational forecasting or research. Module M4 is quite different from the others. It is directed towards those staff in the Meteorological Services who are (or will be) using ECMWF products, either directly as forecasting staff, or in development work aimed at maximising the benefits to users of the Centre's products.

Participants can attend any combination of the four modules. However, those attending only M2 are expected to have a good knowledge of the topics covered in M1. Attendance at the other modules is not a requirement for participation in M4.

In each module, there will be lectures, exercises and problem or laboratory sessions. There will also be some computing, though no computing experience will be assumed. Participants are encouraged to take an interest in the work of ECMWF and to discuss their own work and interests with the staff of the Centre. All the lectures will be given in English and a comprehensive set of lecture notes will be provided.

During January, application forms and a booklet describing the course will be sent to the Meteorological Services of Member States and to many universities and institutions. If you do not have access to one of these, copies can be obtained from Els Kooij-Connally.

The Centre does not charge a course fee for participants from Member States.

Applications from within Member States should be channelled through the National Meteorological Service, but those from non-Member States should be sent to the Secretary-General of WMO. The closing date for applications will be 1 March 1986.

- Bob Riddaway
Els Kooij-Connally

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COMPUTER USER TRAINING COURSES

The Centre is offering another series of training courses for Member State personnel and ECMWF staff. Information will shortly be sent to the Member States. Nominations from ECMWF staff will be invited via Section Heads.

Course: Introduction to the facilities, 3-6/7 March 1986

This is intended for anyone who will be programming the CRAY, to give them sufficient experience to run simple work. It will also introduce them to some of the CYBER facilities they may need to complement their CRAY activity. Prior knowledge of another computing system, plus a knowledge of Fortran is required. An optional fifth day (7 March) is devoted to explaining how to use ECMWF's meteorological database and archive system.

Course: CRAY in depth, 10-14 March 1986

An in-depth course for those who will make heavy use of the CRAY and its many unique facilities. Intending participants will be expected to know how to run simple jobs on the CRAY.

- Andrew Lea

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ECMWF PUBLICATIONS

TECHNICAL REPORT NO. 48:	A numerical case study of East Asian Coastal Cyclogenesis
TECHNICAL REPORT NO. 49:	A study of the predictability of the ECMWF operational forecast model in the tropics
TECHNICAL REPORT NO. 50:	On the development of orographic cyclones
TECHNICAL REPORT NO. 51:	Climatology and systematic error of rainfall forecasts at ECMWF
WORKSHOP, NOVEMBER 1984:	Cloud cover parameterisation in numerical models
TECHNICAL MEMORANDUM NO. 104:	A memory manager for single and multi-tasking applications (updated version of Technical Memorandum No. 73)
TECHNICAL MEMORANDUM NO. 105:	The impact of the El Niño anomaly on the mean meridional circulation as simulated by a high resolution model
TECHNICAL MEMORANDUM NO. 106:	Current and planned meteorological applications systems at ECMWF
TECHNICAL MEMORANDUM NO. 107:	Development of the high resolution model
TECHNICAL MEMORANDUM NO. 108:	Development of the operational parameterisation scheme
ANNUAL REPORT 1984:	German version
FORECAST REPORT NO. 29:	Dec.1984 - Feb. 1985
FORECAST REPORT NO. 30:	March - May 1985
ECMWF FORECAST + VERIFICATION CHARTS:	to 31 July 1985
RESEARCH MANUAL:	Update for Vol. 2 (Adiabatic part) Update for Vol. 3 (Physical parameterisation)

INDEX OF STILL VALID NEWSLETTER ARTICLES

This is an index of the major articles published in the ECMWF Newsletter plus those in the original ECMWF Technical Newsletter series. As one goes back in time, some points in these articles may have been superseded. When in doubt, contact the author or User Support.

*T indicates the original Technical Newsletter series

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- telex (No. 847908)				
- COMFILE (See Bulletin B1.5/1)				
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Deputy Ops. Section Head	-	Graham Holt	CB 024	306
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