European Centre for Medium Range Weather Forecasts

ECMWF NEWSLETTER

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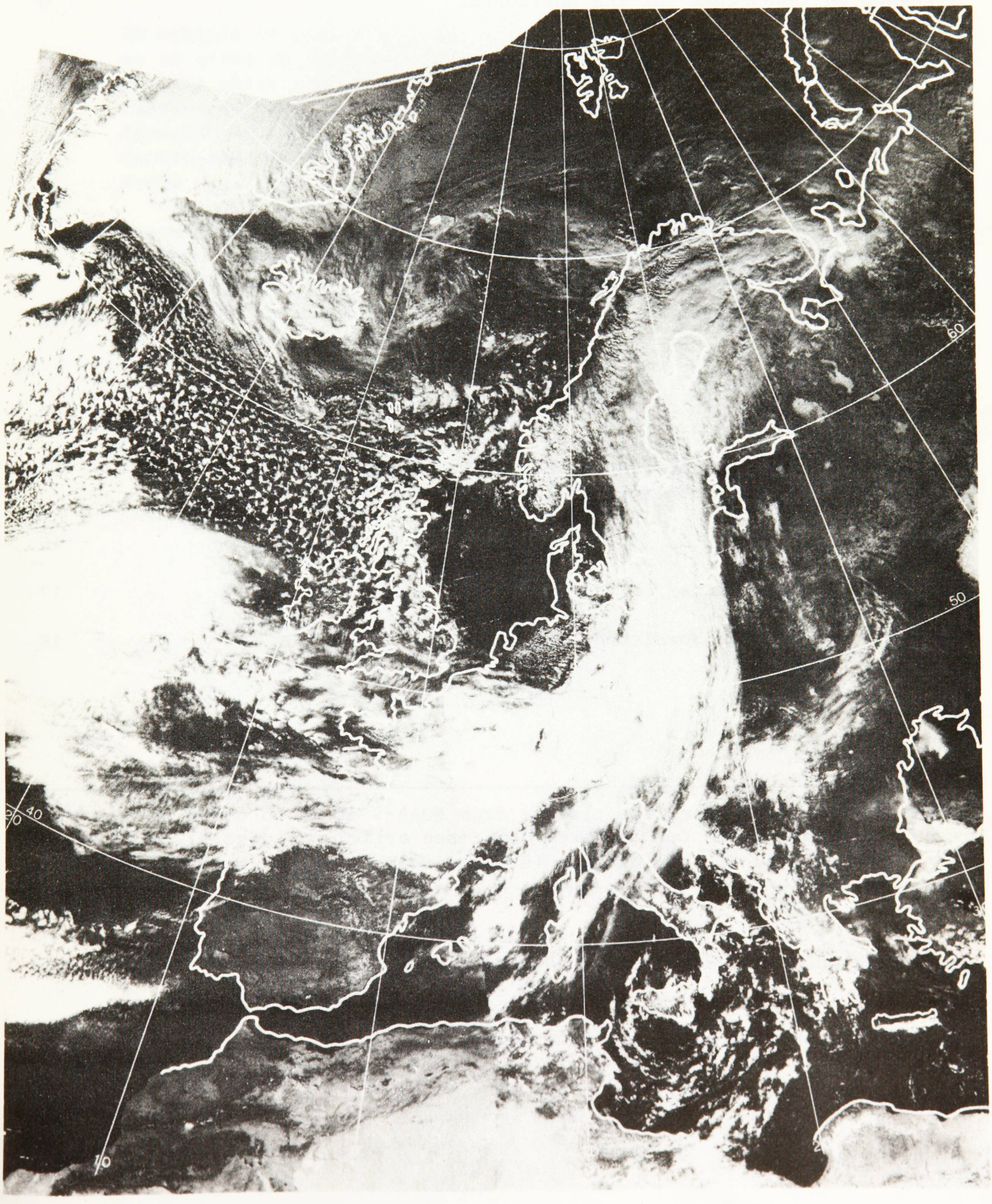
Number 41 - March 1988



IN THIS ISSUE

COVER: Composite satellite picture from NOAA-9 of cloud cover in the visible range, valid for 23 March 1986 (see article on page 3). Reproduced courtesy of the Institut für Meteorologie, Freie Universität Berlin.

This Newsletter is edited and produced by User Support.

The next issue will appear in June 1988.

An article on page 9 will be of interest to numerical modellers as it gives an example of the potential improvement in forecast quality which can be gained by increasing the horizontal resolution of a numerical weather prediction model. Cray Research Inc., Minneapolis, made the test possible by loaning the Centre the use of a more powerfully configured 4-processor Cray X-MP.

Meteorologists should take note of the preliminary announcement of this year's Research Department seminar, which is entitled "Data analysis and the use of satellite data" and will take place in September (see page 17).

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CHANGES TO THE OPERATIONAL FORECASTING SYSTEM

Recent changes

(i) A revised vertical diffusion scheme was implemented on 5 January 1988. The new scheme limits turbulent diffusion to the boundary layer. There are medium-range synoptic improvements resulting from better eddy energetics and a general reduction in mean wind and temperature errors but with no direct impact on weather elements such as rain, cloud, etc.

(ii) At the same time, a number of small changes were made to the parametrisation of surface processes, resulting in minor changes to the surface parameters and post-processed weather elements, with the exception of snow melting episodes, for which the surface temperature will be able to rise above 0 C while some snow cover remains. Objective verification indicates a consistent positive impact on the overall performance of the forecasting system in the medium-range, i.e. days 4 to 7 and thereafter. Weather elements are not directly affected by the changes, with the exception of the 2 m temperature.

(iii) Divergent structure functions were introduced in the analysis on 26 January. This improves the analysis significantly in areas where strong divergent winds occur, mainly in the tropics. The forecast impacts are small.

Planned changes

(i) In the present analysis system, the horizontal correlation of forecast error is modelled using a series expansion of 5 Bessel functions. A system has been set up with 8 Bessel functions in the expansion, the geostrophic assumption being progressively relaxed for the last 3 terms. This will lead to a higher resolution analysis in the horizontal. In individual areas the depth of intense storms and the associated level flow will be analysed more accurately, which leads to significant local improvements in the subsequent forecast.

(ii) A new suite of procedures for carrying out the analysis of surface variables will be implemented in two stages. Stage 1 will involve incorporating within the ECMWF analysis program the present procedures to interpolate snow and SST analysis to the model grid. In Stage 2, procedures to analyse the 2 m temperature and humidity will be incorporated.

- Bernard Strauss

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A GLOBAL FORECAST WITH T213 RESOLUTION

1. INTRODUCTION

The June 1987 issue of the ECMWF Newsletter presented first results from forecasts carried out with a horizontal resolution finer than that of the Centre's operational spectral model, which uses triangular truncation at total wavenumber 106 (T106). The resolution chosen was T159, which is the finest that can be run with acceptable efficiency on the Centre's CRAY X-MP/48, although the running time is too long to be operationally feasible. The restriction on resolution is imposed in the first place by the 32 MW (MWord) size of the SSD (Solid State Storage Device) on the ECMWF CRAY. Were this not the case, resolution could be increased a little more, but the 8 MW central memory would then serve as a limit.

In October of last year, Cray Research Inc. offered to make time available to ECMWF on a 4-processor CRAY X-MP with 16 MW of central memory and an SSD of 512 MW. The machine also had an 8.5ns clock time (compared to the 9.5ns of the Centre's machine) and faster (DD-49) disks. It was located at Mendota Heights, Minneapolis. Taking into account the requirements at ECMWF for the preparation and testing of initial datasets and libraries, it was decided that a horizontal resolution of T213 was feasible, and that an attempt would be made to complete a 10-day forecast.

2. PREPARATION

As much preparation as possible was carried out at ECMWF. This included calculation of an orography and required climatological fields on the .56° grid of the T213 model, preparation of initial data by interpolation of the results of T106 analyses, and limited testing of the model. Execution was possible using two processors (requiring 7 MW of main memory) but since SSD was totally inadequate to support the work files, the elapsed time was very long and only one timestep was executed. In order to test the transfer of data and programs on tape, the process was repeated on a Cray X-MP/28 at Cray UK (Bracknell). Multiple copies of data, program sources and program binaries were transported using both 6250 bpi tapes and 3480 cartridge tapes.

Further preparation was carried out at Mendota during the 5 days leading up to the weekend over which the full 10-day forecast was executed. The X-MP/416 was in general use for software development under the UNICOS operating system, and the T213 was the first serious application of a code utilising more than 8MW of memory under COS. Much of the time was taken in finding efficient ways of circumventing problems encountered with the pre-release COS X.17 system that had to be used. In addition, it was felt important to be able to visualise some fields during the model execution, as it would not otherwise be possible to detect meteorological problems. Since DISSPLA was available, arrangements were made to run simple contour plots, using a VAX to supply interactive station access to the CRAY.

3. RESULTS - COMPUTATIONAL ASPECTS

The basic aim of the mission was successful, in that a 10 day forecast at resolution T213 was completed and the results in the form of GRIB-coded files were transported back to ECMWF. This data has now been archived in MARS, so that it is generally available.

Basic performance data are as follows:

(a)	elapsed time (including post processing) approx.	17	hours
(b)	Central Processor time (model only)	55.4	hours
(c)	main memory	9.3	Mwords
(d)	SSD	65.6	Mwords
(e)	floating point execution rate	450	Mflops

These results were achieved using the pre-release of CFT77 2.0, which performed very well on the model code. Compared to normal production at ECMWF, where an execution rate of under 340 Mflops is normally attained, there are differences due to hardware (clock speed, SSD channel speed, DD49 disks), compiler, and model resolution. In order to quantify these differences, T106 tests were run at Mendota using CFT77 and CFT 1.14. Results indicate that the compiler gives an improvement at T106 of 9%. The faster hardware gives a speedup of about 15%.

4. RESULTS - METEOROLOGICAL ASPECTS

The case chosen for the T213 forecast had the same 20 March 1986 initial date for which first T159 results were presented in the June 1987 Newsletter. For the T123 experiment, the current 19-level vertical resolution was used, and the model was as operational at the time of the experiment, apart from the use of lower coefficients of horizontal diffusion, and a smaller timestep. Use of the more recent model version did not give any significant difference at T106 resolution from the corresponding operational forecast from 20 March 1986, and the T213 results serve to accentuate the differences between T159 and T106 presented earlier.

The case is one in which T106 (and to a greater extent T63) forecasts underestimate the strength of an Alpine lee cyclogenesis early in the forecast range. At day 1, a more accurate central pressure and much improved low level winds and precipitation are found in the T213 forecast for the Mediterranean region. By day 3 the low was weakening, but the upper panel of Figure 1 shows that a marked low level circulation centred south of Italy was present in the analysed state. Little indication of this is seen in the T106 forecast (middle panel), but the system is clearly present at T213 resolution (lower panel), albeit with a somewhat lower amplitude and further to the west than in the analysis.

Maps of cloud as diagnosed in the day 3 T106 and T213 forecasts are shown in the upper and middle panel of Figure 2, and the corresponding satellite picture is presented below. The increase in resolution is of substantial

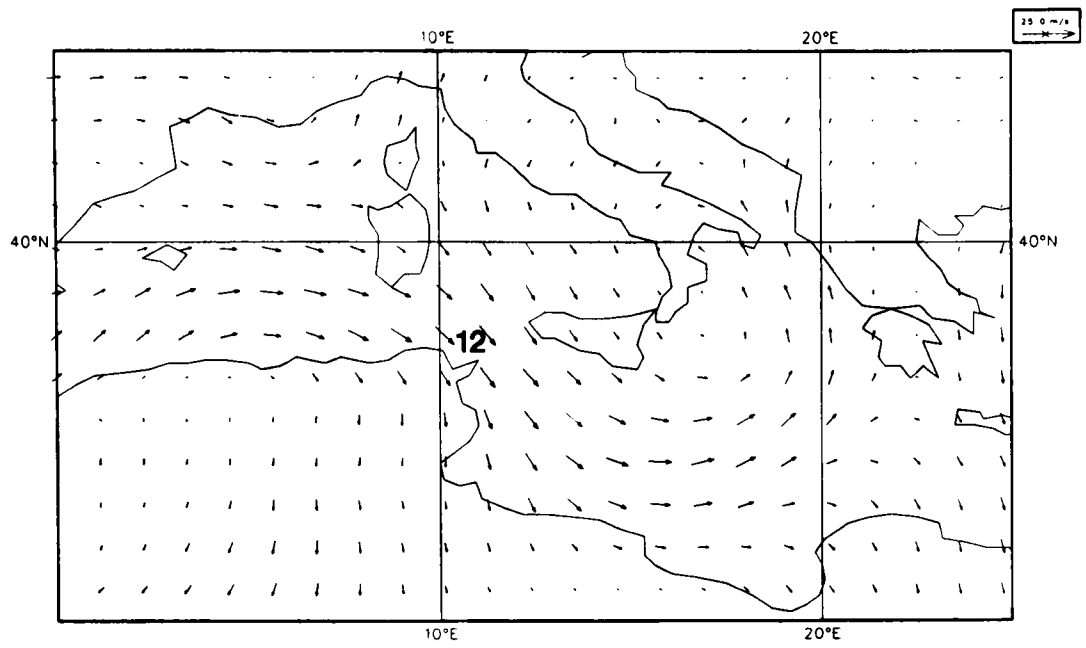
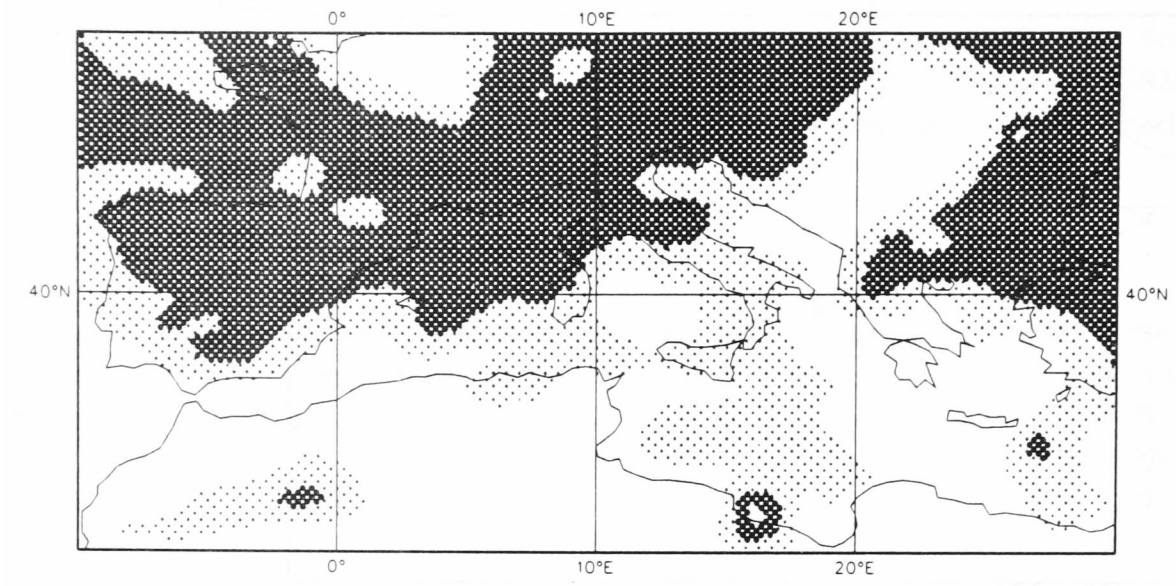


Fig. 1 Wind at 10m, with maxima marked in ms^{-1}, from the operational analysis for 12Z, 23 March 1986 (upper), and from 3-day T106 (middle) and T213 (lower) forecasts for this time.



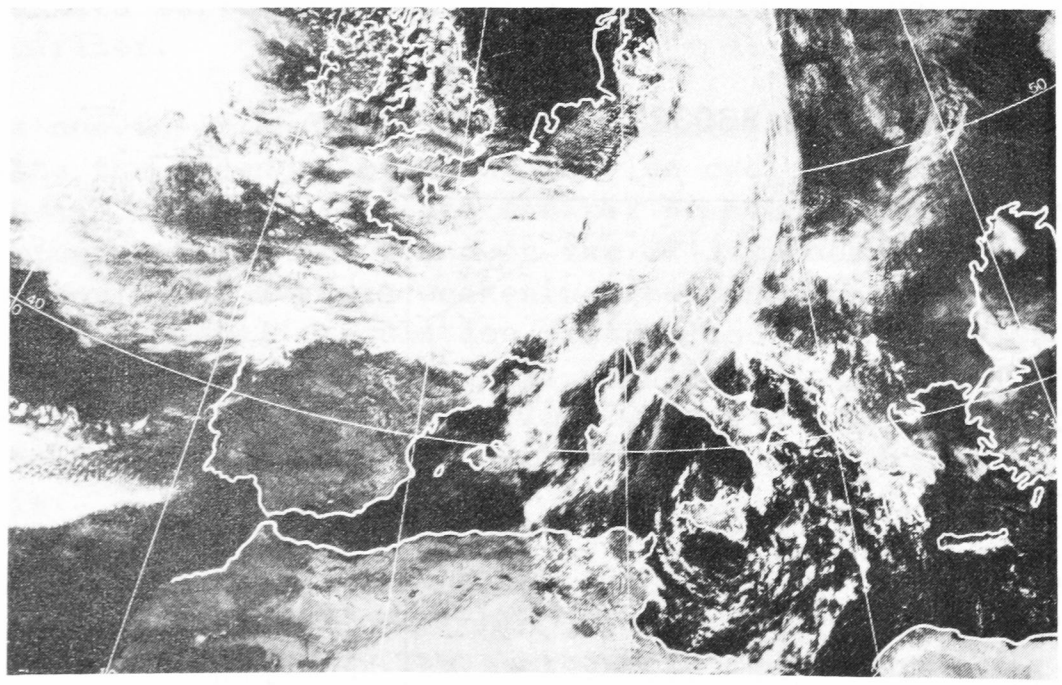


Fig. 2 Day-3 forecasts of cloud cover from T106 (upper) and T213 (middle). The heavier shading denotes cloud cover in excess of 80%, and the light shading shows cover in the range from 20 to 80%. The lower panel shows a composite satellite picture of cloud cover in the visible range valid for about the time in question, published by the Freie Universität Berlin, and reproduced here courtesy of the Meteorological Institute.

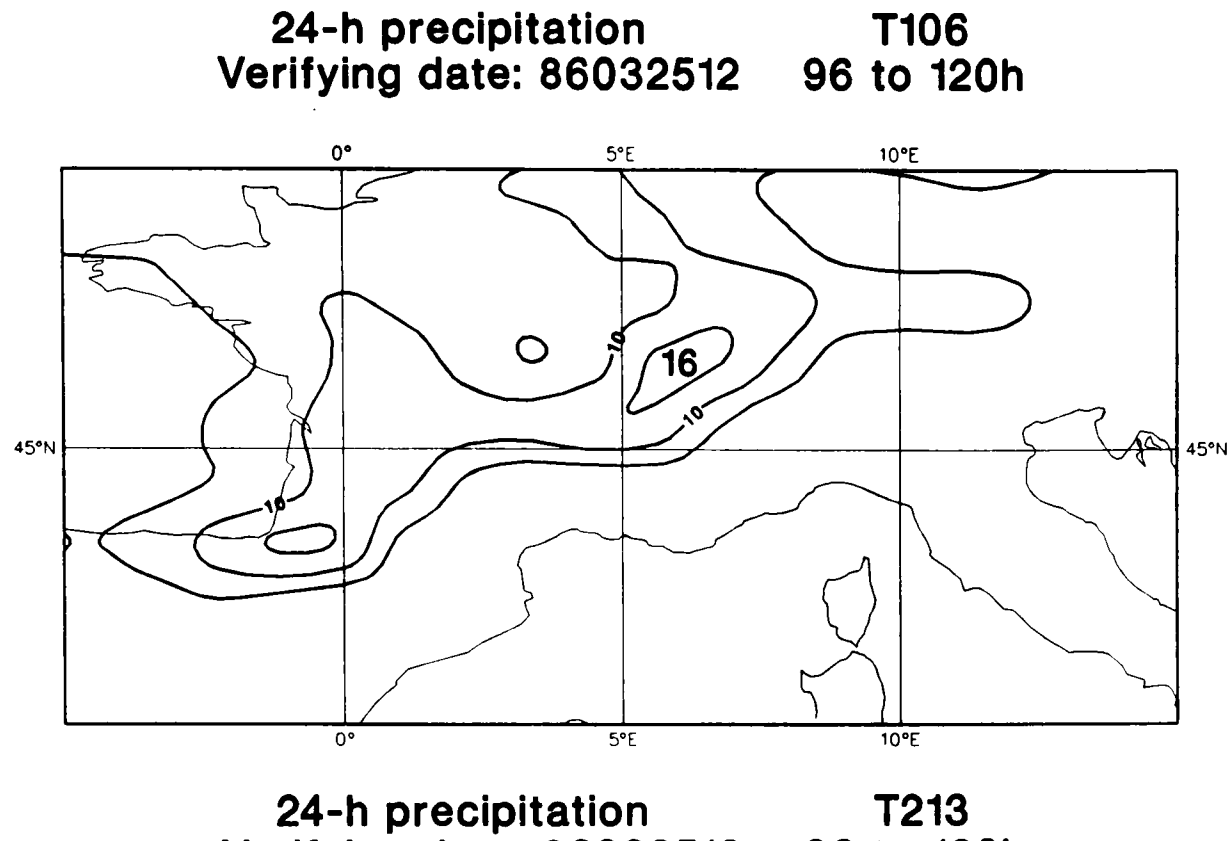


Fig. 3 24-hour net precipitation (mm) for the period 12Z, 24 March to 12Z, 25 March 1986. Forecast values from T106 and T213 are shown in the upper and middle panels respectively, while observed values are plotted in the lower map.

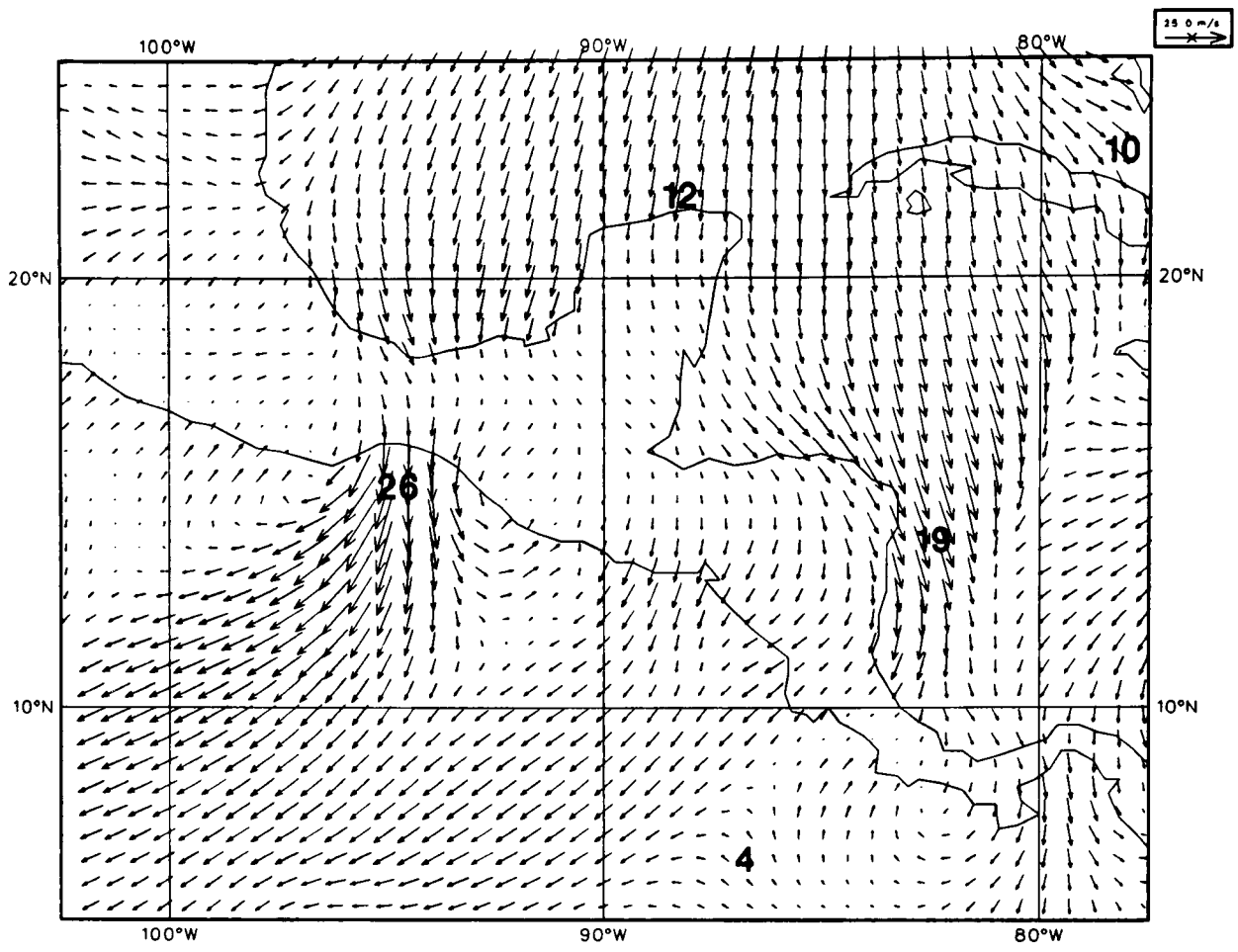


Fig. 4 Wind at 10m for Central America from 60-hour T213 (upper) and T106 (lower) forecasts. Maxima are marked in ms^{-1}.

benefit in producing less cloud over the bulk of the Iberian Peninsula and to the immediate east. The T213 forecast is successful in its depiction of cloud over Yugoslavia and southern Greece that was not captured using T106. A better impression is also given of the banded structure of the cloud field over the Mediterranean south of Italy.

The case in question was one in which the larger scale atmospheric pattern was predicted quite accurately well into the medium range at T106 resolution, and there were no substantial differences between T213 and T106 in this respect. Some significant synoptic differences were nevertheless found. In the June 1987 article an improvement of T159 over T106 was illustrated for a depression over southern Sweden at day 5; the improvement of T213 over T106 with the present model version is similar, but somewhat larger. Synoptic differences over Southern Europe did not appear to be particularly significant at this time, but Figure 3 shows an example of how the expected increase in detail in precipitation forecasts from T106 and T213 resolutions is such as to bring forecast and observation closer to each other.

Diagnosis of the T213 run is still far from complete, and most evaluation carried out to date has been for Europe. An illustration of a pronounced local effect elsewhere is presented in Figure 4. The synoptic situation during the early part of the forecast was one of strong northerly flow over the Gulf of Mexico. Under such circumstances, the mountains of southern Mexico present a major barrier to the low level flow, which is typically channelled through a gap to reach the Pacific ocean as a narrow belt of high winds over the Gulf of Tehuantepec. The figure shows T213 and T106 forecasts at 60-hour range. The increase in resolution brings about a significant increase in wind strength where the flow emerges over the Pacific, and T213 evidently represents a more pronounced flow reversal to either side. Synoptic data for the period in question supports the T213 forecast as the more accurate.

- David Dent, Adrian Simmons

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WORKSHOP ON TECHNIQUES FOR THE HORIZONTAL DISCRETISATION IN NWP MODELS

2-4 November 1987

ECMWF organises regular workshops to assess the current state of knowledge on topics of direct relevance to its objectives and to provide guidance for its programme of research. The workshop held on 2-4 November last year considered techniques for the horizontal discretisation in NWP models, including discussion of the performance of some of these techniques at resolutions finer than that currently used operationally at the Centre. Time-stepping aspects, which are intimately linked with the horizontal discretisation, in particular

semi-Lagrangian techniques, were also considered. The question of the vertical discretisation was not directly addressed, but presentations and discussions included reference to problems such as the appropriate vertical resolution, the representation of orography, and the upper boundary condition for resolved, vertically propagating gravity waves, which are closely related to the topic of the performance of numerical schemes as horizontal resolution is increased. The relationship between parametrisation schemes and numerical techniques and resolution was also discussed.

The workshop followed the usual ECMWF pattern of 1½ days of lectures, followed by one day of discussion within smaller groups, and a final general session to discuss the conclusions of the working groups. Two main groups were set up. The first considered numerical techniques per se, and its discussions were split into two parts. One was concerned with general consideration of aspects such as geometry, computational efficiency and the requirements placed on schemes by the need to simulate particular physical processes. The second dealt with both the use of semi-Lagrangian techniques, whereby computational efficiency is enhanced by the use of longer timesteps, and the general question of transport schemes for rapidly varying fields, where a promising approach is also based on a semi-Lagrangian scheme. The discussions and recommendations were particularly useful as they came at a time when the Centre is preparing to begin active work in this area.

The second working group discussed increased resolution and its implications. Current experience was reviewed, and guidelines laid down for future experimentation. Consideration was given to the possible need for methods of filtering, as models begin partially to resolve a number of mesoscale phenomena. Related problems in parametrisation were also discussed. The resolution of the forecast model also has implications for data assimilation, and aspects of this received attention.

- Adrian Simmons

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WORKSHOP ON DIABATIC FORCING

30 November - 2 December 1987

A second workshop was held on 30 November - 2 December, the subject being the diagnosis and representation of diabatic forcing in NWP models. As the forecast length increases, the importance of the diabatic processes is such as to eventually dominate the forecast quality and 'climate' of a model. The parametrisation of these subgridscale processes (such as radiation, turbulent transports, convection and gravity wave drag) in terms of parameters derived from the resolved scale fields of wind, temperature, etc. is a very difficult task, and progress in this, perhaps more than in most fields, can only be achieved by concerted studies based on observations, models and theory.

For this workshop, scientists with expertise in different disciplines came together to discuss aspects of parametrisation and to make recommendations for future research at ECMWF. The workshop was arranged in the usual way, starting with presentations on recent research, followed by discussions in three groups and finally a plenary discussion.

Since data are extremely important for the design and verification of parametrisation schemes, considerable time was spent on the discussion of data aspects, and the use of observational data sets was encouraged. Moreover, the Centre was strongly advised to pursue methods for diagnosing deficiencies in diabatic forcing using the Centre's data base including the new technique recently developed at the Centre. The existence of typical equilibrium/ neutrality states should also be verified.

Diabatic processes were discussed individually. In view of the importance of tropical forcing for the general circulation, the parametrisation of the tropical boundary layer under convective situations was particularly stressed. The Centre was further encouraged to base parametrisations on physically sound concepts. The current treatment of clouds was cited as an example of an ad hoc approach.

During the discussions of systematic model errors it was reaffirmed that the errors encountered in our forecasts are common to other models as well. However, connections to defects in parametrisation can still not be made conclusively.

A common model deficiency is to underestimate low frequency variability such as the transition to blocked states over the Pacific and North Atlantic. In this regard, it was recommended that the rôle of diabatic heating be studied by budget calculations for anomalous circulation regimes. In addition, "relaxation" experiments, in which, for example, the tropics are prescribed, should be carried out.

Overall, the workshop was very stimulating and will certainly have an impact on the Centre's future research.

- Klaus Arpe, Michael Tiedtke

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MAJOR DELAYS TO DISSEMINATION

In 1984, when it was decided to monitor the running of the operational suite, 4 categories of causes of delays to dissemination were selected: CRAY, Cyber, the operational suite itself and "other". Despite the changes made to the computer system, these categories have been retained, so that useful comparisons can be made.

The computer systems have increased both in complexity and the number of individual systems that can fail and cause delays. It is therefore very encouraging to see that, despite this, the number of major delays has reduced by more than 33% compared with 1986 and 1985 and by almost 50% compared with 1984.

Moreover, the problems causing major delays are being solved more quickly, the average delay of 2.34 hours in 1987 being an improvement on 2.53 hours in 1986, 3.84 hours in 1985 and 3.60 hours in 1984.

A histogram showing the overall number of major forecast delays is presented in Fig. 1 below. The average length of major delays is shown in Fig. 2 overleaf.

Fig. 1 Number of major forecast delays

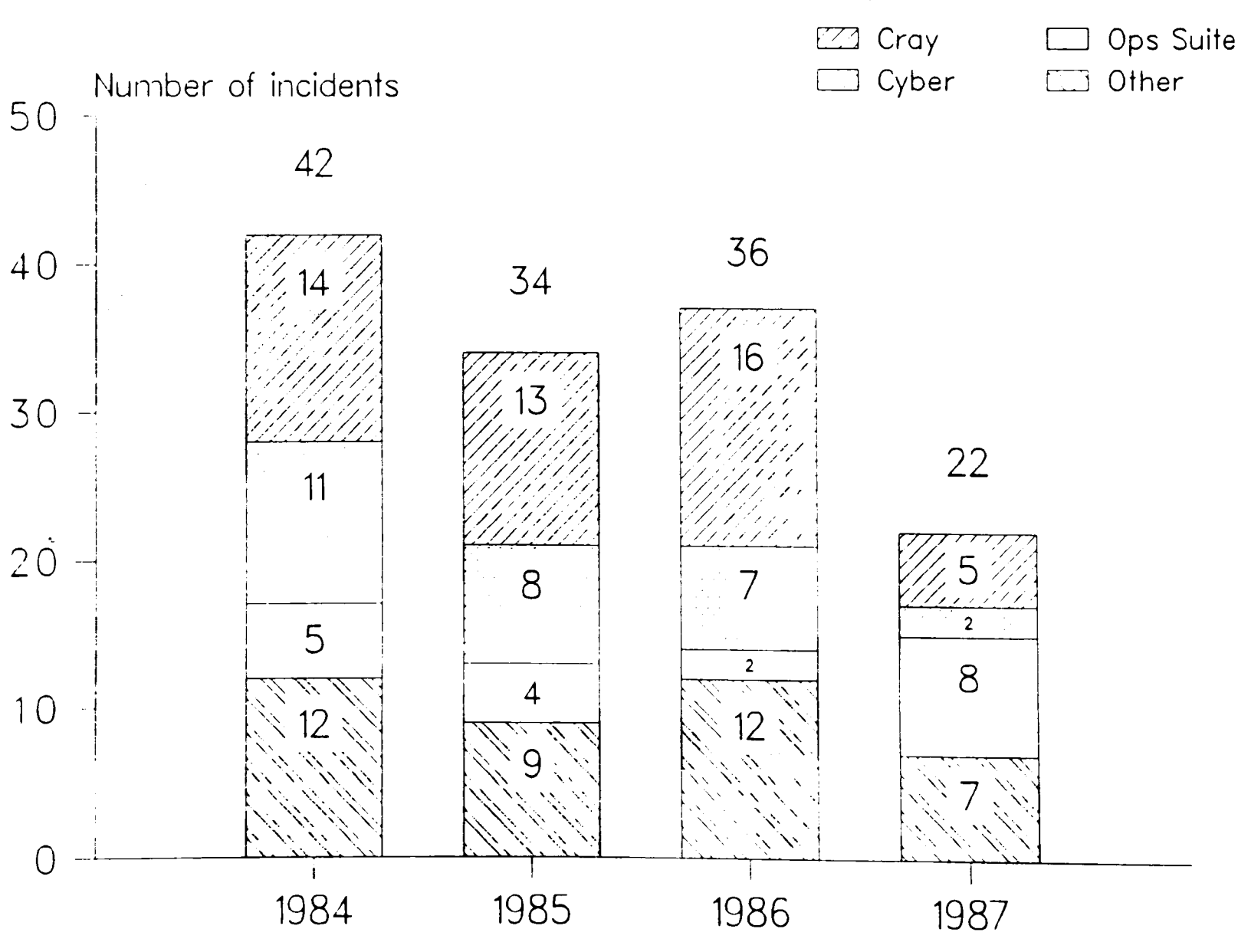
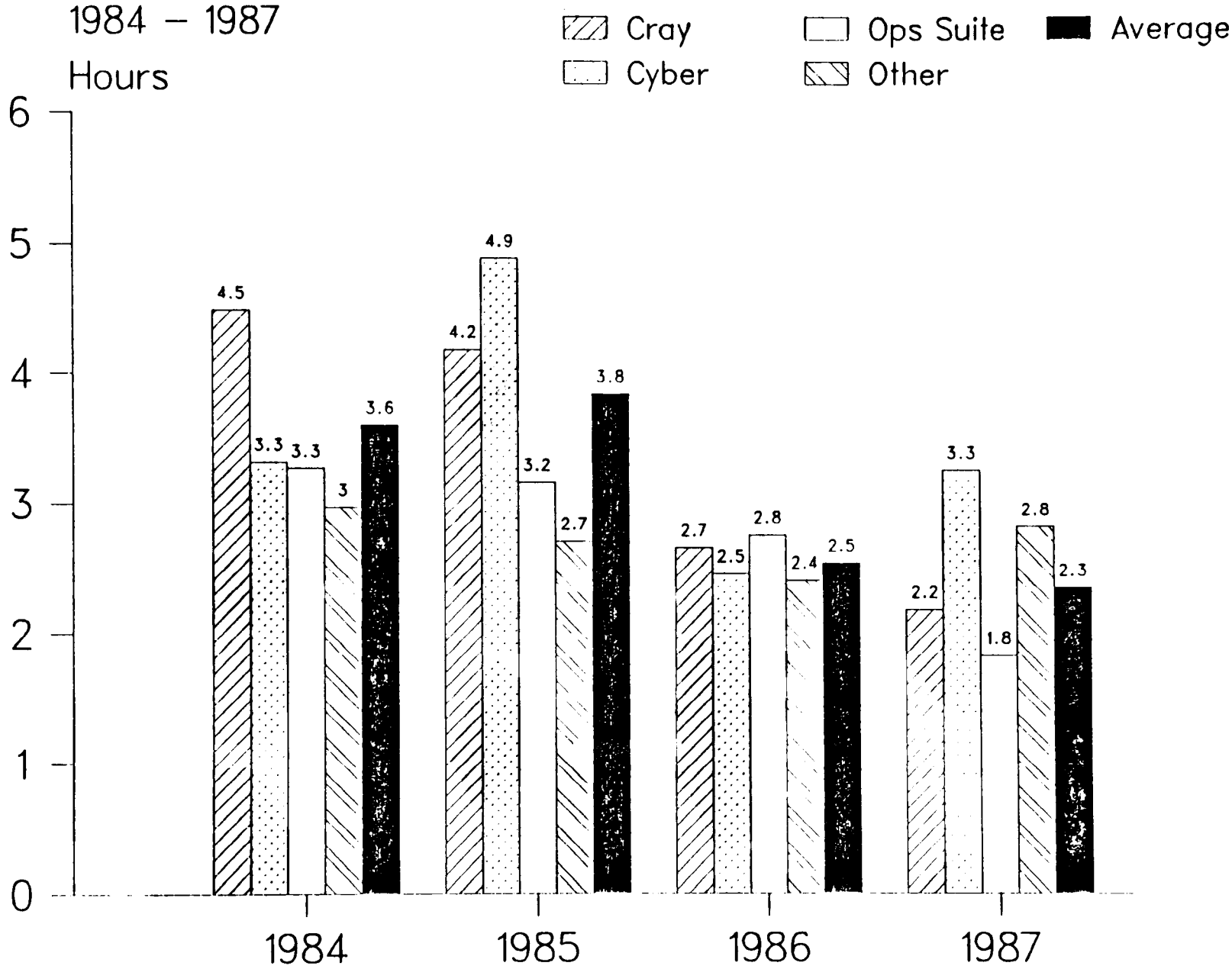


Fig. 2 Average length of major delays to the Operational Forecast
1984 – 1987



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 or republished in this Newsletter series (up to News Sheet 213). All other News Sheets are redundant and can be thrown away.

No.	Still Valid Article
16	Checkpointing and program termination
67	Attention Cyber BUFFER IN users
73	Minimum Cyber field length
89	Minimum field length for Cray jobs
93	Stranger tapes
120	Non-permanent ACQUIRE to the Cray
121	Cyber job class structure
127	(25.1.82) IMSL Library
135	Local print file size limitations
136	Care of terminals in offices
140	PURGE policy change
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
172	Change to CFT Compiler default parameter (ON=A)
176	Archival of Cyber permanent files onto IBM mass storage
178	TIDs on Cray include 2 chara. TID plus 3 chara. source computer ID. Caution with ACQUIRE on RERUN jobs
183	NEXT version of Cray ECLIB and CONVERT
186	PROCLIB changes
187	CFT 1.14. Bugfix 4 Maximum memory size for Cray jobs
189	ROUTEDF
190	Using ROUTE to direct RJE output to the Centre
194	NOS/BE level 664 Preventive maintenance schedules
197	MARSINT - subroutines for transformation from spectral to Gaussian or regular lat.-long. grid, and Gaussian to/from regular lat.-long. grid PROCLIB changes
198	Using the MOHAWK printer
201	New Cray job classes
203	Magnetic tape problems and hints on avoiding them
204	VAX disk space control
205(8/7)	Mispositioned cursor under NOS/VE full screen editor
206	MARSINT software changes
207	FORMAL changes under NOS/VE Job submission from within a Cray job, using LAUNCH
208	Restriction of Cray JCL statement length
210	ECMWF data archives
212	MFICHE command from NOS/VE
213	Changes to MARSINT software

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TABLE OF TAC REPRESENTATIVES, MEMBER STATE COMPUTING REPRESENTATIVES AND METEOROLOGICAL CONTACT POINTS

Member State	TAC Representative	Member State Computing Representative	Meteorological Contact Point
Belgium	Dr. W. Struylaert	Dr. W. Struylaert	Dr. J. Nemeghaire
Denmark	Mrs. A.M. Jørgensen	Mr. P. Henning	Dr. P. Aakjaer
Germany	Dr. R. Lamp	Dr. R. Lamp	Dr. Rüge
Spain	Mr. B. Orfila	Mr. M. Hortal	Mr. R. Font Blasco
France	Mr. M. Jarraud	Mr. S. Senesi	Mr. M. Jarraud
Greece	Mr. G. Barbounakis/ Mr. D. Katsimardos	Mr. I. Iakovou	Mr. A. Kakouros
Ireland	Mr. W.H. Wann	Mr. D. Murphy	Mr. P.M.P. MacHugh
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Netherlands	Mr. S. Kruizinga	Mr. H. van Soest	Mr. G. Haytink
Austria	Dr. G. Wihl	Dr. G. Wihl	Dr. H. Gmoser
Portugal	Mr. A.P.Da Costa Malheiro	Mr. M.J. Rodrigues de Almeida	Mrs. M.I. S.A. Barros Ferreira
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Sweden	Mr. G. Ryne	Mr. S. Orrhagen	Mr. R. Joelsson
Turkey	Mr. M. Cemil Özgül (Major Gen. Rt.)	Mr. M. Cemil Özgül (Major Gen. Rt.)	Mr. M. Cemil Özgül (Major Gen. Rt.)
United Kingdom	Dr. R. Wiley	Dr. A. Dickinson	Mr. R. M. Morris

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ECMWF CALENDAR 1988

8-9 March	40th session of the Finance Committee
14-18 March	Computer User Training Course: INTRODUCTION
21-25 March	Computer User Training Course: CRAY
25 April-17 June	Meteorological Training Course:
	Met. 1 NWP I: dynamics, numerical methods and assimilation (25 April-13 May - 3 weeks)
	Met. 2a NWP II: parametrisation (16-26 May - 2 weeks)
	Met. 2b NWP II: general circulation, systematic errors and orography (31 May - 3 June - 1 week)
	Met. 3 Use and interpretation of ECMWF products (6-17 June - 2 weeks)
4-5 May	28th session of the Council
16-18 May	Workshop on predictability
5-9 September	Seminar: "Recent developments in analysis and data assimilation"
12-14 September	16th session of the Scientific Advisory Committee
14-16 September	13th session of the Technical Advisory Committee
27-29 September	41st session of the Finance Committee
17-19 October	Workshop on surface processes
23-24 November	29th session of the Council
5-9 December	Workshop on use of parallel processors in meteorology

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THE ECMWF ANNUAL SEMINAR

5-9 September 1988

PRELIMINARY ANNOUNCEMENT

The 1988 ECMWF Seminar is entitled Data assimilation and the use of satellite data. The seminar aims to present, in a tutorial context, a rounded view of the current status of theory and practice in meteorological data assimilation, and the scientific and technical considerations involved in the use of satellite data for numerical weather prediction.

The format of the seminar will be the same as in previous years - formal lectures by invited speakers and staff from the Centre, followed by publication of the proceedings.

There will be sessions covering the following topics:

SESSION 1: Developments in operational assimilation methods

A. Hollingsworth	The theory of optimal interpolation
A. Lorenc	Iterative approximations to optimal interpolation
P. Lönnberg	Development in the ECMWF system
L. Gandin	Comprehensive quality control
P. Undén/W. Heckley	Tropical assimilation
N. Gustafsson	Methods for high resolution analysis
A. Hollingsworth	Verification of analysis

SESSION 2: Variational analysis

O. Talagrand	4-dimensional variational analysis - I
O. Talagrand	4-dimensional variational analysis - II
P. Courtier	4-dimensional variational analysis
A. Lorenc	4-dimensional non-linear O/I
J. Pailleux	Variational analysis and satellite soundings
P. Moll	Comparisons of optimal interpolation/ Kalman Bucy/4-dimensional variational analysis in a simple model

SESSION 3: Satellite data

G. Kelly	Theories of retrieval methods
L. McMillin	Physical retrievals at NESDIS
J. Eyre	Current work at UKMO
A. Chedin/J-F. Flobert	The 3-I retrieval method
J. Pailleux	Current work at ECMWF
H. Böttger	Monitoring the satellite data
K. Katsaros	Water information from SMMR-SSM/I
P. Menzel	Winds from satellites
D. Anderson	Wind scatterometers

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.

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- as new operational model	20	Apr. 83	1
- Gaussian grid and land-sea mask used	21	June 83	8
- increased resolution - studies of	38	June 87	10
- parameterisation of gravity wave drag	35	Sept.86	10
- surface and sub-surface scheme revised	38	June 87	3
- T106 high resolution version	31	Sept.85	3
- vertical resolution increased from 16 to 19 levels	34	June 86	9
Systematic errors - investigation of, by relaxation experiments	31	Sept.85	9

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* T indicates the original Technical Newsletter series

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