European Centre for Medium Range Weather Forecasts

ECMWF NEWSLETTER

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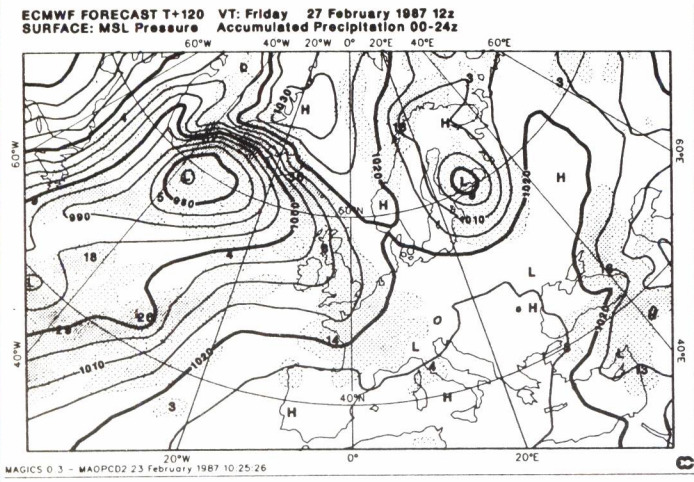
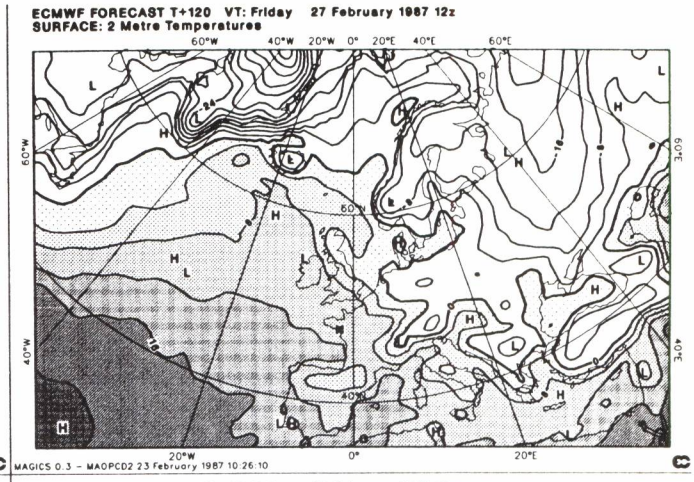
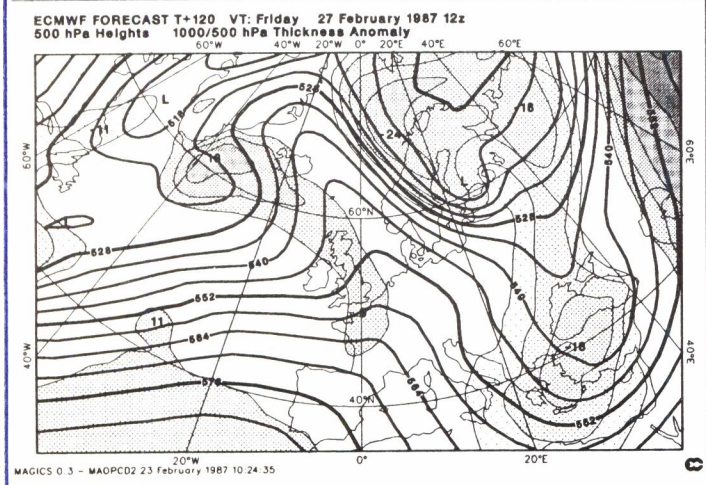
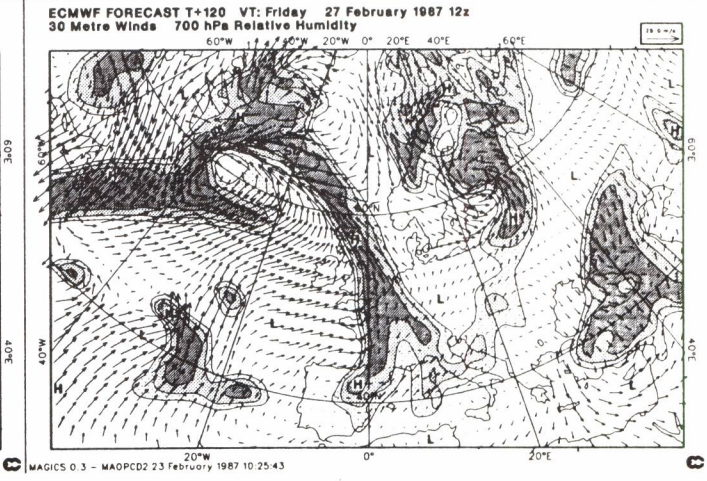
Number 37 - March 1987









IN THIS ISSUE

COVER: Top left hand diagram: mean sea level pressure together with precipitation amount;
bottom left hand diagram: 500 hPa height and 1000/500 hPa thickness anomaly (deviation from climate;
top right hand diagram: temperature at 2 m above the model surface;
bottom left hand diagram: wind at the lowest model level (30 m) and 700 hPa relative humidity.
See also the piece in the Editorial opposite.

This Newsletter is edited and produced by User Support.

The next issue will appear in June 1987.

This issue includes information on the 1987 ECMWF Meteorological Course (p. 14), for those who have not yet seen these details. There is also preliminary information on the annual seminar, which takes 'The nature and prediction of extra-tropical weather systems' as its subject this year (p. 15), and on a workshop on 'Meteorological operational systems', which will take place in December (p. 16).

An article on p. 5 continues the description of progress made in the multitasking of the operational forecasting model.

The front cover

All graphics produced at the Centre will soon be based on MAGICS (Meteorological Application Graphics Integrated Colour System).

While the presentation of model output in colour provides many advantages and allows the viewer to assimilate the results in the best and most comprehensive way, monochrome hardcopy devices will still have to provide an operational service in the future.

The Centre is now in the process of developing a new standard set of charts to display the weather forecast from the most recent operational run. An example of a set of charts for one forecast day is shown on the front cover. Shading with varying density is utilised to highlight the weather pattern and to delineate frontal structures.

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CHANGES TO THE OPERATIONAL FORECASTING SYSTEM

Recent changes

No changes having any significant impact on the performance of the ECMWF analysis and forecast system were introduced during the last three months.

Planned changes

(i) Revision of the model surface and sub-surface scheme:

- a revision of the parameterisation of the surface and sub-surface processes;
- a revision of the post-processing of near-surface parameters.

The modification of the post-processing of the near-surface parameters will have the most noticeable effect on the products from the users' point of view. A more realistic simulation of the diurnal temperature variation under clear sky conditions, during which nocturnal inversions near the surface develop, can be expected. The revised parameterisation of surface processes will lead to an improved treatment of the thermal properties of snow covered soil. The parameter most affected by the change is the near-surface temperature (T at 2 metres), although preliminary evaluations indicate that a modest but positive impact can also be expected for the 10 metre wind and the dewpoint at 2 metres. Users of these parameters may need to adjust their forecasting practices after careful local evaluation of this modification.

(ii) Two modifications to the analysis are tentatively planned for the end of the coming 3-month period:

- to make better use of satellite sounding data in agreement with the vertical resolution given by the satellite instruments;
- to increase the effective horizontal resolution of the analysis system by modifying the horizontal filtering of small scale atmospheric features.

Additional information on all these changes will be provided in forthcoming Newsletter articles.

- Horst Böttger

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SEMINAR AND WORKSHOP
ON
OBSERVATION, THEORY AND MODELLING OF OROGRAPHIC EFFECTS
15-20 SEPTEMBER 1986

ECMWF holds an annual scientific seminar to provide participants with both a review and a picture of some recent research relating to a topic of importance for numerical weather prediction. The Centre also organises regular workshops to assess the current state of knowledge on topics of direct relevance to its objectives and to provide guidance to its programme of research.

A seminar on The Observation, Theory and Modelling of Orographic Effects was held at the Centre from 15-19 September 1986. The speakers at the seminar reviewed the fundamental rôle of orography on a variety of scales and the presentations focused on current ideas on how to represent orography in numerical models of the atmosphere. There were sessions on:

- The influence of orography on the large-scale
- Orographically induced cyclogenesis
- Barrier effects
- Mountain waves
- The representation of orography in large-scale forecasting models.

Following on from the seminar, many of the lecturers stayed at the Centre for a 1½-day (19-20 September 1986) workshop to discuss lines of research in modelling orography.

The workshop reviewed four main topics:

- the general development of the last 10 years
- parameterisation of the effects of sub grid-scale orographic variations
- use of observations and very fine scale models to verify the representation of local processes in larger scale models
- diagnosis of the performance of models on larger time and space scales - implications for the representation of orography.

Over the last ten years there has been a marked shift in the perception of the rôle of mountains in the general circulation and of their importance for numerical weather prediction. Ten years ago many operational models were running with crude representations of mountains, little was known about the structure of the errors of forecast models, climate drift was not widely perceived as a central problem for general circulation modelling and theoretical studies of the rôle of mountains still focused on their rôle in forcing the climatological stationary waves.

The ALPEX programme stimulated much progress in theory, modelling, and understanding of the synoptic and subsynoptic scales. We have a much deeper appreciation of the effects of the mountains on cyclogenesis and of the rôle of transients in maintaining long-lived phenomena like blocks. The theory of multiple equilibria has also brought the importance of mountains to the fore. The symptoms of climate drift have been extensively documented for many models. Observational and modelling studies on the generation and radiation of Rossby waves, along with all the other developments, have changed the whole approach of modellers to the diagnosis of model errors.

Progress continues apace, spurred by the availability of extensive global and regional sets of observational and analysed data, by the massive increases in the power and sophistication of models, and by the excitement arising from the yet unexploited potential of these resources.

The representation of orography has undergone considerable development over the last ten years. Realistic high resolution data sets, such as the 16 km resolution US Navy data set, are used to provide grid-scale orography and sub grid-scale statistics. The effect of sub grid-scale variations is currently being represented by envelope prescriptions, some sort of enhancement of orography above grid-scale mean values and/or parameterisations of gravity wave drag.

A great deal of the workshop discussions centred around the problem of validating parameterisation schemes using data from special experiments, results from high resolution models and diagnosis of short-range forecast errors and climate simulations.

The seminar and workshop proceedings will be published in the summer of 1987 and many of the workshop recommendations will be of relevance for centres involved in research connected with orography.

- David Burridge, Adrian Simmons

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THE MULTITASKING MODEL - PART 3

Introduction

Since the publication of part 2 of this occasional series (March 1986), there have been several changes to the production spectral model, some meteorological and some technical. These are first summarised and then the performance of the current version is presented. Finally, some multitasking development, aimed at reducing known inefficiencies and increasing flexibility is described.

Model changes

13 May 1986: Vertical resolution increased to 19 levels.

15 July 1986: Gravity wave drag parameterisation introduced.

March 1987: Revision of surface parameterisation to include vegetation
Reorganisation of mask and zonal mean diagnostics
Additional post-processing field options
Reduced space requirement for grid point work file
Provision for MARS archiving via Fields Data Base

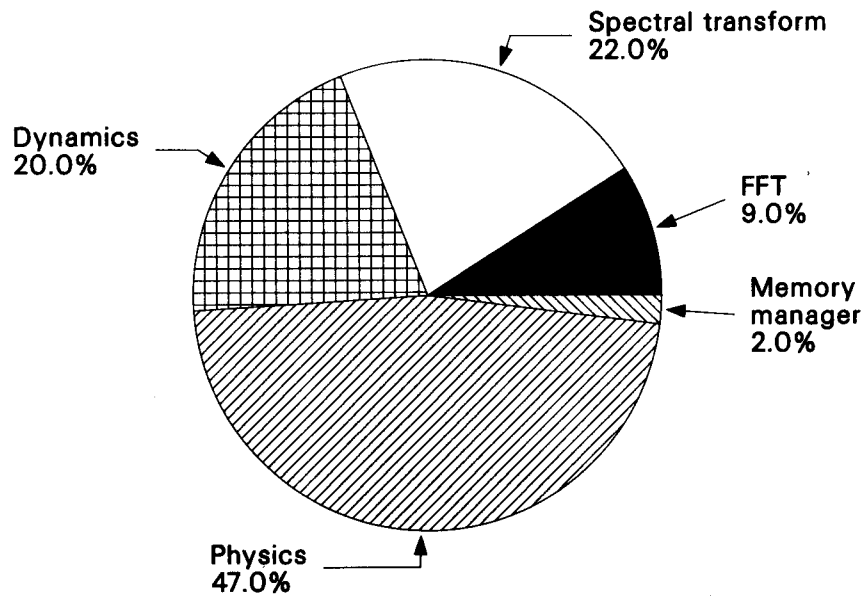
Current performance

The changes introduced in 1986 increased the floating point operation count, with the result that the hardware performance monitor now measures the following rates:

execution rate	= 335 Megaflops/sec
vectorisation	= 99% of all floating point operations
multitasking efficiency	= 3.6 (speed up over one processor)

The share of computation between various components of the model is shown in figure 1.

Fig. 1: Relative costs of various components of the spectral model

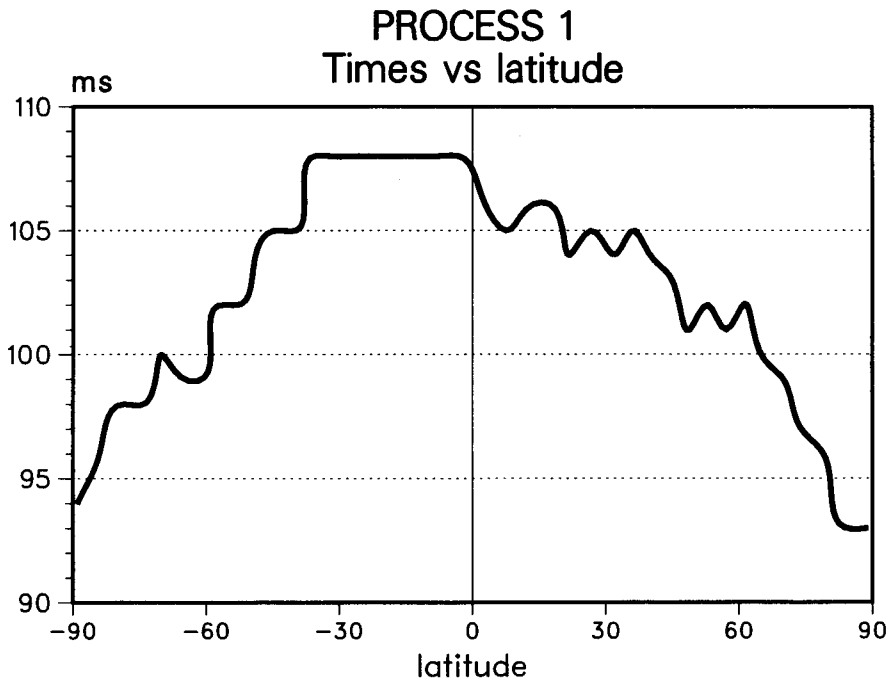


Known variations in the time to process different lines of latitude have been further examined and are depicted in figure 2. These measurements support the assumption that most of the variation is due to the parameterisation of convection. Clearly, these measurements were made on a winter case (easy exercise for the reader!).

"Time stamps" placed at appropriate points in the code allow specific inefficiencies to be measured. These are presented in figure 3 overleaf, where

out of balance	= waste due to differing task sizes
reproducibility	= delays due to forcing a set order of computation
MT overheads	= cost of starting tasks and lock control
single-tasked	= code not yet multitasked

Fig. 2: Variations in the time to process different lines of latitude



Revised multitasking strategy

As mentioned in the previous Newsletter article, additional main memory in the Cray X-MP/48 allows a dynamic strategy to be considered. The motivation for this is to:

(a) reduce out of balance losses

(b) increase flexibility (so that the model will run with any number of processors)

(c) improve multitasking efficiency (by reducing the number of tasks).

The revised strategy for scan 1 of the model is illustrated in figure 4. Each task is given a unique row number to process. This identifies a north-south pair of latitude rows which are dealt with sequentially by the task. Memory requirements increase by about 150 Kwords, since a Fourier workfile record must be in memory for each task instead of one for each pair of tasks. However, no synchronisation point is necessary after each north-south pair is completed, and the only interaction between tasks is the mechanism to retain reproducible results using EVENTS. This is achieved in a similar way to the current method, that is, using EVENT control to introduce logic, which forces the Legendre transforms to be executed in a predetermined order, but with some refinement to minimise the waste. Task synchronisation is only necessary when the scan is complete. Therefore, out of balance waste occurs only as each processor finishes its last row and becomes idle.

To complement this dynamic strategy, a revised I/O scheme is necessary and this has been done so that the Cray queued I/O (QIO) package can be utilised. The advantage offered is a reduced system overhead in processing I/O requests, providing that new requests can be made before the current request has completed. Therefore, the revised I/O scheme always tries to fill all available buffer space by initiating as many requests as possible simultaneously. It also offers the capability of accessing the data belonging to neighbouring rows (to the north and south) for research purposes. With further increases in model resolution, this may be important for physical parameterisation processes.

This revised multitasking strategy has been developed and tested but awaits the implementation of COS 1.15 on the Cray to allow satisfactory use of QIO. Initial timings suggest that much of the out of balance waste has been removed and task overheads reduced. It is planned to introduce the scheme into the production model in the next few months.

Further plans

Several technical developments aimed at increasing the flexibility and efficiency of history generation will soon be implemented. Post-processing from within the model code is already working for an experimental limited area version of the model. When available for general use, it will reduce I/O delays and allow more frequent creation of archive data. For example, selected fields may be archived every timestep during the early part of an integration, allowing closer study of the spin-up problem. Similarly, diagnostic data for limited areas (mask diagnostics) may be generated at any desired frequency.

Fig. 3: Efficiency of the multitasking operational model

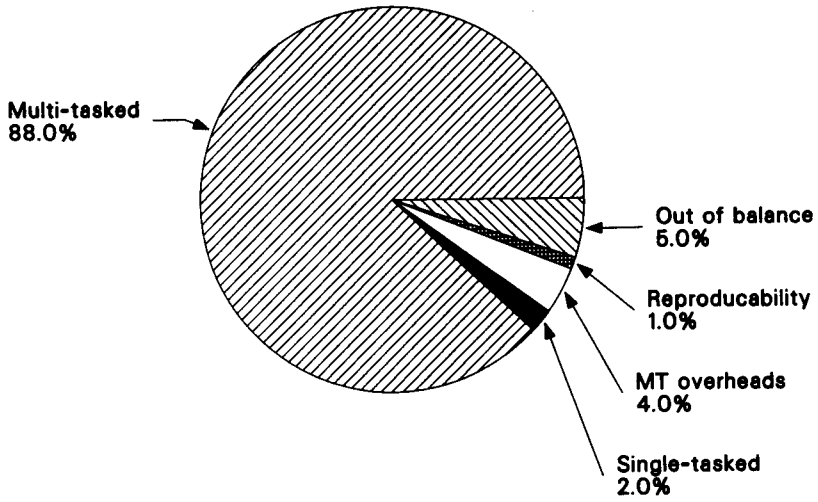
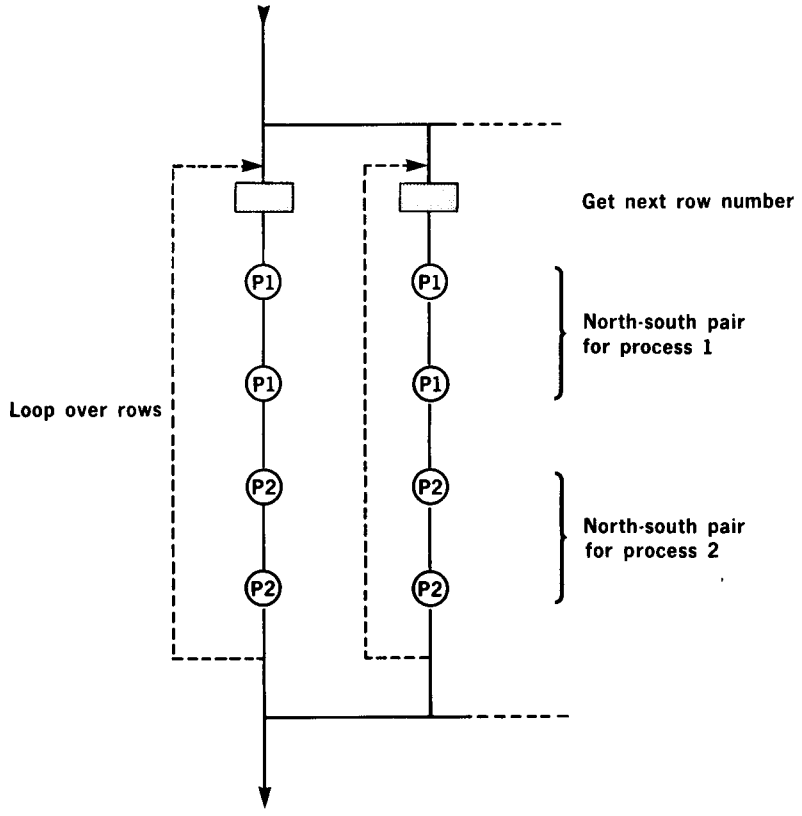


Fig. 4: Dynamic multitasking strategy for scan 1



In the area of multitasking, the complementary use of microtasking will be investigated. Microtasking is normally applied at a low level in comparison to multi or MACRO tasking. The possibility of using the microtasking technique underneath the existing macrotasking allows relevant parts of the code to make use of idle processors if they are available. This is particularly attractive for the direct Legendre transform, since it is during the execution of this code that processors are forced to become idle, awaiting the completion of the Legendre transform in the interests of reproducibility. Also, the same code executes at the end of scan 1 during the out of balance phase. If microtasking can be used to accelerate the calculation of the Legendre transforms in these circumstances, both reproducibility and out of balance inefficiencies will be further reduced.

- David Dent

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COMPUTER RESOURCE ALLOCATION TO MEMBER STATES IN 1987

At its twenty-fourth session Council approved the allocation of computer resources to Member States for 1987 as shown below. These allocations came into effect on Monday, 29 December 1986.

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	405	29	2.2
Denmark	324	23	1.8
Germany	1663	118	9.1
Spain	593	42	3.2
France	1700	99	7.7
Greece	286	20	1.6
Ireland	200	17	1.3
Italy	300	65	5.2
Yugoslavia	119	21	1.9
Netherlands	500	36	2.8
Austria	260	24	1.9
Portugal	100	18	1.4
Switzerland	412	29	2.3
Finland	300	21	1.7
Sweden	430	30	2.3
Turkey	200	23	1.8
UK	1224	87	6.7
TOTAL	9016	702	54.9
Special Projects*	402	78	6.1
OVERALL TOTAL	9418	780	61.0

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

SPECIAL PROJECTS 1987

Member State(s)	Institution undertaking the project	Project Title	Resource allocations for 1987		
			Cray Kunits	Cyber Kunits	On-line Storage Mwords
Continuation Projects					
Germany	Institute for Geophysics and Meteorology, Cologne	Interpretation and calculation of energy budgets	7	10.8	0.1
	Max Planck Institute for Meteorology, Hamburg	Further development of a third generation global wave model	20	3.2	0
	Fraunhofer Institut für Atmosphärische Umweltforschung	Container Project	5	3.2	0.7
France	Laboratory of Atmospheric Optics, University of Science and Technology, Lille	Intercomparison of radiation codes in the ECMWF model	20	3.2	0.2
Netherlands	KNMI	Testing and evaluation of a third generation ocean wave model at ECMWF	150	19	3.5
United Kingdom	Imperial College of Science and Technology, London	A North Atlantic Ocean circulation model for WOCE observing system simulation studies	75	15.8	0.2
	University of Reading	Normal modes of 3-D atmospheric flow	20	3.2	0.35
	Meteorological Office	Model intercomparison project	20	2.5	0.35
New projects					
Germany	Institute for Geophysics and Meteorology, Cologne	Parameterisation of radiation and clouds for use in general circulation models	10	10.8	0.35
United Kingdom	Department of Applied Mathematics and Theoretical Physics, University of Cambridge	Dynamical studies using isentropic potential vorticity and high resolution baroclinic models of the stratosphere	75	6.3	0.35
		TOTAL REQUESTED	402	78	6.1
		AMOUNT AVAILABLE	1000	78	6.1

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 199). 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
166	Corrections to the Contouring Package
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
183	NEXT version of Cray ECLIB and CONVERT DAYFILE/DAYFIL commands
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

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THE METEOROLOGICAL TRAINING COURSE, 27 APRIL - 19 JUNE 1987

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

The course is divided into three modules:

Met1 : Numerical weather prediction I
Dynamical meteorology, data assimilation, numerical methods and adiabatic formulation of models (27 April - 15 May 1987).

Met2A: Numerical weather prediction II
General circulation, systematic model errors and orography (18 - 21 May 1987).

Met2B: Numerical weather prediction II
Parameterisation of diabatic processes (25 May - 5 June 1987)

Met3 : Use and interpretation of ECMWF products (8 - 19 June 1987)

Modules Met1 and Met2 will be of most interest to scientists who are involved in the development of numerical models for operational forecasting or research. Module 3 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 modules. However, those attending only Met2 are expected to have a good knowledge of the topics covered in Met1. The module Met2A is a transition module which, though a good introduction to module Met2B, is not a prerequisite for module Met2B and may be taken alone or with Met1. Attendance at the other modules is not a requirement for participation in Met3.

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.

Application forms and booklets have been sent to the meteorological services of Member States and many universities and institutions. If you do not access to one of these, copies can be obtained from Els Kooij-Connally at ECMWF.

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.

- David Burridge

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THE E C M W F ANNUAL SEMINAR
7-11 September 1987

PRELIMINARY ANNOUNCEMENT

The subject of the 1987 seminar will be The nature and prediction of extra-tropical weather systems. The objective of the seminar is to give an up-to-date picture of the theory, the predictability and the prediction of cyclone development and blocking. It is intended that the presentations should include discussions of the rôle of extra-tropical cyclones in forcing low frequency components and "changes in flow regime".

The format of the seminar will be similar to that of previous years - presentations by invited speakers and ECMWF staff, followed by the publication of their presentations in the proceedings of the seminar.

Sessions will cover the following topics:

	Lecturers
Synoptic studies	R. Dole R. Reed L. Bosart H. Böttger
Theory	B. Hoskins R. Sadourny B. Legras A. Speranza M. McIntyre
Diagnostic studies	H.-D. Schilling L. Uccellini L. Bosart P. Sardeshmukh
Modelling/Prediction	L. Bengtsson S. Tibaldi A. Simmons J.-F. Geleyn B. Machenhauer

The seminar forms part of the educational programme of the Centre and should be of particular benefit to young scientists in the Member States. The distribution of the final announcement and registration forms will be made in May.

- David Burridge

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Planned Workshop on Meteorological Operational Systems

ECMWF plans to hold a workshop on Meteorological Operational Systems at Shinfield Park, 7-11 December 1987.

1. Rationale

During the last decade significant progress has been made in the fields of numerical weather prediction and the analysis and assimilation of meteorological data. To obtain maximum benefit from such progress it is essential that the numerical models be supported by effective operational systems to generate, pre-process, post-process, monitor and display the data. This workshop will examine these support functions, focussing on three principle aspects - data management, data availability and quality, and graphical presentation of meteorological data. Topics will be discussed in the context of their relevance to the World Weather Watch (WWW) long term plan. Emphasis will be given to systems appropriate for the support of meteorological centres using supercomputers for global modelling. Nevertheless, it is anticipated that many of the systems presented will be of general interest and could provide a basis for future co-ordination and co-operation.

2. Data Management

Without sufficient observational data of acceptable quality, numerical prediction cannot produce acceptable results. The workshop will examine WWW data management plans, then look in some detail into the systems for management of meteorological data in use or being developed at various centres. Topics will include pre-processing, post-processing and archiving, and aspects of data representation and storage will be covered.

3. Data Availability and Quality

The data requirements for global numerical forecasting will be discussed and compared with current data availability. The present observational network and the exchange of the data over the Global Telecommunication System exhibit many

deficiencies which need to be addressed. Global monitoring systems provide the means to detect data problems both in the long term and in real time, if a sudden degradation in the data quality occurs. The monitoring systems and results will be presented and the ways of an efficient exchange of monitoring results will be discussed.

4. Graphical Presentation of Meteorological Data

Modern supercomputers can handle and produce data at rates beyond human comprehension. Thus it is essential to isolate significant data properties and depict them in a readily recognisable form. Graphical techniques must be developed to enable meteorologists to comprehend their data and understand the mechanisms at work within their models; without such understanding further progress is not possible. The use of colour and of animation is contributing considerably to the scientific evaluation of model performance. Presentations and demonstrations will be given indicating the current state of the art with respect to graphical presentation and suggesting the course of future developments.

- Daniel Söderman

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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	Mr. H. Voldborg
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
Italy	Dr. C. Finizio	Dr. S. Pasquini	Dr. M. Conte
Yugoslavia	Mr. M. Jovasević	Mr. M. Gavrilov	Mr. S. Nickoviċ
Netherlands	Mr. S. Kruizinga	Mr. R.J. Hoogendoorn	Mr. D. Heijboer
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
Switzerland	Mr. M. Haug	Mr. G. Siegwart	Mr. M. Schönbächler
Finland	Dr. M. Alestalo	Mr. T. Hopeakoski	Mr. P. Kukkonen
Sweden	Mr. B. Hellroth	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	Mr. D.H. Johnson	Dr. A. Dickinson	Mr. R. M. Morris

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ECMWF CALENDAR 1987

18-19 March	38th session of the Finance Committee
23-27 March	Computer User Training Course: INTRODUCTION
30 March-3 April	Computer User Training Course: CRAY
27 April-19 June	Meteorological Training Course: (see article on p. 14)
11-12 June	25th session of the Council
7-11 September	Seminar: "The nature and prediction of extra-tropical weather systems" (see article on p. 15)
14-16 September	15th session of the Scientific Advisory Committee
16-18 September	12th session of the Technical Advisory Committee
29 September-1 October	39th session of the Finance Committee
2-4 November	Workshop on Numerical Methods
25-26 November	26th session of the Council
30 November-2 December	Workshop on Diabatic Forcing
7-11 December	Workshop on Meteorological Operational Systems (see article on p. 16)

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ECMWF PUBLICATIONS

ECMWF Long-term Strategy 1987-1996

Medium-range Weather Forecasts - The First 10 Years	Proceedings of a seminar to commemorate the 10th anniversary of ECMWF, 22 November 1985
TECHNICAL MEMORANDUM NO. 128:	Objective analysis for numerical weather prediction
TECHNICAL MEMORANDUM NO. 129:	Report on a trial production of ECMWF forecasts based on 00z data, 10 September-30 November 1986
TECHNICAL MEMORANDUM NO. 130:	Systematic errors in surface and upper lows in the ECMWF operational spectral model (T106) during winter 1985/86 compared with corresponding errors in the T63 model
TECHNICAL REPORT NO. 59:	Diabatic non-linear normal mode initialisation for a spectral model with a hybrid vertical co-ordinate

FORECAST REPORT NO. 35 (JUNE/AUGUST 1986)

FORECAST AND VERIFICATION CHARTS: Up to 31 December 1986

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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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*T indicates the original Technical Newsletter series

USEFUL NAMES AND 'PHONE NUMBERS WITHIN ECMWF

			Room*	Ext.**
Director	-	Lennart Bengtsson	OB 202	200
Head of Operations Department	-	Daniel Söderman	OB 010A	373
ADVISORY OFFICE - Open 9-12, 14-17 daily Other methods of quick contact: - Telex (No. 847908) - Telefax (No. 869450) - COMFILE (See Bulletin B1.5/1)			CB Hall	309
Computer Division Head	-	Geerd Hoffmann	OB 009A	340/342
Communications & Graphics Section Head	-	Peter Gray	OB 227	448
COMPUTER OPERATIONS				
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Reception Counter) Tape Requests)	-	Jane Robinson	CB Hall	332
Terminal Queries	-	Norman Wiggins	CB 028	454
Operations Section Head	-	Bruno Baumers	CB 023	351
Deputy Ops. Section Head	-	Graham Holt	CB 024	306
DOCUMENTATION	-	Pam Prior	OB 016	355
Distribution	-	Els Kooij-Connally	OB 316	422
Libraries (ECMWF, NAG, CERN, etc.)	-	John Greenaway	OB 017	354
METEOROLOGICAL DIVISION				
Division Head	-		OB 008	343
Applications Section Head	-	Rex Gibson	OB 101	369
Operations Section Head	-	Horst Böttger	OB 004	347
Meteorological Analysts	-	Taskin Tuna	OB 005	346
	-	Alan Radford	OB 006	345
	-	Liam Campbell	OB 003	348
Meteorological Operations Room	-		CB Hall	328/443
REGISTRATION				
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Intercom & Section Identifiers	-	Jane Robinson	CB Hall	332
Operating Systems Section Head	-	Claus Hilberg	CB 133	323
Telecommunications Fault Reporting	-	Graham Holt	CB 024	306
User Support Section Head	-	Andrew Lea	OB 018	353
RESEARCH DEPARTMENT				
Head of Research Department	-	David Burridge	OB 119A	399
Computer Coordinator	-	David Dent	OB 123	387

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* CB - Computer Block
OB - Office Block

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