European Centre for Medium Range Weather Forecasts

ECMWF NEWSLETTER

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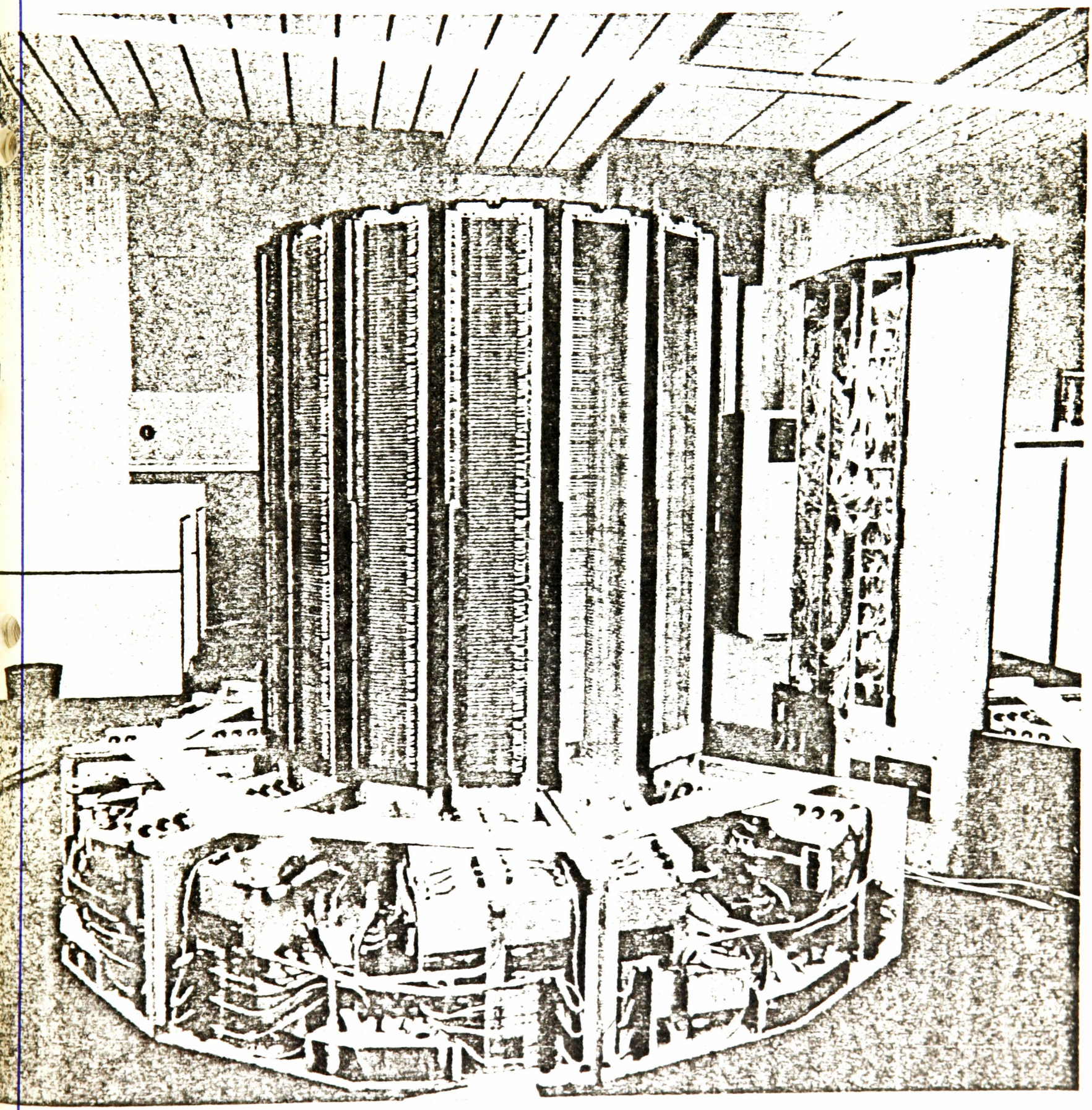

A METRIC CAMERA EXPERIMENT IN SPACE

On 28 November the space shuttle was launched from Cape Kennedy in Florida. On board the shuttle there were besides 4 astronauts, 2 scientists and a laboratory for various experiments in, for instance, astronomy, medicine and earth observation studies. The European-built space laboratory, provided by the European Space Agency, is equipped with a high resolution metric camera which was flown as part of the earth observation programme payload.

The application of metric cameras in space, an area which has been neglected up to now, can effectively contribute to an improved cartographic coverage of the earth. The Metric Camera Experiment was the first step towards filling this gap. The lack of maps of scales between 1:50000 and 1:250,000 is particularly evident in developing countries in Africa, South America and parts of Asia but map revision and updating is also needed in populated and developed areas of the world.

The selected camera is a modified aerial survey camera (of the type ZEISS RMKA 30/23) using a film format of 23 cm by 23 cm and is expected to provide imagery at a ground resolution of 20 to 30 m. For stereoscopic evaluation, the photographs will be taken with 60% overlap, and by aerial triangulation a planimetric position accuracy of ± 5 to 10m and an elevation accuracy of ± 20 to 35m can be expected.

These high resolution images might potentially be useful to other disciplines, e.g. geology, land use, agriculture, oceanography and perhaps to meteorology.

The whole Spacelab Mission will have taken 9 days, of which approximately 36 hours are planned for earth observations. A limiting factor for space photography is the illumination conditions. The selected films, black/white and colour infrared, can only be properly exposed when the sun elevation is greater than 15°.

Owing to the limited amount of film carried, only 2/3 of the operational opportunities can actually be used during the mission. In total, an area of 15.5 million square kilometres will be photographed during the mission. A final selection of the preprogrammed operation cycles will be made by ground control and will be based on global weather information. This is where ECMWF has a role to play. The final decision as to which cycles to use or delete will be made about 12 hours ahead of each pass. The images obtained by this experiment will be available for unrestricted distribution by purchase from DFVLR (Deutsche Forschungs-und Versuchsanstalt für Luft-und Raumfahrt) and an image catalogue will be issued by ESA after the mission.

Cloud cover forecasts along the flight paths of Spacelab were issued by ECMWF to the ground control in Houston, Texas once per day as soon as they were available, in the early hours of the morning. These were sent by facsimile and were constantly reviewed and updated by a meteorologist at the Centre via telephone, based on the latest available information, e.g. Meteosat images and surface observations. Recently established systematic errors in ECMWF forecasts were also corrected prior to dissemination.

The forecast information was disseminated in the format shown in Fig.1 where the numbers indicate the cloudiness in oktas for defined points along the flight paths numbered 1 to 29. Dates and times of the flights to which those forecasts apply, are also indicated.

Fig.2 gives an example of forecast clouds with flight paths over Europe on that day. Flights 20, 27, 28, 30 and 31 were originally intended to cover flight paths over areas in the north where, owing to the delay in the shuttle's take-off (from 28th September to 28th November), light conditions are now inadequate for photography. Some of the other tracks have been extended in their stead.

- Ove Åkesson

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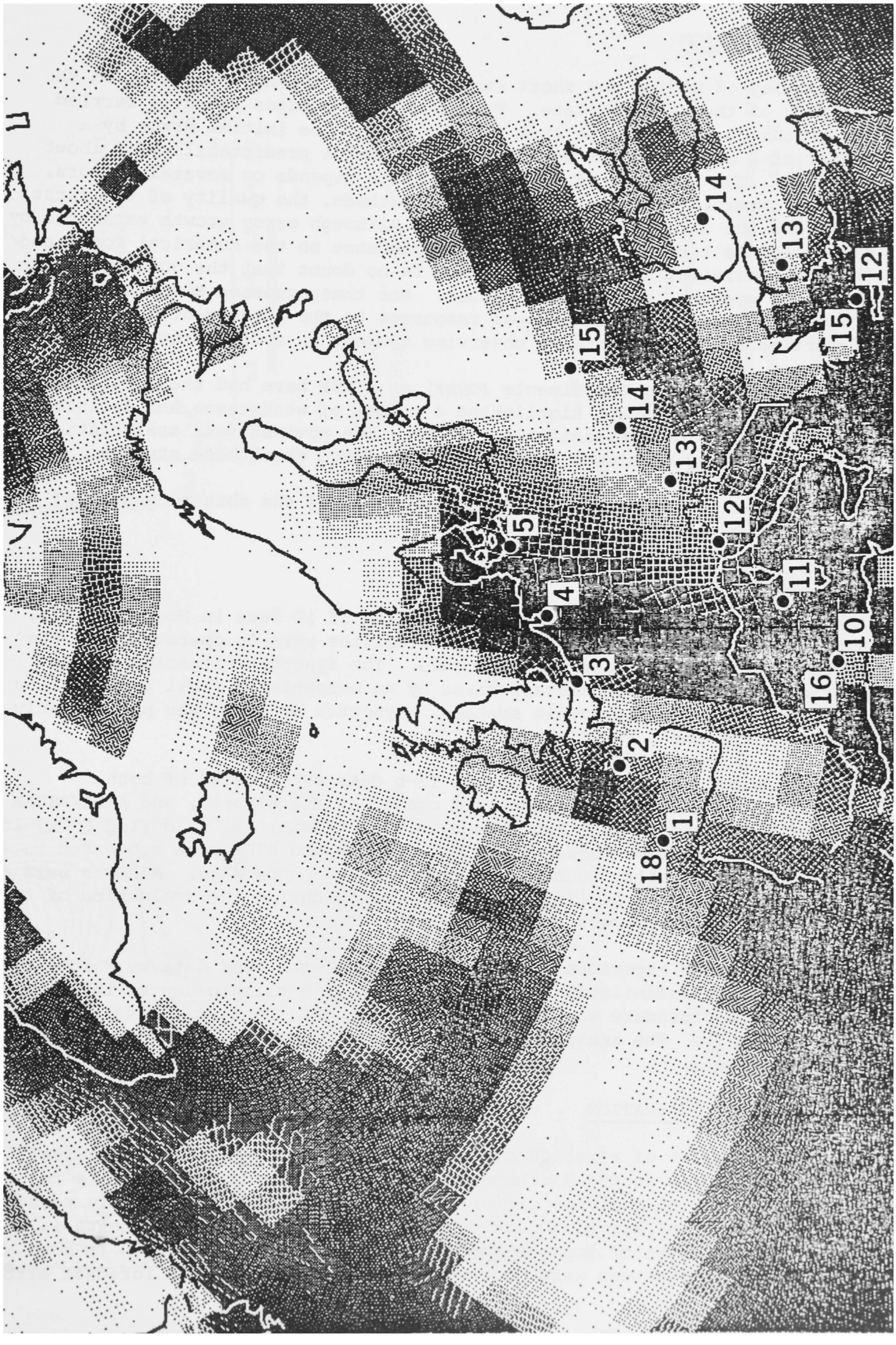
ECMWF CLOUD FORECAST (OKTA) FROM 29

1	2	3.33	0. 1. 6. 5. 7. 1. 0.
2	2	5. 0	0. 0. 0. 0. 1. 5. 4. 2.
3	2	6.22	1. 2. 6. 8. 5. 8. 5. 7. 1. 4. 5. 0. 0. 0. 1. 0. 0. 0. 3. 1.
4	2	7.57	4. 7. 5. 2. 4. 1. 0. 0. 1. 3. 0. 6. 8.
5	2	9.25	2. 0. 0. 0. 0. 0.
6	2	10.45	7. 6. 1. 5. 1. 2. 6. 4. 1.
7	2	11. 6	8. 1. 0. 0. 2. 6.
8	2	12.18	0. 0. 5. 5. 6. 4. 7. 8. 7. 1.
9	2	12.37	8. 3.
10	2	13.51	5. 6.
11	2	15.27	3. 6. 3. 7. 6. 6. 5. 7. 8. 8. 7. 4. 8.
12	3	3.23	8. 8. 3.
13	3	4.44	3. 3. 8. 5. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 3. 2.
14	3	6.13	1. 7. 8. 8. 3. 8. 8. 2. 3. 2. 0. 0. 2. 2. 1. 0. 3. 0. 0.
15	3	7.47	3. 6. 6. 2. 1. 1. 0. 2. 2. 0. 1. 0. 6. 8.
16	3	9.19	0. 0. 0. 0. 0. 0. 0. 3. 0. 1. 0. 1. 4. 6. 6.
17	3	10.35	4. 1. 5. 5. 4. 5. 1.
18	3	10.55	4. 3. 5. 0. 1.
19	3	12. 7	0. 0. 0. 8. 5. 7. 8. 8. 7. 1. 0.
21	3	15.17	3. 1. 4. 4. 8. 8. 8. 8. 7. 7. 6. 8. 8.
22	5	4.28	0. 0. 0. 0. 0.
23	5	5.54	8. 4. 1. 1. 2. 1. 2. 5. 7. 8. 8.
24	5	7.25	7. 4. 2. 2. 1. 0. 0. 0. 1. 0. 1. 6. 8.
25	5	8.57	0. 0. 0. 0. 0. 0. 0. 2. 0. 1. 4. 6. 7. 5.
26	5	10.31	1. 1. 1. 8.
29	5	13.20	4. 0. 3.

Fig. 1


ECMWF 83/11/29. FORECAST D+4
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OBSERVING SYSTEM EXPERIMENTS - THE IMPACT OF AIRCRAFT DATA

1. INTRODUCTION

The quality of medium and short range forecasts depends crucially on the accuracy of the initial state. Predictability studies recently carried out at the Centre indicate that a reduction of the initial error by a factor of 2 could lead to an extension of useful predictability of about two days. The accuracy of the initial state depends on several factors, such as observing systems, the analysis methods, the quality of the first guess and the data assimilation method. Although error growth estimates by simple models indicate a substantial dependence on the numerical model and the data assimilation frequency, there is no doubt that the quality of the observing systems is a crucial factor. For these reasons ECMWF has devoted substantial computer and manpower resources to the assessment of the impact of particular observations or observing systems on medium-range prediction.

The Observing System Experiments (OSEs) at ECMWF have had the additional advantage that they have highlighted a number of weaknesses and deficiencies in the Centre's data assimilation system. The revised data assimilation scheme now being developed has clearly benefited from these studies.

This article is concerned with just one aspect of the observing system: the impact of aircraft data.

2. THE EXPERIMENTS

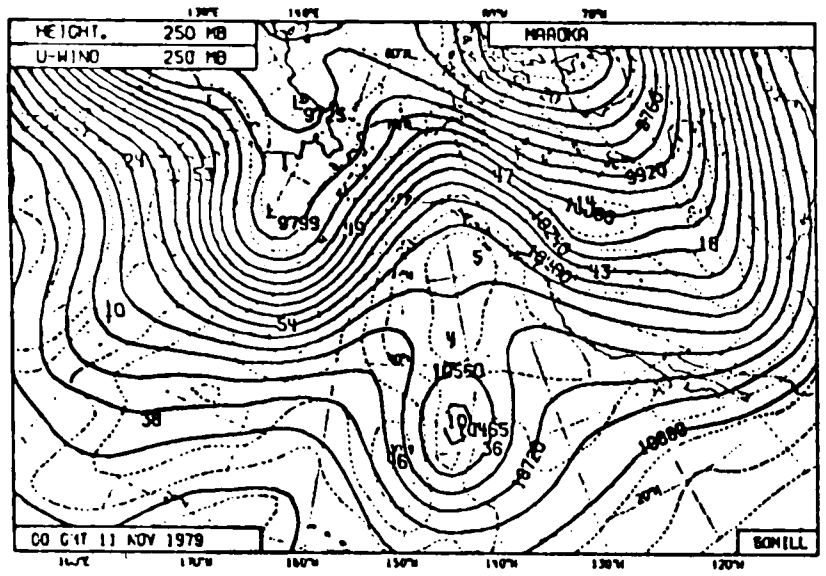
The experiments used FGGE data from a period of 10 days in November 1979. During this period, 2 polar orbiting satellites were in operation and the coverage of aircraft data was very good. The synoptic situation at the Northern Hemisphere was characterised by an essentially zonal type of flow with very active medium-scale systems. Synoptic activity was particularly high over the North Pacific region.

Aircraft wind data in the FGGE level II-b data set consist of both conventional AIREP data, transmitted orally by the aircrew, and AIDS/ASDAR data, transmitted in real time via satellite (ASDAR) or, as during FGGE, in delayed mode via tape cassettes (AIDS). ASDAR and AIDS were subjected to a careful manual quality control to eliminate erroneous data. AIREP's were not subjected to further quality control, although during the evaluation of the experiments many apparent errors were spotted.

In the reference experiment (experiment A), all the FGGE data were included and 11 days of assimilation were carried out with climatology as the first guess. This procedure was then repeated with all the aircraft data omitted (experiment B). The analyses and forecasts from experiments A and B were then compared.

3. SYNOPTIC EVALUATION

A positive impact of aircraft data on the forecasts was found on several synoptic features in the Northern Hemisphere. Often it was possible to trace this back to analysis differences over the oceans, apparently related to the presence of aircraft data. In particular, small improvements in the phase and the shape of troughs and ridges at 250 mb were found. In most cases these differences were, however, small compared to the forecast errors.



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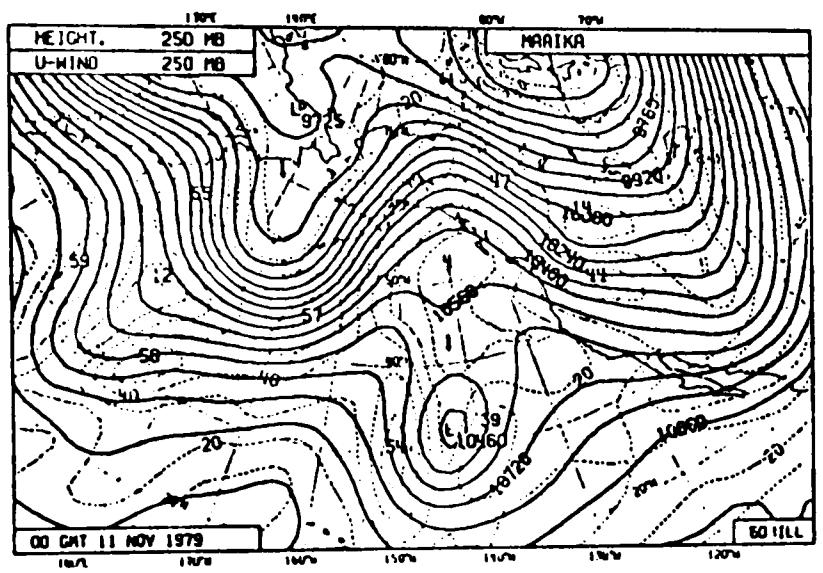
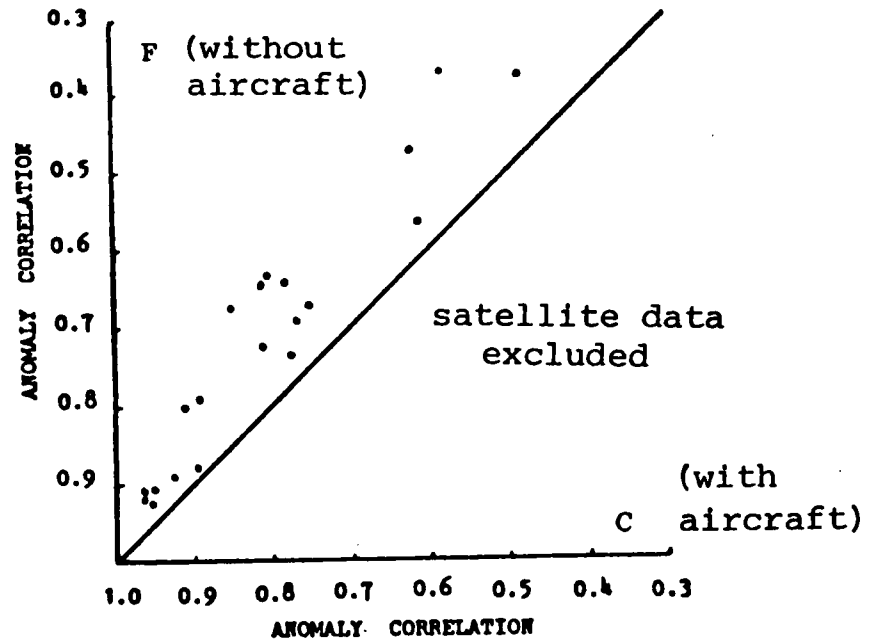


A

Fig. 1 Analysis of 250mb height and isotachs of 11 November 1979 00Z over the Pacific. Lower panel: with aircraft data (experiment A). Upper panel: without aircraft data (experiment B). Full lines: isohypses, interval 80m; dashed lines: isotachs, interval 10 m/s.



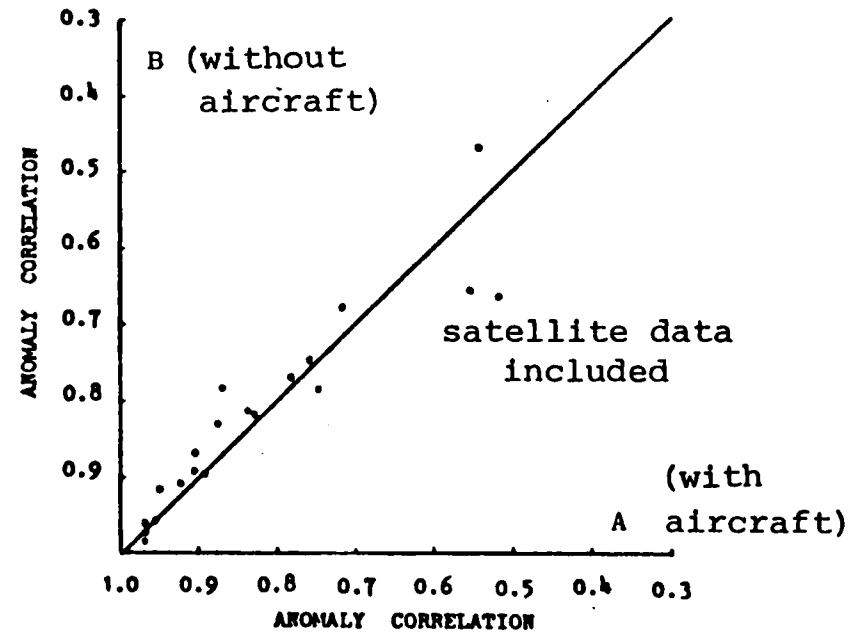
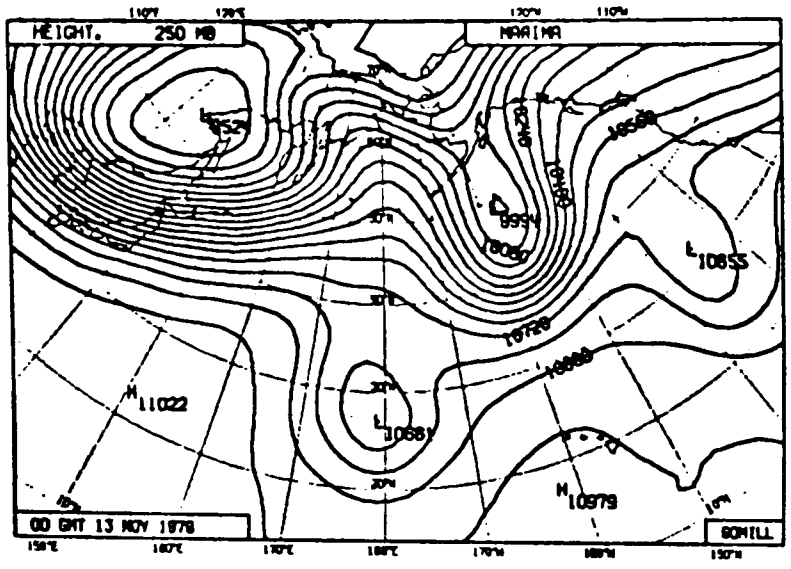
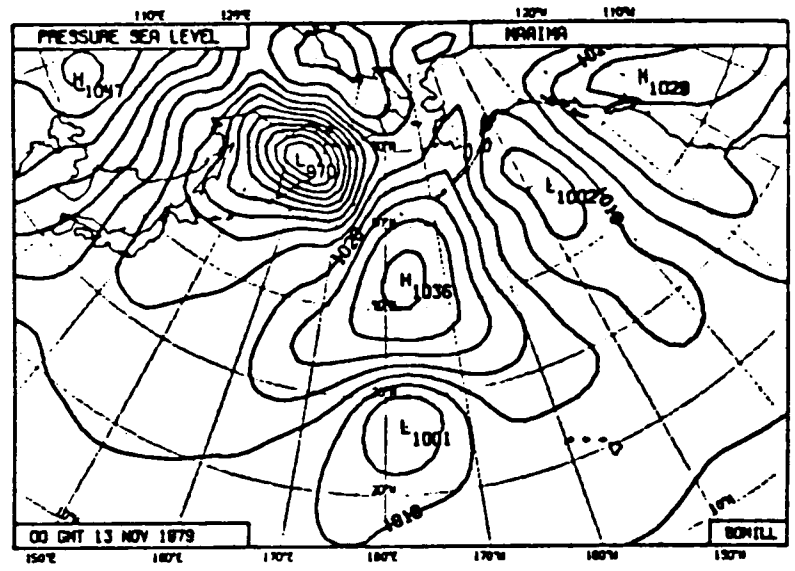


Fig. 4 Comparison of anomaly correlation of day 2-6 forecasts with (A) and (C) and without (B) and (F) aircraft data. Lower panel: with satellite data; upper panel: without satellite data.



(c)



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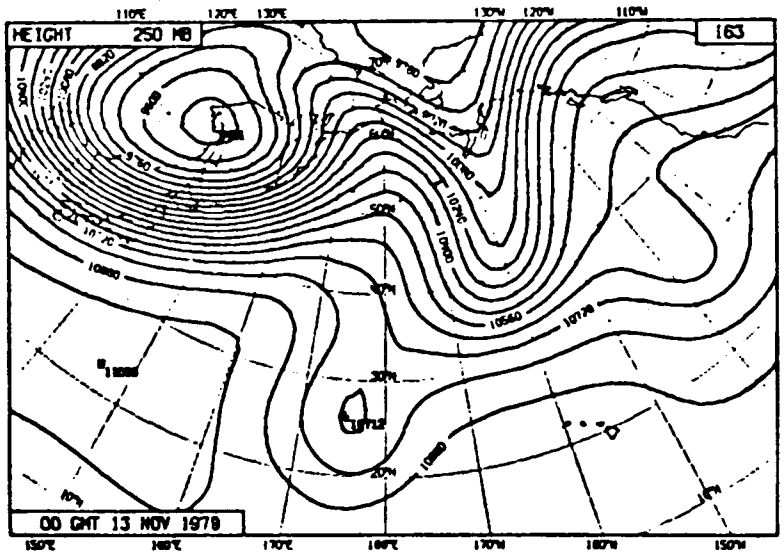
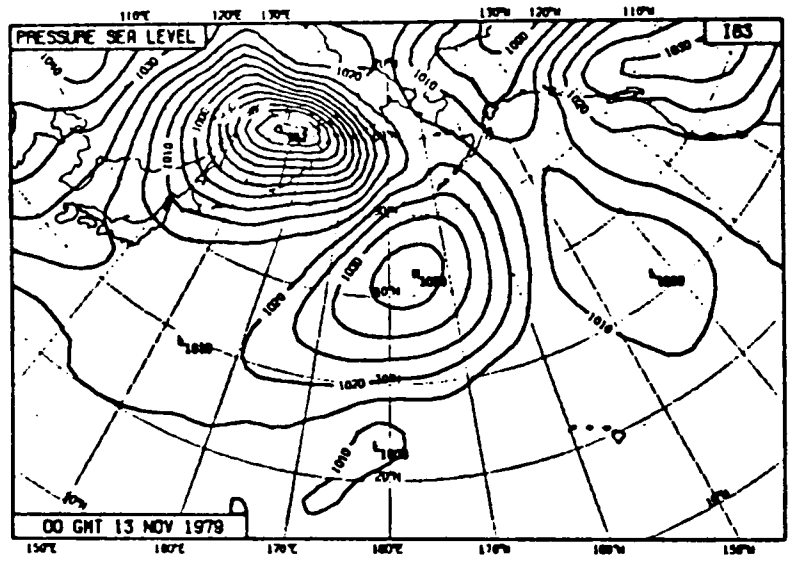
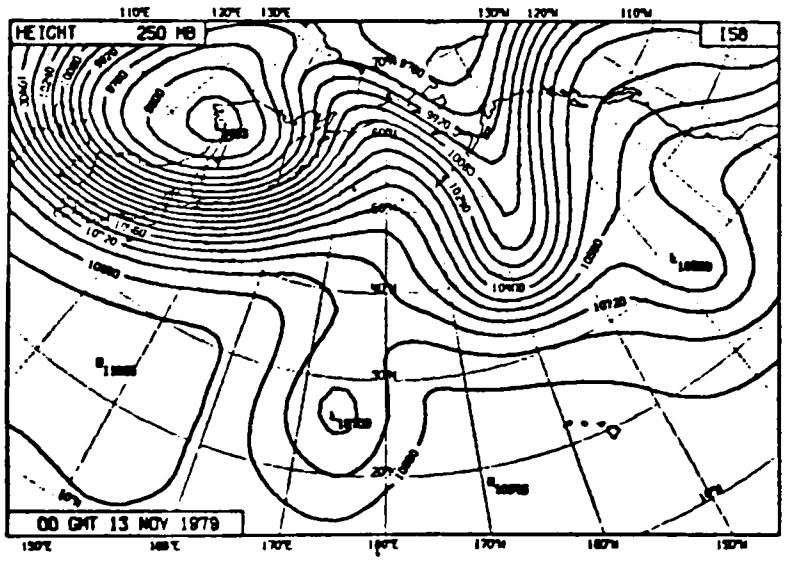


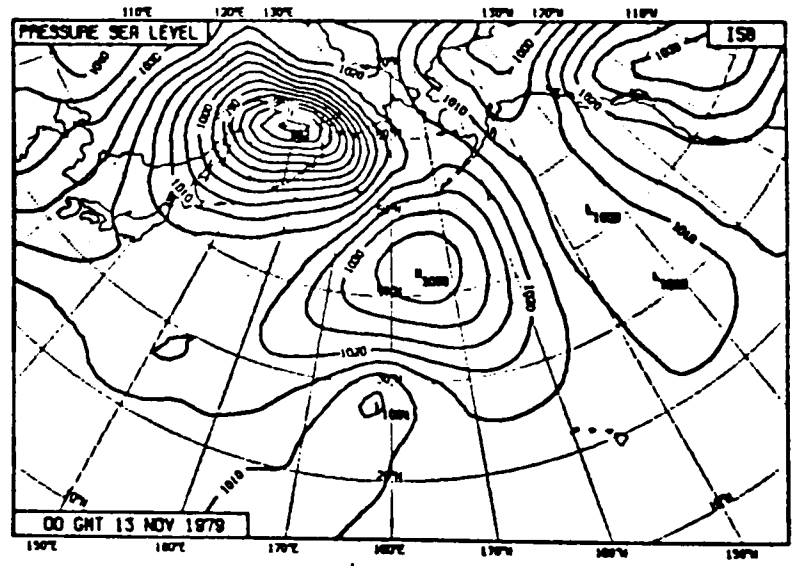
(b)



(b)



(a)



(a)

Fig. 2 48h forecast of 250 mb height with (a) and without (b) aircraft data and verifying analysis (c) for 13 November 1979 00Z. Notice that orientation of maps is different from Fig. 1.

Fig. 3 Same as Fig. 2 but for sea level pressure.

As an example of synoptic differences we will consider just one analysis and forecast.

The 11th November 00Z was selected because the shape of a trough over the Pacific around 170°E was considerably different in the two analyses. The 250 mb height analysis (Fig. 1) shows that the inclusion of aircraft data produces a much sharper trough with stronger jet maxima on its forward and backward sides.

We investigated the vertical structure of the jet maximum difference in a cross-section through the trough along the 175° meridian. The difference has a maximum around 220 mb and a barotropic vertical structure. The 48 h forecast of the 250 mb height is shown in Fig. 2a (exp. A) and 2b (exp. B) with verifying analysis in Fig. 2c. The shape and position of the trough near 160°W improved when aircraft data were used although both forecasts are admittedly fairly poor. Also the shape of the low at 180°E, 25°N definitely improved. The improvement is more convincingly shown in the sea level pressure forecasts in Fig. 3a and 3b, verifying in Fig. 3c. The structure of the high and the depth of the developing low south of it is clearly much better in experiment A than in experiment B.

The same (A) forecast shows an improved forecast compared to (B), of a 250 mb trough over W. Europe, that can be traced back to analysis differences over the North Atlantic.

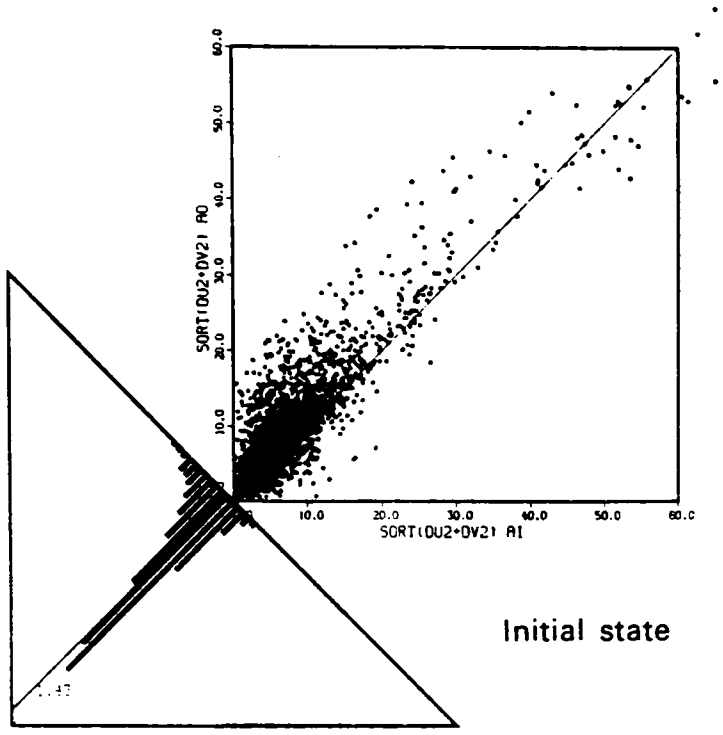
It may be concluded that aircraft data can contribute to an improvement of the forecast in the structure and phase of synoptic features on the Northern Hemisphere, not only at 250 mb but also sometimes at the surface.

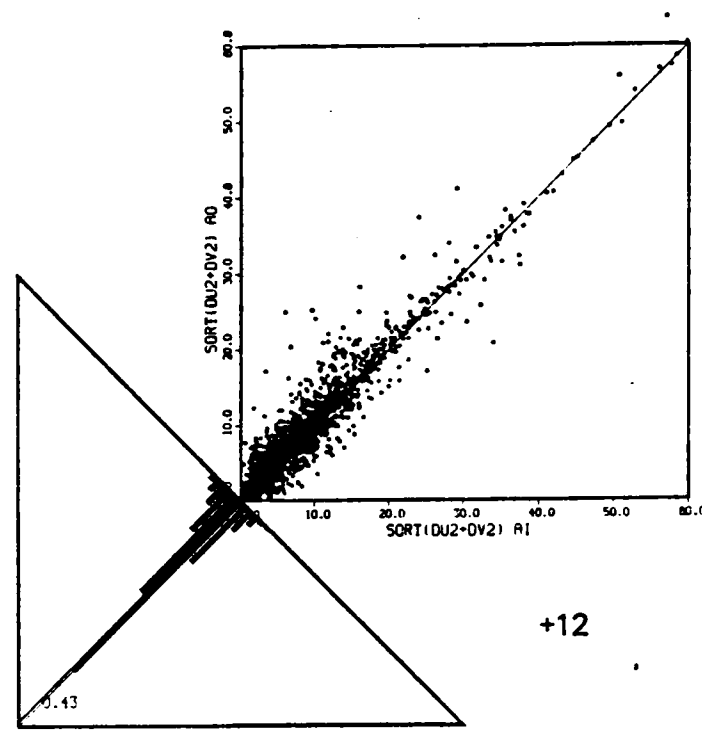
4. OBJECTIVE EVALUATION

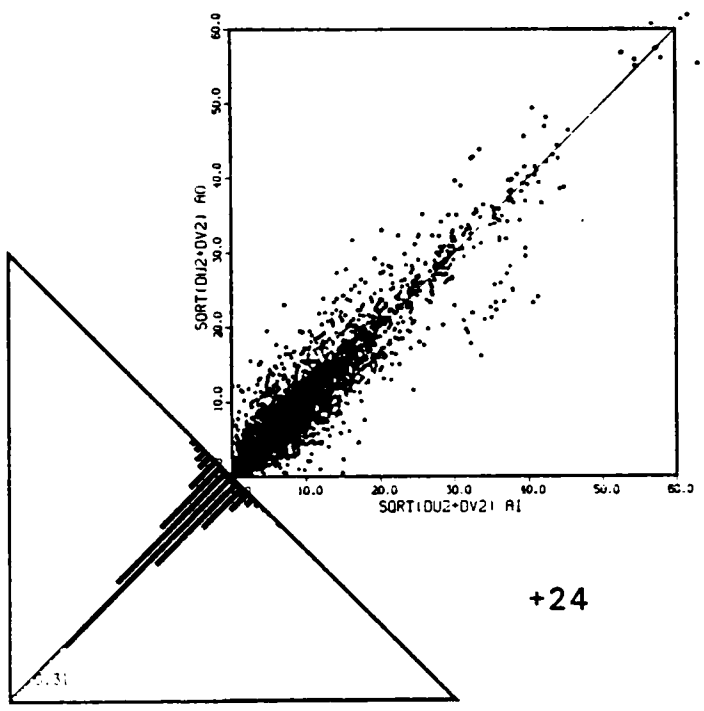
The synoptic evaluation revealed that improvements to analyses and forecasts from aircraft data are demonstrable but small. Accordingly, it appeared difficult to corroborate the improvements with objective scores. Fig. 4 (lower panel) shows a comparison of the anomaly correlations of all day 2 to day 6 00Z forecasts of the 250 mb height over the Northern Hemisphere with and without aircraft data. Most points are above the diagonal, indicating a slight improvement of the 250 mb height forecasts. A similar plot, averaged over the troposphere from 1000 to 200 mb, did not show such systematic improvement.

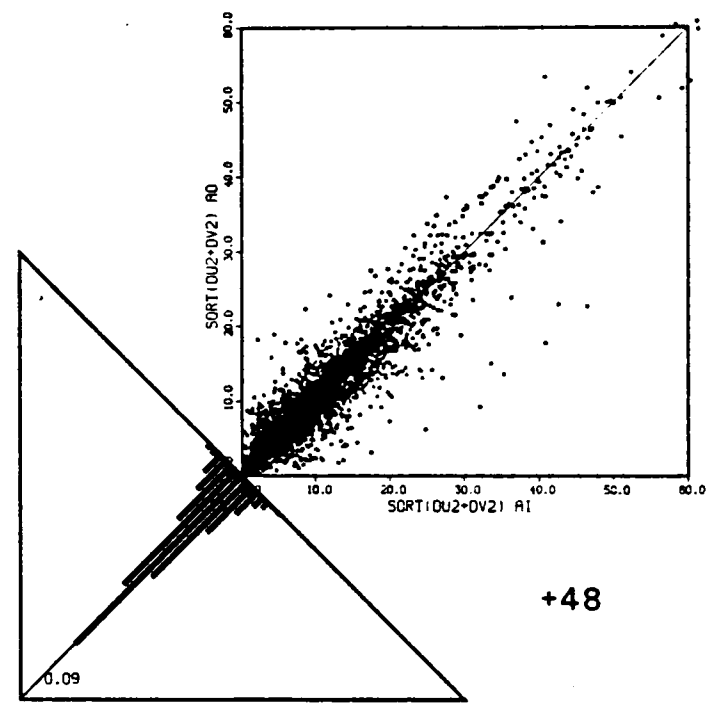
Because it was suspected that the relatively small impact was due to the abundance of satellite wind and temperature data in the FGGE level II-b data set, both assimilations were repeated but now excluding the satellite data. These runs are indicated as C (satellite data out, aircraft data in) and F (satellite data out, aircraft data out). Fig. 4 (upper panel) summarises the results of the four forecasts on these analyses. Now a clear and convincing impact of aircraft data is apparent. A synoptic evaluation gives the same picture.

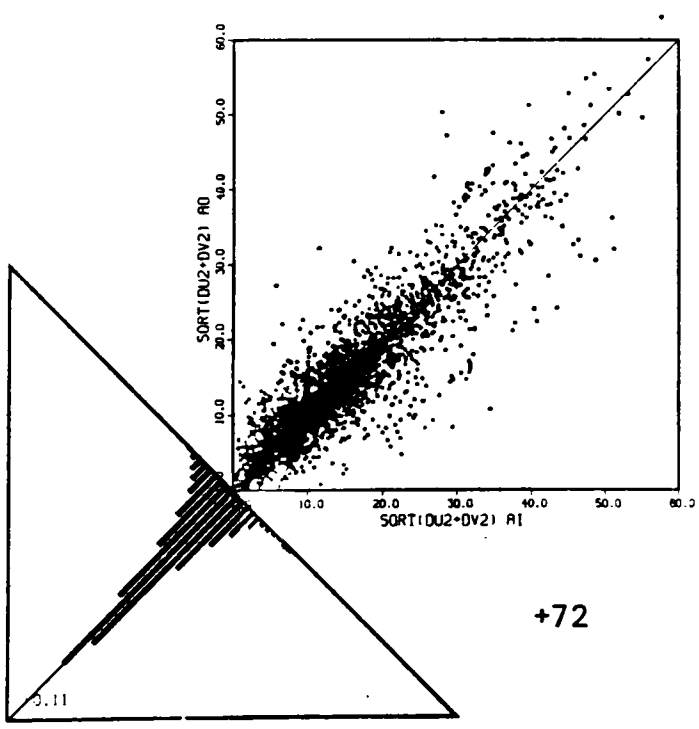
These results show that aircraft wind data are a valuable source of information with a relatively small but significant impact on both Northern Hemisphere analyses and forecasts. During the FGGE-period studied, the impact is partly masked by the large amount of satellite temperature and wind data. However, it must be emphasised that the normal, operational, non-FGGE situation is certainly much less favourable from this point of view, which implies that the impact of aircraft data is likely to be larger in an operational context.











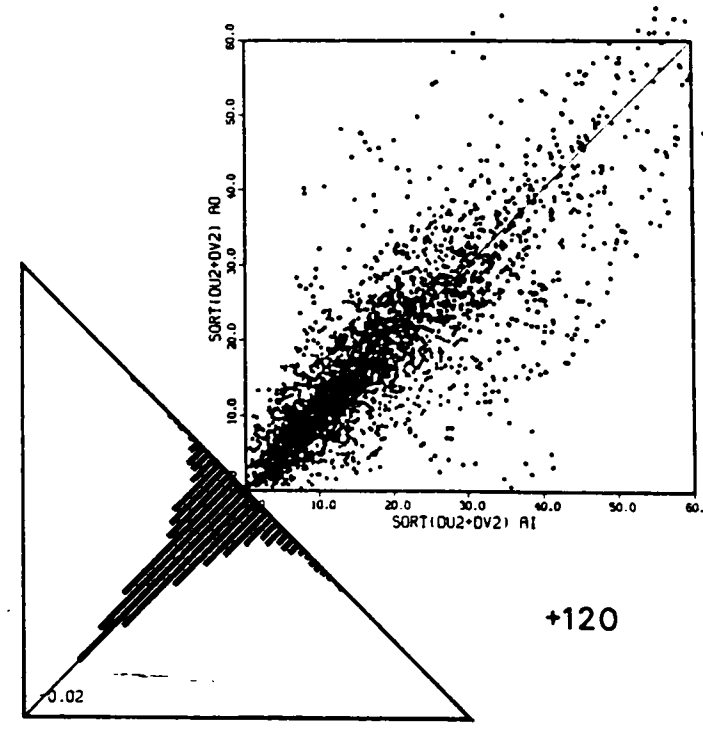


Fig. 5 Distributions of wind speed error (aircraft-in error/aircraft-out error) for four 10-day forecasts at 250 mb and histograms of the deviation of each point from the diagonal. Results for the initial state, T+12, T+24, T+48, T+72 and T+120. (All winds, also those rejected by the analysis, are used, which explains some of the outlying points).

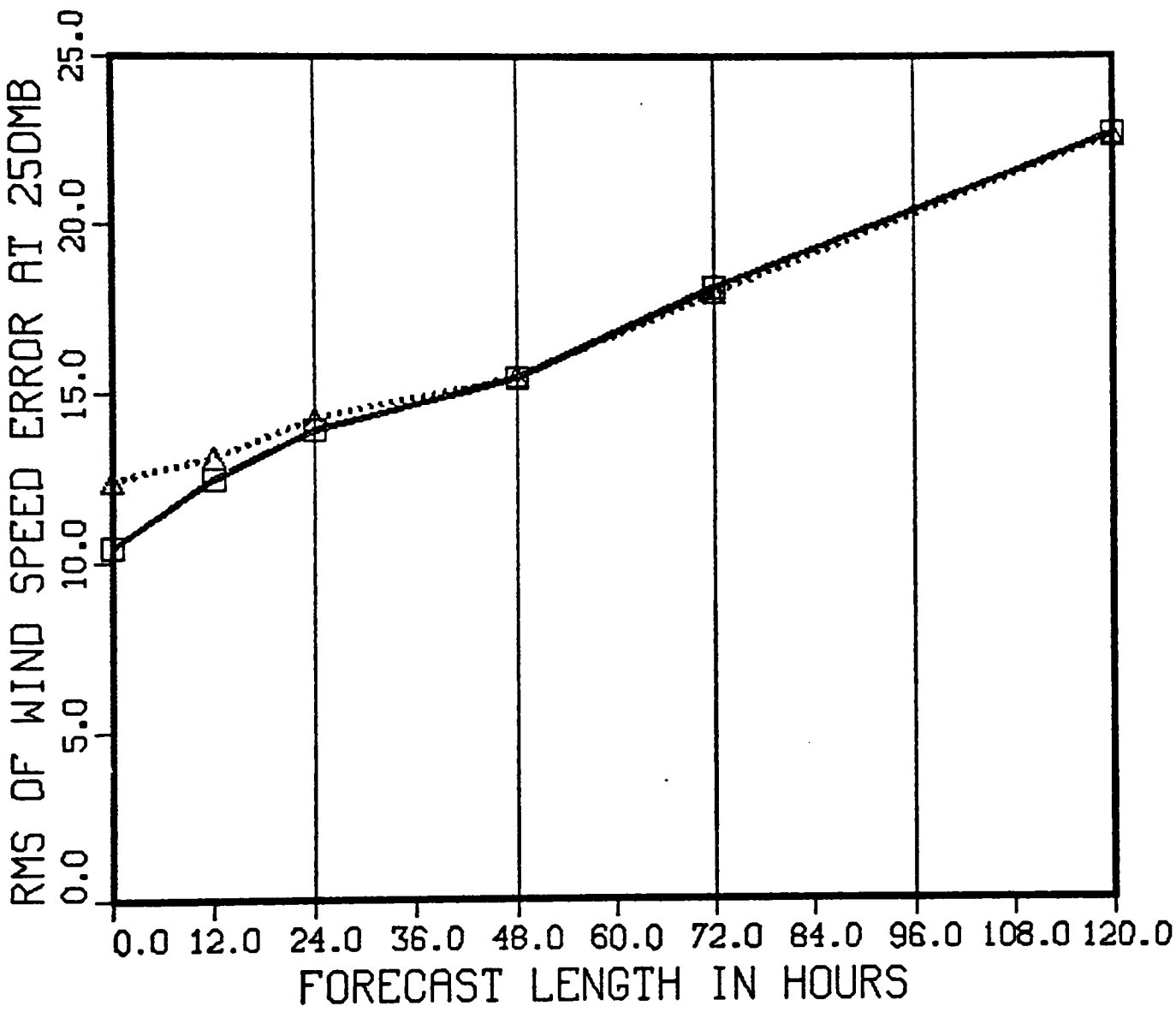


Fig. 6 The evolution of mean RMS of wind speed error at 250 mb for the aircraft-in forecasts (full line) and aircraft-out forecasts (dotted line).

Moreover it is important to stress that not enough is known yet about the optimal way to extract information from single-level data sources.

5. OBJECTIVE VERIFICATION AGAINST OBSERVATIONS

The forecasts were also verified against aircraft winds. Fig. 5 shows scatter diagrams of vector wind error for experiment A (x axis) and experiment B (y axis). Note that there is a small bias in favour of the inclusion of aircraft data for up to 48 hours. This is also apparent in the associated histograms of deviations from the diagonals. It is interesting to note that even the 120 hour forecasts show some "skewness" which does not appear to be random.

An alternative way of representing these results is to plot the mean RMS vector wind error at 250 mb for experiments A and B as a function of forecast length. This is done in Fig. 6 and it again reveals the positive impact of aircraft data during the early period of the forecasts.

6. SUMMARY OF RESULTS

The analyses and forecasts were evaluated both subjectively and objectively and the following conclusions can be drawn:

(a) The quality of the automatically transmitted aircraft data is high. In the AIREP data set many apparent errors were spotted; this in itself is a strong argument in favour of automatic aircraft data transmission.

(b) Considerable local differences of over 20m/s were found between both sets of analyses, particularly over the tropical and Northern Hemisphere oceans; further evaluation showed that the impact is beneficial and most significant in the tropics; outside the tropics there seems to exist a certain redundancy between aircraft and satellite data, a redundancy that could be smaller however in the operational non-FGGE situation.

(c) A careful comparison of forecast results revealed a small but significant beneficial impact on some synoptic features at 250 mb and sometimes also near the surface.

(d) A comparison of forecast anomaly correlations showed hardly any impact, indicating that the impact was indeed small and local.

(e) In an attempt to explain why the impact was small, it was found that the impact was much larger when satellite data were excluded from the assimilation; the conclusion must be that the ECMWF system is able to extract valuable information from the aircraft data, but that during FGGE this information was partly masked by the abundance of satellite data; it is likely that the impact of aircraft data on forecasts is more significant in a normal non-FGGE operational context.

(f) A comparison against the aircraft data showed that a systematic positive impact can still be found up to 48 hours, even five-day forecasts gave this signal.

- Sakari Uppala

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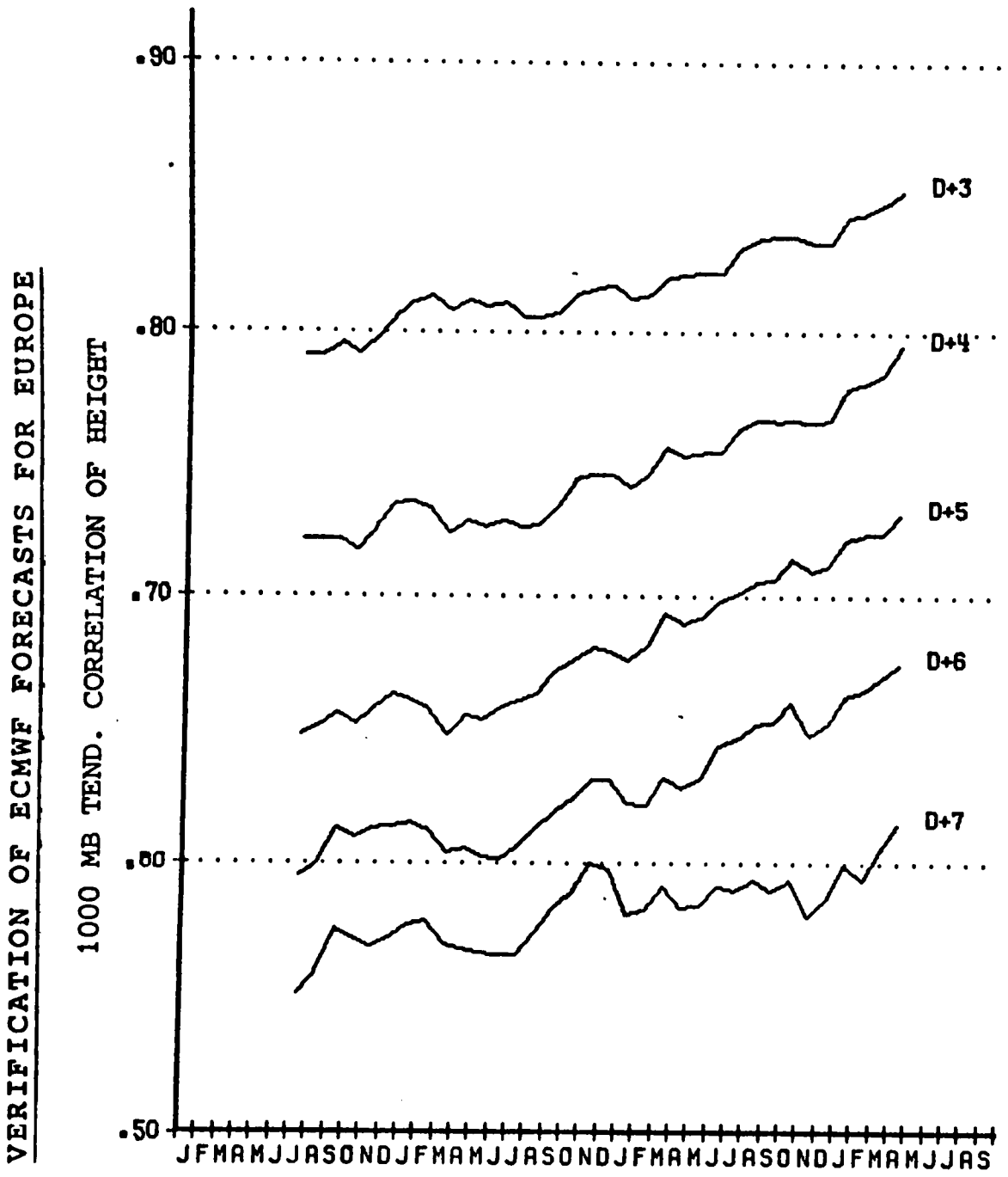
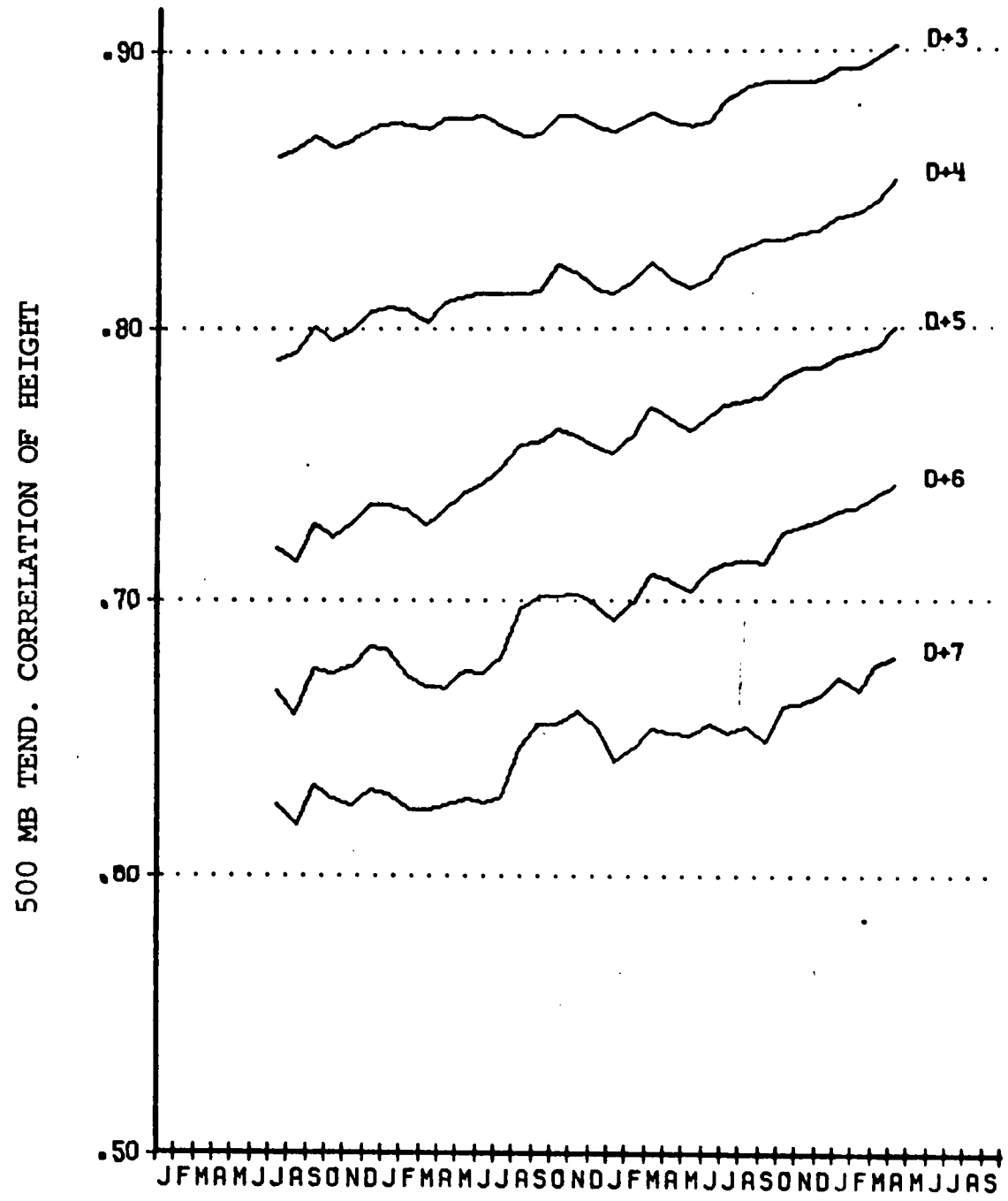


JANUARY 1980 - SEPTEMBER 1983
AREA=1 EUROPE
(72N-38N.12W-42E)

Fig. 1



JANUARY 1980 - SEPTEMBER 1983
AREA=1 EUROPE
(72N-38N.12W-42E)

Fig. 2

Twelve month moving average tendency correlation scores of ECMWF forecasts for the European area for 1000 mb (Fig. 1 - left) and 500 mb (Fig. 2 - right) three to seven day forecasts from January 1980 to September 1983 indicate a continuing upward trend in the quality of the Centre's forecasts.

- Rauno Nieminen

VISITS BY ECMWF METEOROLOGISTS TO MEMBER STATES

In order to ensure a continuing exchange of information between the Centre and the forecasters in the Member States who are users of the Centre's products, the Centre plans that the meteorological forecasting offices in all of the Member States will be visited by ECMWF meteorologists in the coming months. These visits will be broadly similar to those made during the period October 1981 to April 1982. The ECMWF meteorologists will normally plan to present seminars, including information on recent changes to the forecasting system. These seminars will lead to discussions with meteorological staff in the Member States. Topics of mutual interest which could be discussed during the visit may include, for example:

Reception of data from ECMWF, including any problems or delays experienced by the Member State.

Plotting of fields and other presentation of information to the forecaster.

Further processing of products
e.g. statistical forecasting
derived fields or products (thunderstorm index etc.)

Dissemination of EC products (or forecasts based on them) within the Member State.

The end users: who are they, and in what form is the forecast information presented to them?

To what forecast day are forecasts issued, how does this compare to previous experience, and what are future plans?

Cost/benefit information.

Use of experimental products (defined in Met.Bulletin M3.4/1).

Verification of forecasts (both subjective and objective, especially systematic errors).

What has been the impact of the new model?

Use of forecast products from other Centres.

Current and planned status of the computer system in the Member State.

Internal communications within the Member State.

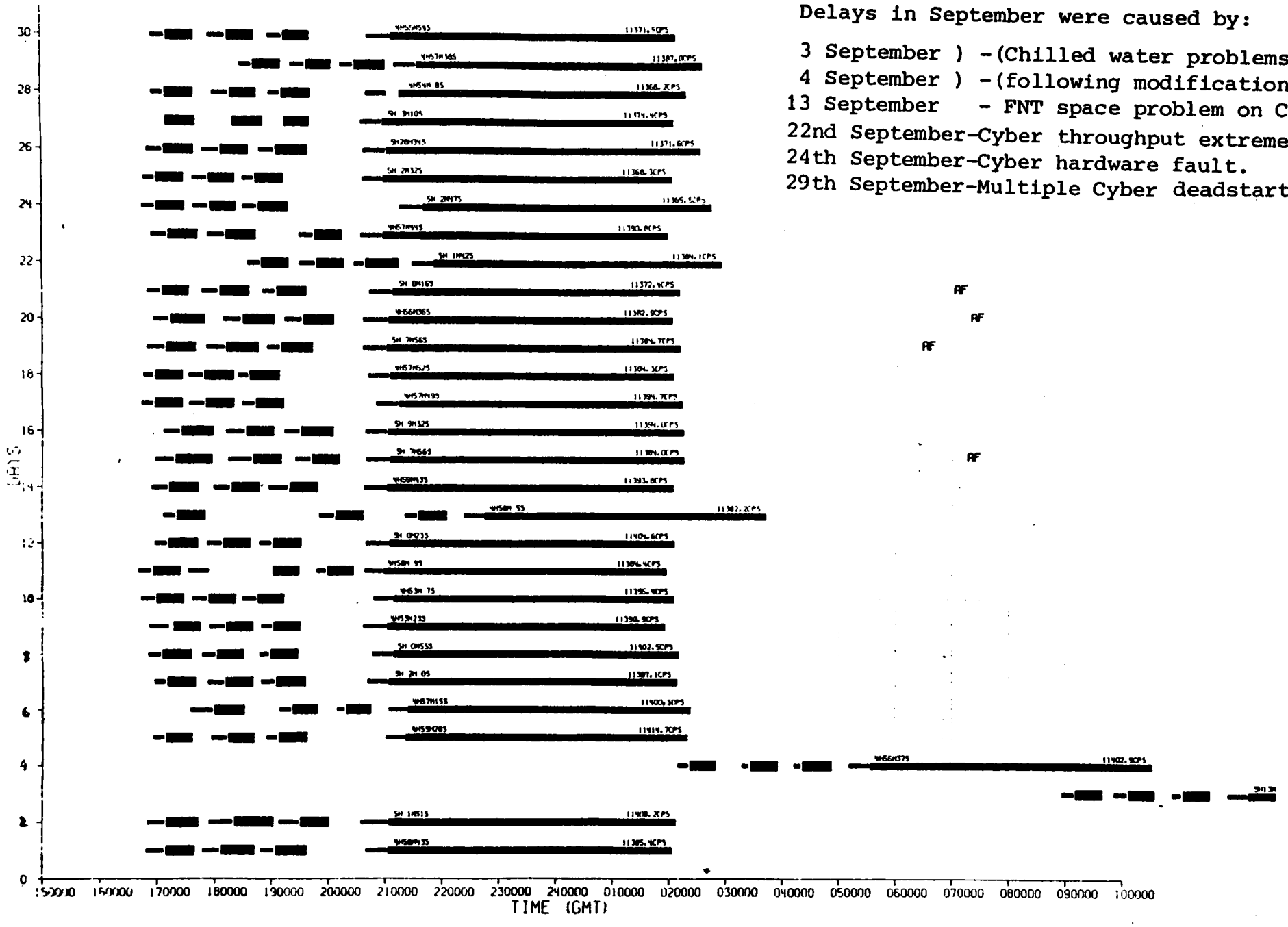
Plotting and display facilities available.

The impact of the Centre's present operational schedule on the forecasting activities of Member States, and possible improvements to this schedule.

Centre publications (Newsletter, Forecast Report, Reference Charts, Analysis Publication): their distribution within the Member State and any requirements for improvements, etc.

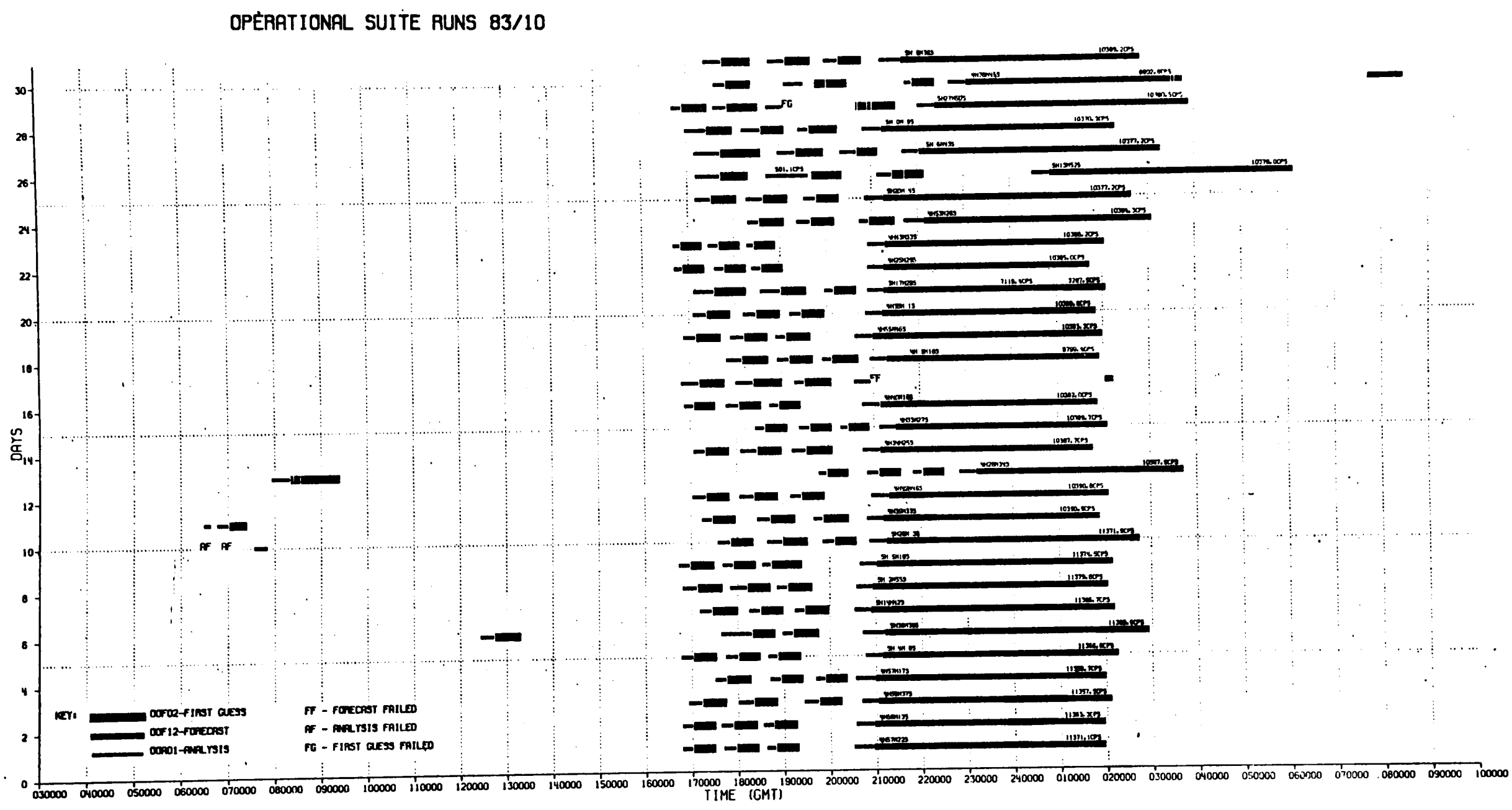
- Austin Woods

OPERATIONAL SUITE RUNS 83/09



Delays in September were caused by:

3 September) -(Chilled water problems on Cybers
4 September) -(following modification to power supplies
13 September - FNT space problem on Cyber
22nd September-Cyber throughput extremely slow
24th September-Cyber hardware fault.
29th September-Multiple Cyber deadstarts



Delays in October were caused by:

13 October - Cray power supply problem
17 October - No problem - database entry incorrect
24 October - Cyber disk controller problem
26 October - Cyber 175 crashes + suspected Cray hardware errors
27 October - Cyber throughput extremely slow
29 October) - (Cray disk problems after
30 October) - (adjustments to 60 Hz M.G.set

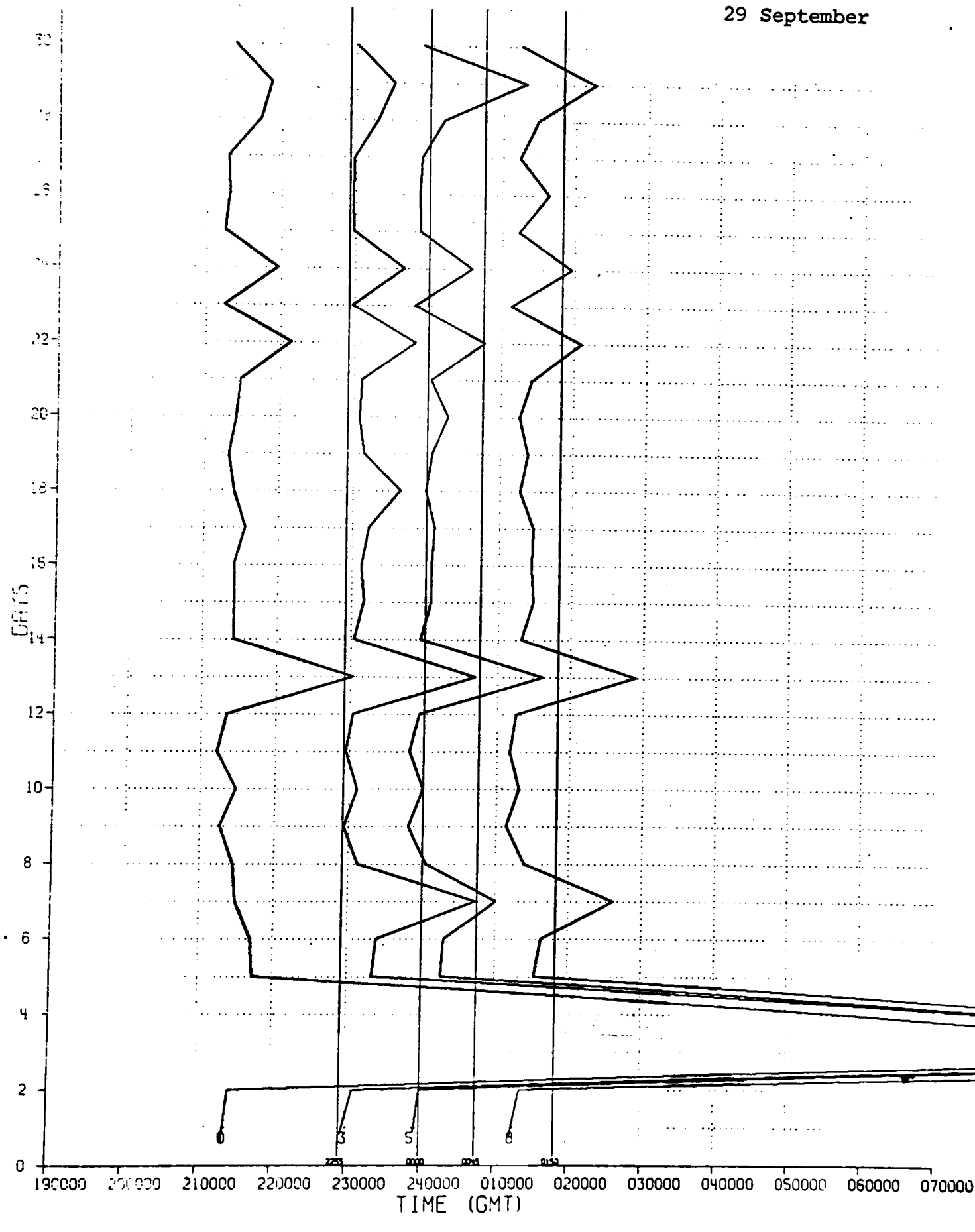
On the 24th October COS 1.12 was introduced and the forecast then took 30 mins.longer on average than when COS1.11 was in service. (This has since been reduced to 15 mins.)

DISSEMINATION RUNS

September 1983

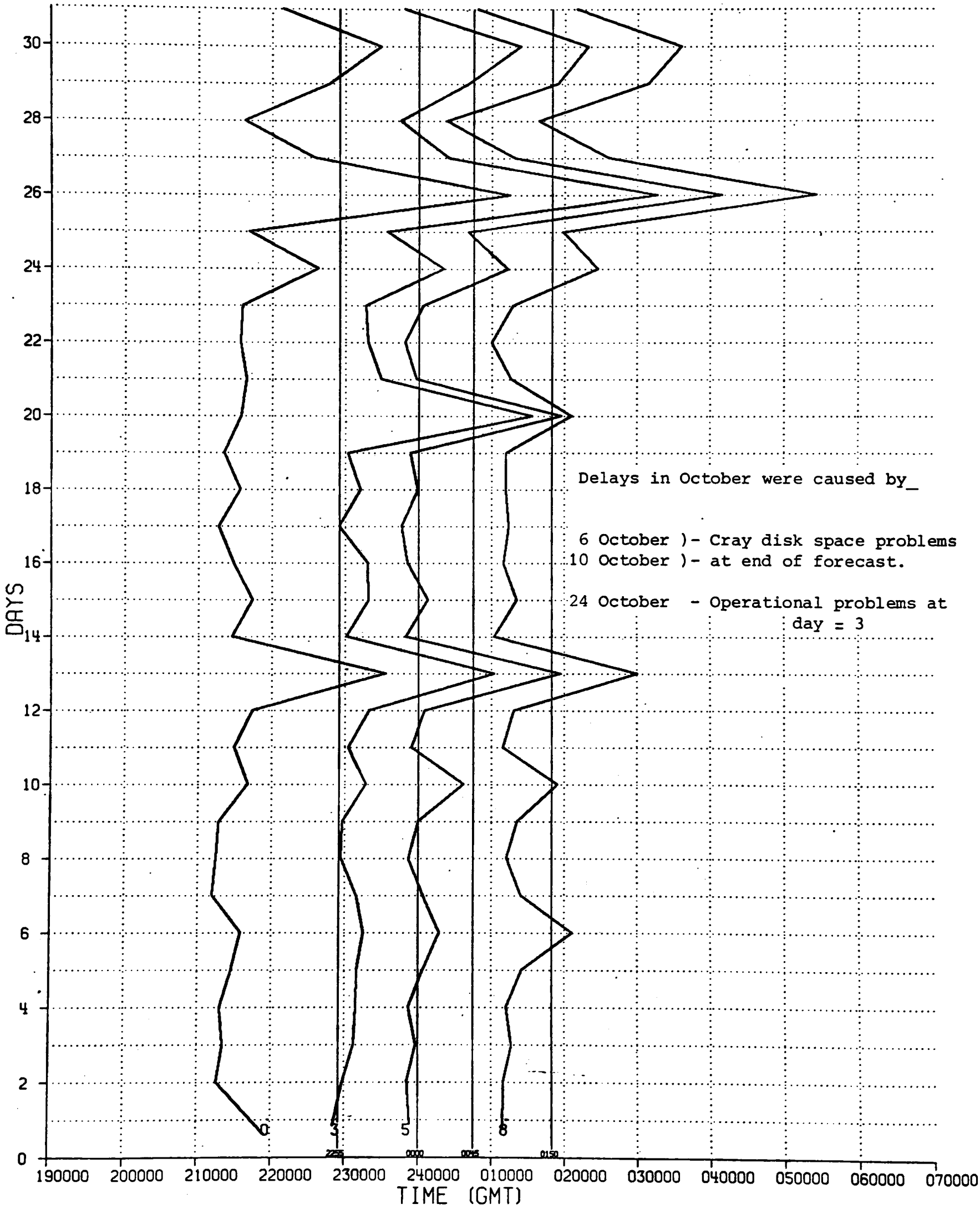
Delays in September were caused by:

3 & 4 September	Chilled water problems on the Cyber
7 September	Cyber hardware fault
29 September	NFEP problems



DISSEMINATION RUNS

October 1983



Delays in October were caused by_

6 October)- Cray disk space problems
10 October)- at end of forecast.

24 October - Operational problems at day = 3

THE ARRIVAL OF THE CRAY X-MP

The Cray X-MP system arrived on October 11th, and the engineers connected the system to power on October 13th. Since then, it has been through very thorough testing by both ECMWF and Cray staff: as an example, it has produced the equivalent of almost three 10 day forecasts per day. We believe that through this exercise we have found all the teething problems from which new computers suffer.

The successful provisional acceptance trial was completed on November 22nd. The necessary technical information about how to convert jobs to run on the X-MP and how to make test-runs on the X-MP is contained in News Sheets 153 and 154.

- Claus Hilberg.

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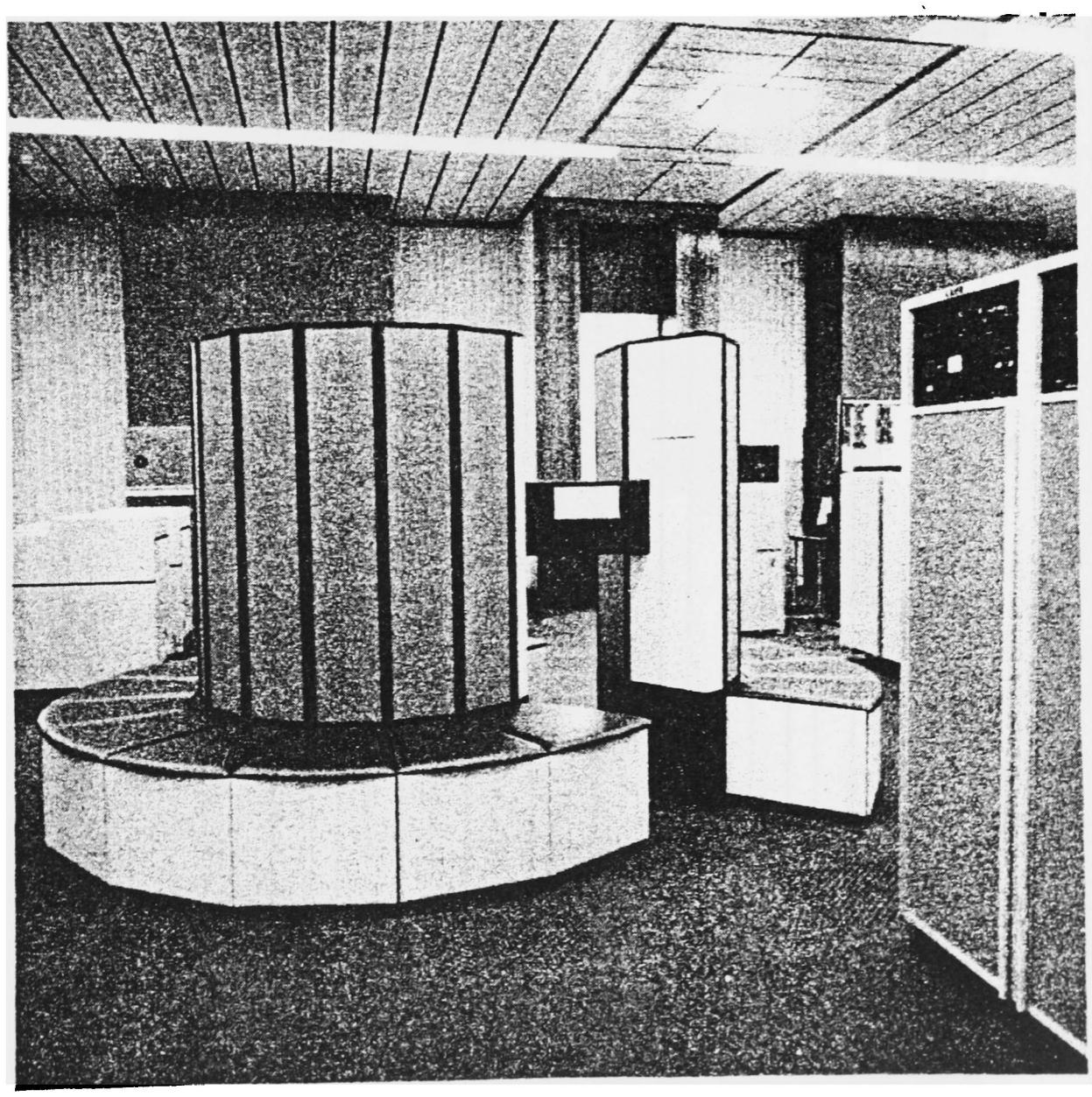
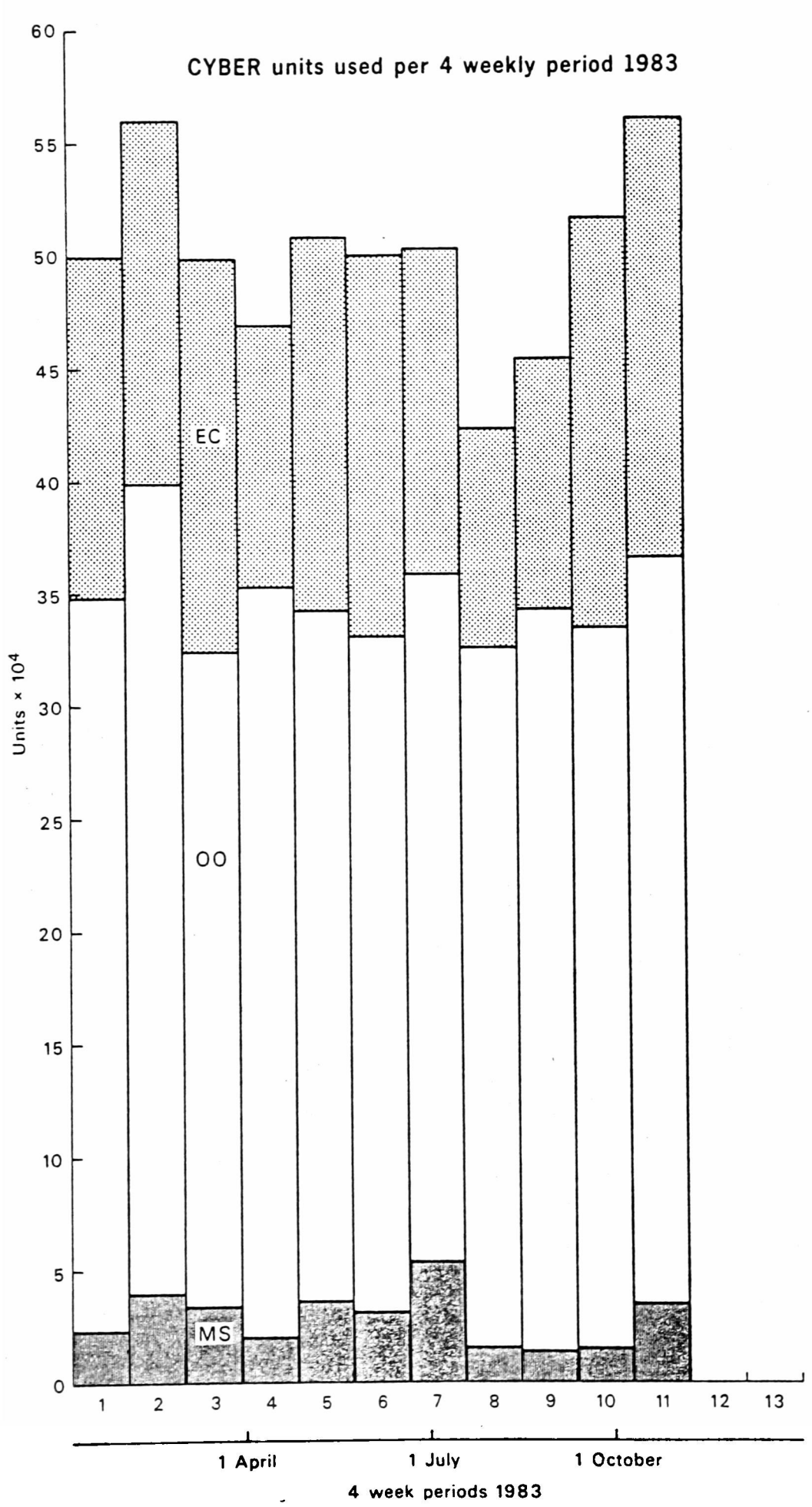


Figure: The CRAY X-MP fully installed with the Solid State Device (SSD) to the right.

COMPUTER USAGE STATISTICS 1983

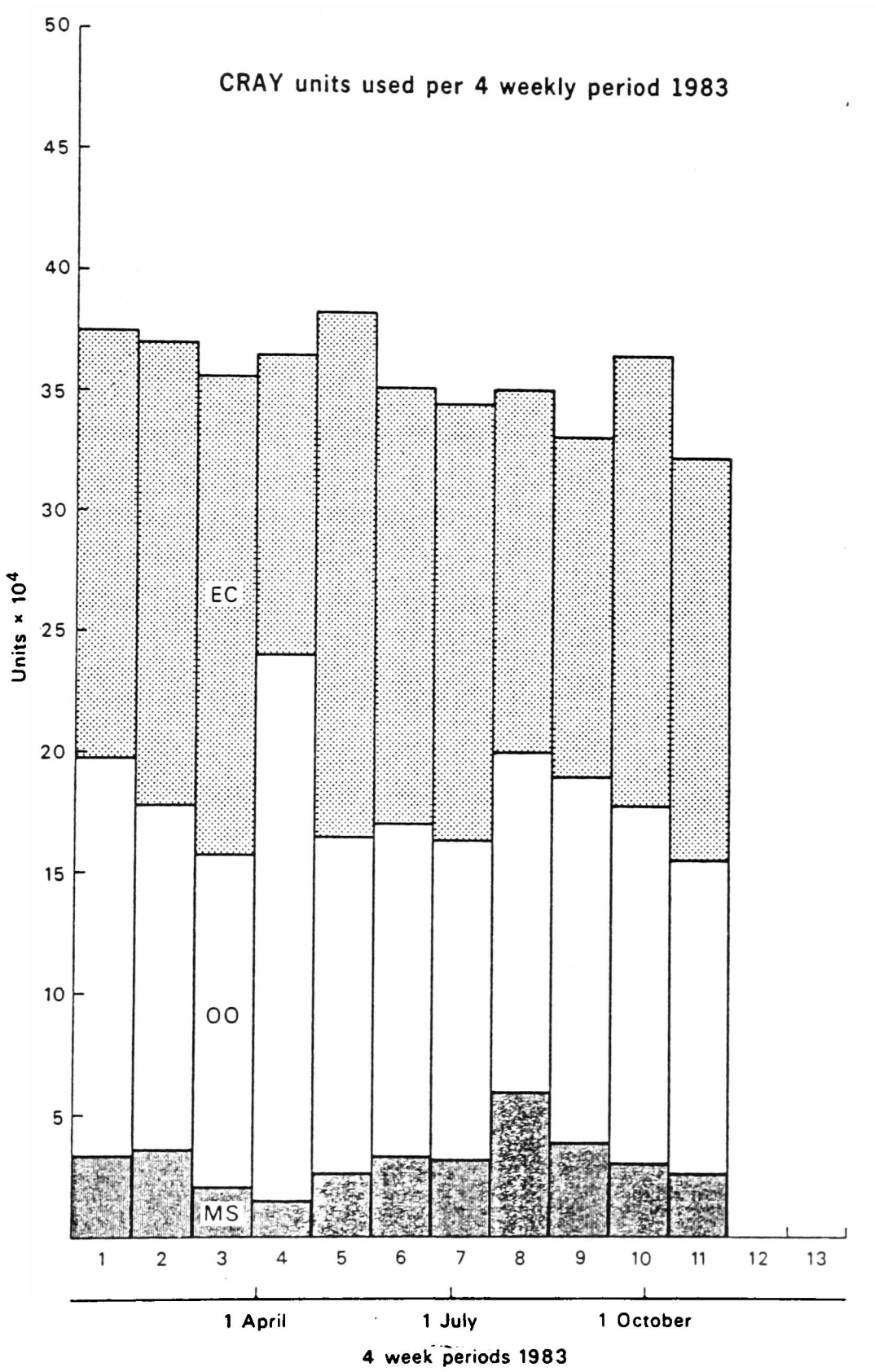


EC = Centre users

OO = operational suite running

MS = Member State users, including Special Projects

EC + OO + MS = total usage, less those jobs classed as systems overheads



COMPUTER RESOURCE ALLOCATION TO MEMBER STATES IN 1984

At its eighteenth session (23-24 November, 1983) Council approved the allocation of computer resources to Member States for 1984 as shown below. These allocations will come into effect on Monday, 2nd January.

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

- 1000 Cray units equals approximately 1 CP hour (for the Cray X-MP it will be 1500 units)
- 1650 Cyber units equals approximately 1 CP hour.

Member State	1984 Allocations		
	Cray (Kunits)	Cyber (Kunits)	On-Line Mass Storage (Mwords)
Belgium	45	26	2.3
Denmark	75	22	1.8
Germany	382	50	9.3
Spain	125	40	3.0
France	295	84	7.2
Greece	60	17	1.4
Ireland	40	14	1.2
Italy	184	53	4.4
Yugoslavia	74	21	1.9
Netherlands	41	29	2.7
Austria	40	19	1.5
Portugal	60	15	1.2
Switzerland	10	25	2.2
Finland	50	18	1.5
Sweden	140	30	2.3
Turkey	15	8	0.5
UK	250	69	5.1
Special Projects (1)	210	60	5.5
OVERALL TOTAL	2096	600	55.0

Notes:
1. This allocation is distributed between 9 special projects as shown in the table overleaf.

Special Projects 1984

Member State	Institution(s) undertaking project and project title	1984 allocation CRAY (Kunits)	Cyber (Kunits)	Mass storage (Mwords)
Germany	Meteorological Institute, Bonn and Institute for Geophysics and Meteorology, Cologne - Mesoscale diagnosis of atmospheric energetics in the ALPEX area	1	1	0.1
	Institute for Geophysics and Meteorology, Cologne. -Global climate diagnostics	7	17	0.2
	Hamburg University. - Simulation of clouds in a general circulation model	40	6	0.2
	Hamburg University. - 3D-mesoscale simulation model.	50	7	0.2
	Technical High School, Darmstadt - Parameterisation of turbulent fluxes of momentum and heat over irregular terrain.	25	3	0.1
France	University of Science and Technology, Lille - Aerosol radiation code in the ECMWF general circulation model	32	7	0.1
Finland	Finnish Meteorological Institute - CAS/NWP Intercomparison project	15	10	4
United Kingdom	Meteorological Office - Model Intercomparison project	20	4	0.5
Germany	Max Planck Institute for Meteorology - Global wave prediction	20	5	0.1
	TOTAL	210	60	5.5

— Andrew Lea

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TELECOMMUNICATIONS SCHEDULE

Council approved a revised implementation schedule for the remaining 5 medium speed circuits, as shown below:

Member State	Speed (bps)	Line to be set up
Greece	2400	February 1984
Italy	4800	November 1984
Turkey	2400	November 1984
Switzerland	2400	July 1985
Yugoslavia	2400	Indefinite

- Andrew Lea

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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 154). 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)
47	Libraries on the Cray-1
54	Things not to do to the Station
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
142	INTERCOM login default procedures
144	DISSPLA FTN5 version
146	Cyber dayfile message switches
147	(20.7.83) NOS/BE level 577
152	Job information card
153	COS.1.12 products
154	Cray X-MP

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ECMWF PUBLICATIONS

Technical Report No.38	The response of the ECMWF model to the El-Niño anomaly in extended range prediction experiments
Technical Memorandum No.79	Plotting of ECMWF forecast products in some Member States
Technical Memorandum No.80	A multi-tasking numerical weather prediction model
ECMWF Forecast and Verification Charts	to 30 September 1983 to 31 October 1983 to 15 November 1983
Forecast Report No.23	July - September 1983

ECMWF Annual Report
for 1982, French and German versions.

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CALENDAR OF EVENTS AT ECMWF

6-10 February 1984	ECMWF Computer user training course: Introduction to the facilities
13-17 February 1984	ECMWF computer user training course: Cray in depth
5-6 March 1984	31st session of Finance Committee
3-4 May 1984	19th session of Council
12-14 September 1984	12th session of Scientific Advisory Committee
18-20 September 1984	7th session of Technical Advisory Committee
21-22 November 1984	20th session of Council

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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.

*T indicates the original Technical Newsletter series

USEFUL NAMES AND 'PHONE NUMBERS WITHIN ECMWF

		Room*	Ext.**
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) - COMFILE (See Bulletin B1.5/1)		CB 037	309
Computer Division Head	- Geerd Hoffmann	OB 009A	340/342
Communications & Graphics Section Head	- Peter Gray	OB 101	369
COMPUTER OPERATIONS			
Console	- Shift Leaders	CB Hall	334
Reception Counter) Tape Requests)	- Jane Robinson	CB Hall	332
Terminal Queries	- Norman Wiggins	CB 035	209
Operations Section Head	- Eric Walton	CB 023	351
Deputy Ops. Section Head	- Graham Holt	CB 024	306
DOCUMENTATION	- Pam Prior	OB 016	355
Libraries (ECMWF, NAG, CERN, etc.)	- John Greenaway	OB 017	354
METEOROLOGICAL DIVISION			
Division Head	- Frédéric Delsol	OB 008	343
Applications Section Head	- Rex Gibson	OB .227	448
Operations Section Head	- Austin Woods	OB 007	344
Meteorological Analysts	- Veli Akyildiz	OB 005	346
	- Herbert Pümpel	OB 006	345
Meteorological Operations Room		CB Hall	328/443
REGISTRATION			
Section & Project Identifiers	- Pam Prior	OB 016	355
Intercom	- Jane Robinson	CB Hall	332
Operating Systems Section Head	- Claus Hilberg	CB 133	323
Telecommunications Fault Reporting	- Stuart Andell	CB 035	209
User Support Section Head	- Andrew Lea	OB 018	353
RESEARCH DEPARTMENT			
Computer Coordinator	-	OB	
Meteorological Education and Training	- Bob Riddaway	OB 319	478

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* CB - Computer Block
OB - Office Block

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