European Centre for Medium Range Weather Forecasts

ECMWF NEWSLETTER

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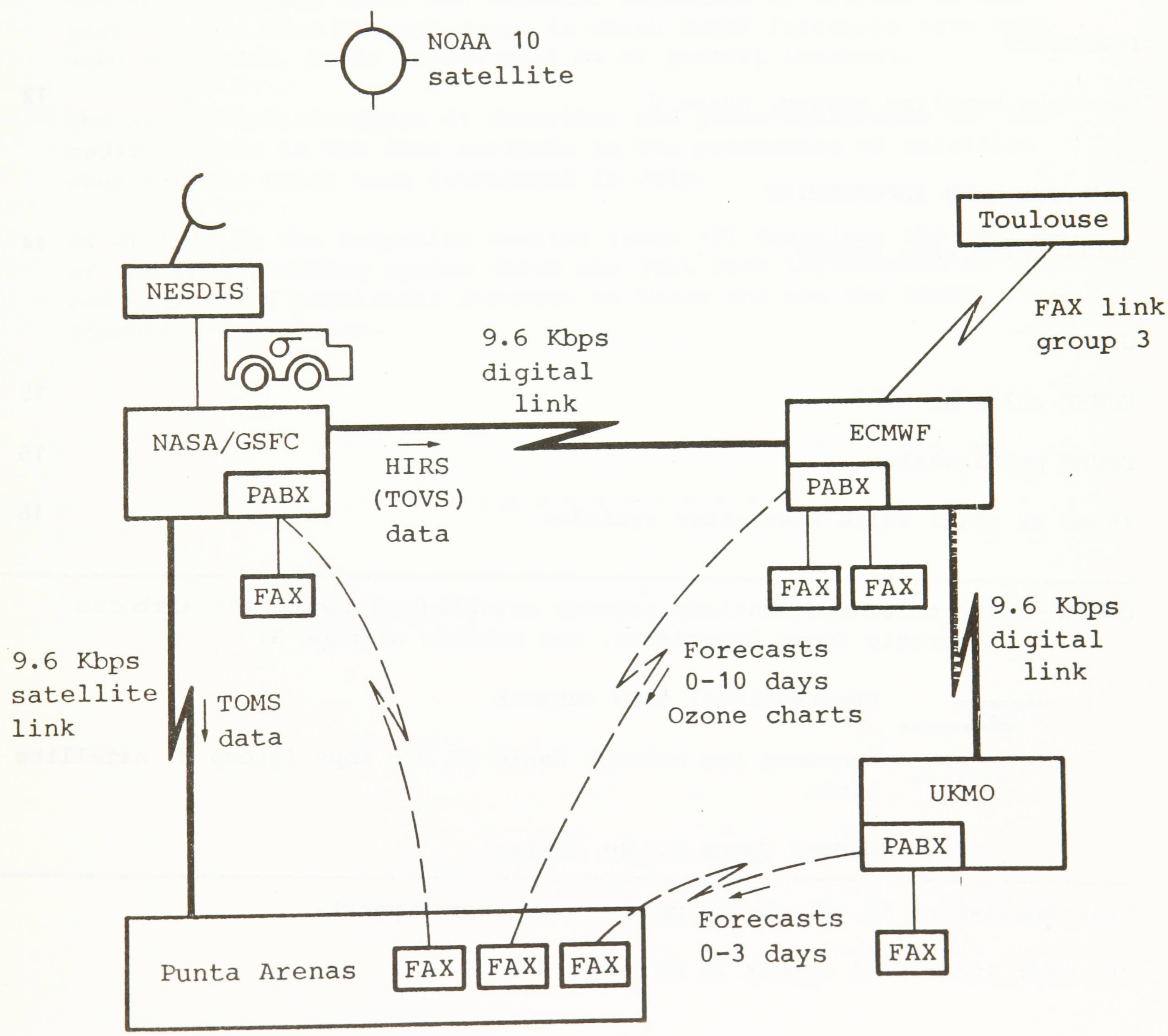
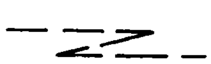
Number 39 - September 1987



IN THIS ISSUE

COVER: The telecommunications network established during the Airborne Antarctic Ozone Experiment, see article on page 3.

 Observational data network

 Document fax network based on 9.6 Kbps (group 3) satellite links

GSFC - Goddard Space Flight Center

This Newsletter is edited and produced by User Support.

The next issue will appear in December 1987.

The first article, on page 3, describes how ECMWF, the Météorologie Nationale, France, and United Kingdom Meteorological Office are involved in the important Airborne Antarctic Ozone Experiment. It continues an occasional series of articles (which has included round the world sailing races and Atlantic crossings by balloon in the past) on the more unusual areas in which ECMWF forecasts have been used and which, it is hoped, will be of general interest.

The second article (page 4) describes and gives background to the modifications to the data analysis in its processing of satellite observations which were introduced in July.

An article in the computing section (page 12) describes the upgrade of the data handling system which has just been implemented at ECMWF and will be of particular interest to those who use the ECMWF computing facilities.

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CHANGES TO THE OPERATIONAL FORECASTING SYSTEM

Recent changes

(i) Several modifications to the data analysis were implemented on 21 July 1987. The most important items were:

- Use of 7 SATEM layers in the vertical instead of 11: 100/700 hPa, 700/500 hPa, 500/300 hPa, 300/100 hPa, 100/50 hPa, 50/30 hPa and 30/10 hPa. The modification allows better use to be made of satellite sounding data in agreement with the vertical resolution given by the satellite instruments. It also permits more satellite data to be used in the horizontal. The overall impact on the resulting forecast is small, however, in the Southern Hemisphere, where SATEMs are the main data source, the effect is noticeably positive.

- Revision of the satellite observation error statistics and quality control.

Further details of the analysis changes and the impact on the forecasts are summarised in a Newsletter article on pages XXX.

Planned changes

(i) Forecast error correlation statistics will be revised, resulting in a higher horizontal and slightly increased vertical resolution of the analysis. As a consequence, the analysis will draw more to wind data and less to height observations.

(ii) A linear, vertical hybrid-coordinate scheme (finite element scheme) is expected to replace the operational finite difference scheme later this year.

- Horst Böttger

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THE ANTARCTIC OZONE PROJECT

In May this year the Centre was requested by NOAA (National Oceanic and Atmospheric Administration), USA, to provide support for a joint NASA/NOAA project, based in Punta Arenas, Chile, to investigate the stratospheric ozone layer over the Antarctic. The Météorologie Nationale, France, and the United Kingdom Meteorological Office are also actively involved in this project.

The Airborne Antarctic Ozone Experiment, as it is called, is flying specially instrumented NASA ER-2 and DC-8 aircraft into the ozone hole (layer of minimum ozone concentration) over the Antarctic in August and September, when the hole, which expands and contracts seasonally, is anticipated to be at its maximum size.

The ER-2 is the limited range, high altitude research aircraft and is able to penetrate the ozone hole at the altitude of the maximum decline in ozone (around 20 km). The DC-8 is equipped with remote sensors which will map the vertical distributions of ozone and aerosols above the cruising altitude of the aircraft and within the hole. It will attain altitudes associated with the lower extremes of the ozone hole and, since it has a greater range than the ER-2, will survey the polar vortex and explore the region of high ozone outside the vortex.

ECMWF participation in the project is on two important fronts. Firstly, surface weather at Punta Arenas can change rapidly when cyclogenesis occurs to the west of the Ross Sea; surface winds of up to 60 knots can occur. In addition, upper air temperatures of -95°C or colder may be expected over large volumes of air in the vortex during August and September and this may cause problems with the operation of the aircraft; winds of up to 200 knots may be expected at ER-2 cruise levels in some regions. Considerations of aircraft and personnel safety therefore require the availability of the best possible forecast charts for interpretation by a forecaster experienced in that particular region: ECMWF forecast products up to day 10 are, with United Kingdom Meteorological Office forecasts to day 3, sent to Punta Arenas daily by facsimile for flight planning.

Secondly, the success of the flights also depends upon knowing the exact position of the hole at the time of each flight. Two methods are being used for this purpose. The first is total ozone maps produced using TOMS (Total Ozone Mapping System), as observed from the Nimbus satellite. This is supplemented by a second system which shows the total ozone, including that in regions of darkness. The HIRS instrument (High resolution Infrared Radiation Sounder) on a TIROS series satellite provides total ozone retrievals which are relayed from NASA and acquired onto the ECMWF Cray X-MP/48 system. Here, a suitable subset of orbits are extracted and are then processed using an ozone model developed by D. Cariolle, CRNM, Toulouse. The resulting ozone map is also sent to Punta Arenas as an aid to flight planning.

A complex telecommunications network (see front cover illustration) was established to fulfil these purposes, linking NASA Goddard Space Flight Centre in Washington to Punta Arenas, ECMWF and the UK Meteorological Office. ECMWF has lines to Washington, Punta Arenas and the UK Meteorological Office. A small telephone exchange linking these sites into a "local" network has been installed at ECMWF, in addition to two facsimile machines for the transmission of forecast charts and ozone maps. The costs of the project are being covered by NASA.

- Pam Prior

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REVISED USE OF SATELLITE DATA IN THE OPERATIONAL ANALYSIS

Over the last few years several modifications have been introduced into the operational forecasting system to improve the use of satellite data. Since February 1985 data with a resolution of 250 km have been used - twice the resolution of the data generally available on the GTS. Initially, because of the structure of the analysis code, SATEM reports were assumed to comprise 14 levels of information, subsequently this practice was altered and from October 1985 only 11 levels were used. In addition, more stringent checking procedures were introduced and satellite data has, from time to time, been blacklisted for some geographical regions and for some levels, in order to deal with operational problems.

It is clear that the satellite radiance measurements from which SATEMs are derived can only provide 6/7 layers of information in the vertical. Any additional detail in SATEM reports can only come from the retrieval method used to deduce temperature and humidity profiles from the observed radiances.

Over the past year a major study has been undertaken to review the use of SATEM data in the operational system. Two periods have been studied - 14 to 20 November 1979 and 30 January 1987 to 14 February 1987 - and three possibilities have been evaluated: an 11-layer SATEM, a 7-layer SATEM, no SATEM data. The results of this study may be summarised as follows:

(i) many SATEM reports have large errors which are mainly due to cloud-clearing (the procedure to derive clear-column radiances from a cloud contaminated field) or rain contamination of microwave data (this is the main reason why large errors have been attributed to satellite data);

(ii) because of the large observational errors ascribed to satellite data, they have a modest effect on analyses; as a consequence, if there are large differences between accurate SATEM reports and the first guess, in the absence of other data a significant correction to a first guess can only be achieved after a number of assimilation cycles;

(iii) in the Southern Hemisphere the impact of SATEM data is consistently positive, however, in the Northern Hemisphere the impact is often dependent on the synoptic situation;

(iv) the use of 7 layers in place of 11 layers improves analyses, however, the impact on the resulting forecasts is small - in the Southern Hemisphere, where SATEMs are the main data source, the impact is noticeably positive; the use of 7 layers permits more data to be used in the horizontal.

Following the previous study a modification was made to the operational analysis on 21 July. The main purpose was to use 7 SATEM layers in the vertical instead of 11: 1000/700 hPa, 700/500 hPa, 500/300 hPa, 300/100 hPa, 100/50 hPa, 50/30 hPa and 30/10 hPa.

The other technical changes related to SATEMs are:

(i) rederivation and retuning of vertical covariance matrices for SATEM observation errors. The new statistical sets contain two 7 x 7 covariance matrices: one for clear soundings and one for cloudy and microwave soundings;

(ii) revision of the SATEM quality control checks, which are now more stringent;

(iii) SATEMs are no longer blacklisted below 400 hPa in the polar areas;

(iv) the horizontal correlation of SATEM observation error is put to zero when the two SATEMs belong to different satellites. Also, when the observations belong to the same satellite, it is reduced by a factor which depends on the time difference between the two observations.

Some technical changes not related to the use of SATEMs are also included:

(i) modification of the weights given to different boxes in the horizontal overlapping technique;

(ii) introduction of an overlap in the vertical between the two layers, or slabs, for which wind analyses are produced;

(iii) improvement of the data selection near the poles.

The impact of the operational modification of 21 July is illustrated by the scatter diagrams in the top part of Fig. 1, which show the comparison of the anomaly correlations of 15 forecasts at day 4 for the old system versus the new system ("7 LAYER EX") during the period 30 January - 15 February 1987: the improvement obtained from the modified analysis is really significant only in the Southern Hemisphere. As a reference, the bottom diagrams show the impact of SATEMs presented in the same way: "NO-SATEM" versus "OLD SYSTEM".

- Graeme Kelly, Jean Pailleux, Per Undén

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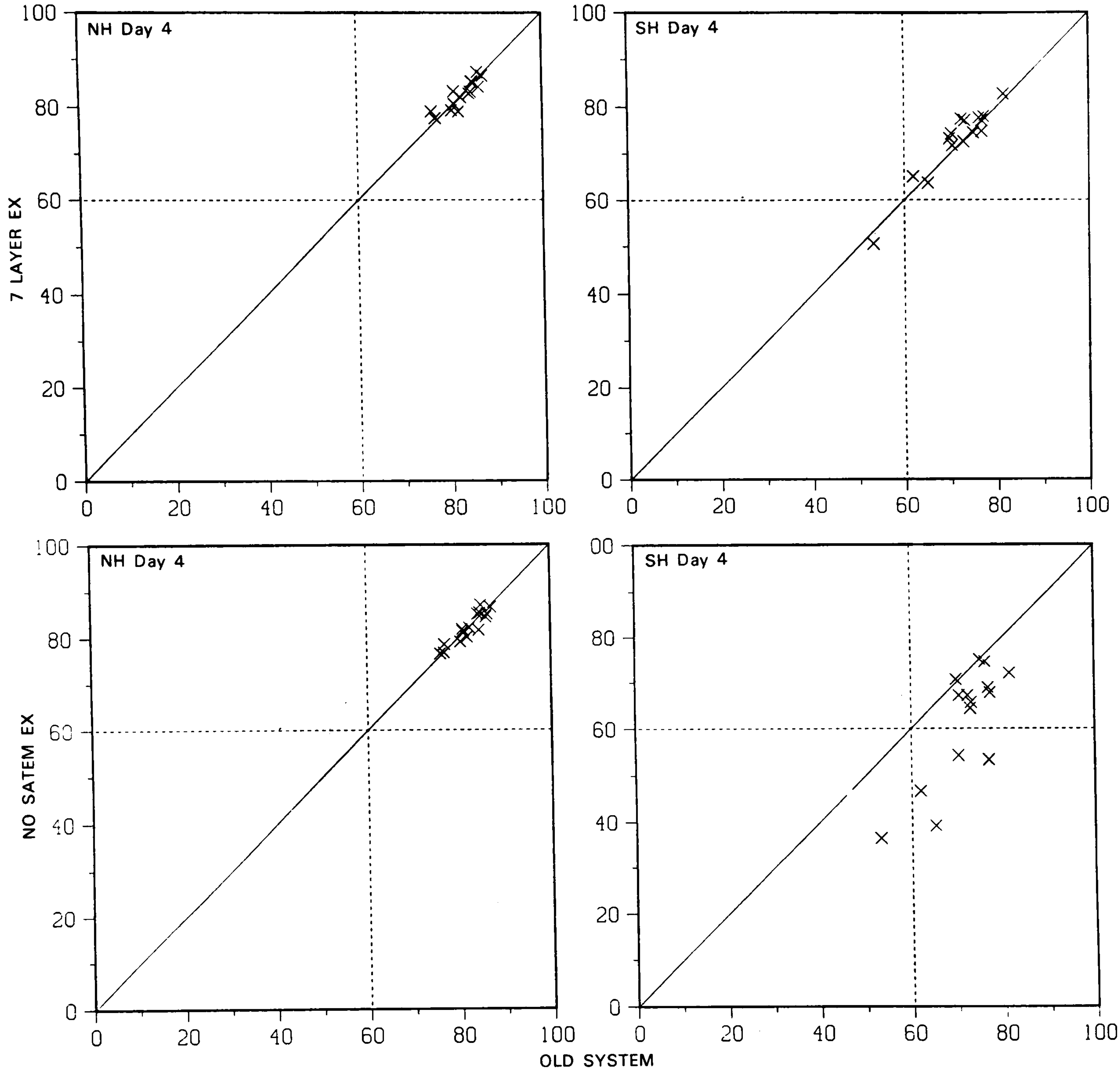

Fig. 1: Impact of the SATEMs and of the revised use of SATEMs on the quality of the forecast

Each scatter diagram shows 15 points, each of them comparing the anomaly correlation at day 4 of two forecasts from a case between 30 January and 15 February 1987.

- Horizontal axis: anomaly correlation of the old system (operations before 21 July 1987 - 11 layers for SATEMs)
- Vertical axis: anomaly correlation of the new operational system, 7 layers (top diagrams), or of the "No-SATEM" experiment (bottom diagrams)

NH - Northern Hemisphere on the left

SH - Southern Hemisphere on the right

THE SPIN-UP PROBLEM

An important problem in numerical forecast models is the specification of well balanced initial conditions. In the case of purely adiabatic processes constraints on mass and wind fields must be preserved to avoid the generation of gravity modes during the forecast. When diabatic processes are included, the balance is more complex, involving the thermal as well as the dynamical state of the model. Imbalances in the initial thermodynamic state result in a mutual adjustment of the model fields as they approach a dynamical and physical balance. This initial adjustment phase, which can be as long as three days in the tropics, is commonly referred to as the "spin-up". A study of the model "spin-up" and the imbalance typical of the initial state may give insights into deficiencies in the data, in the analysis technique and the initialisation. Since the spin-up is also a function of the dynamics and the physical parametrisation, it may also provide insights into possible model deficiencies. A better understanding of the behaviour of the model in its initial adjustment phase will also help in the understanding of its subsequent time evolution and how the model approaches climatology.

The adjustment during the spin-up manifests itself in various aspects of the forecast fields. It is particularly evident in quantities such as vertical velocity, humidity and rainfall. Fig. 1 plots the mean specific humidity as a function of forecast time. The drying is very intense in the first few days, indicating a large imbalance between precipitation and evaporation. This is clearly displayed in the global hydrological budget, Fig. 2, which provides a good global measure of the spin-up. Precipitation exceeds evaporation in the first few days, with a maximum precipitation between 24 and 36 hours. An equilibrium is reached only after 3 days. A separation between large scale and convective heating shows that the spin-up is mainly a tropical problem. Closer study of the geographical distribution of excess precipitation in the tropics shows that it is not confined to one specific area; it rains excessively over the major convective regions, particularly Indonesia, the Indian Ocean and Southern America. In the first few days the convective rain tends to be too widely spread and does not exhibit the typical banded structure of the tropical forecast. Only after 3 days does the rainfall pattern show a more organised structure.

The characteristic signature of the spin-up hardly appears to have changed over the years, although there are some noticeable differences from earlier versions of the forecast model (Fig. 3). In the previous model (T63 and original parametrisation), the hydrological cycle was initially much too weak and quickly spun up to its balanced state (Fig. 3a). In the present model (T106 with modified physics) the hydrological cycle, despite starting at a higher but more realistic level, still spins up as before but falls later to reach a balance by day 3 (Fig. 3c). The introduction of a stronger horizontal diffusion into the previous model in March 1984 had little effect on the spin-up other than lengthening the spin-up time from 2 to 5 days (Fig. 3b). In the following, the hydrological budget will be used as a measure of the sensitivity of the spin-up to changes in the initial state and the model formulation.

A series of sensitivity experiments has been carried out to test how the "spin-up" problem is affected by initialisation, the use of data and model physics. These experiments have shown that the hydrological cycle is insensitive to the initialisation procedure, shows rather more sensitivity to the use of various data types in the analysis, especially moisture data, but is most sensitive to the convective parametrisation scheme. Each convective scheme has its own characteristic signature in the spin-up. The time-scale over which a hydrological balance is eventually reached is a function of the parametrisation scheme used (and its tuning). The operational version of the KUO-scheme (Fig. 2) develops rather widespread convective rain, particularly between 24-36 hours. On the other hand, when other convection schemes such as the "adjustment scheme" are used, the model tends to adjust on a much shorter time-scale, but more vigorously. Fig. 4 shows a hydrological budget typical of an "adjustment" forecast; it tends to give excessive rainfall in the first 12 hours,but adjusts quickly to a balance. Although the time scale is much shorter than in the operational KUO, there is still evidence of an adjustment process. Other more complex convection schemes such as the new Massflux scheme, behave differently again (Fig. 5). The excess of precipitation in the first few days is no longer present and a balance is reached rather quickly. On the other hand, in the later stages of the forecast, the model precipitation tends to be too low with respect to climatology. In summary, then, the "spin-up" as seen in the hydrological budget is very sensitive to the type of convection scheme used. This suggests that a vigorous spin-up may be due to an inconsistency between the thermodynamic structure as defined both by the data and the analyses and the thermodynamic structure typical of the forecast, which is determined largely by the convection scheme. Further studies are planned to isolate the types of data and the manner in which they are used in the analysis, leading to this inconsistency. A more detailed account of some of the major aspects of this complex problem will be found in ECMWF Technical Memorandum No. 137.

- Lodovica Illari

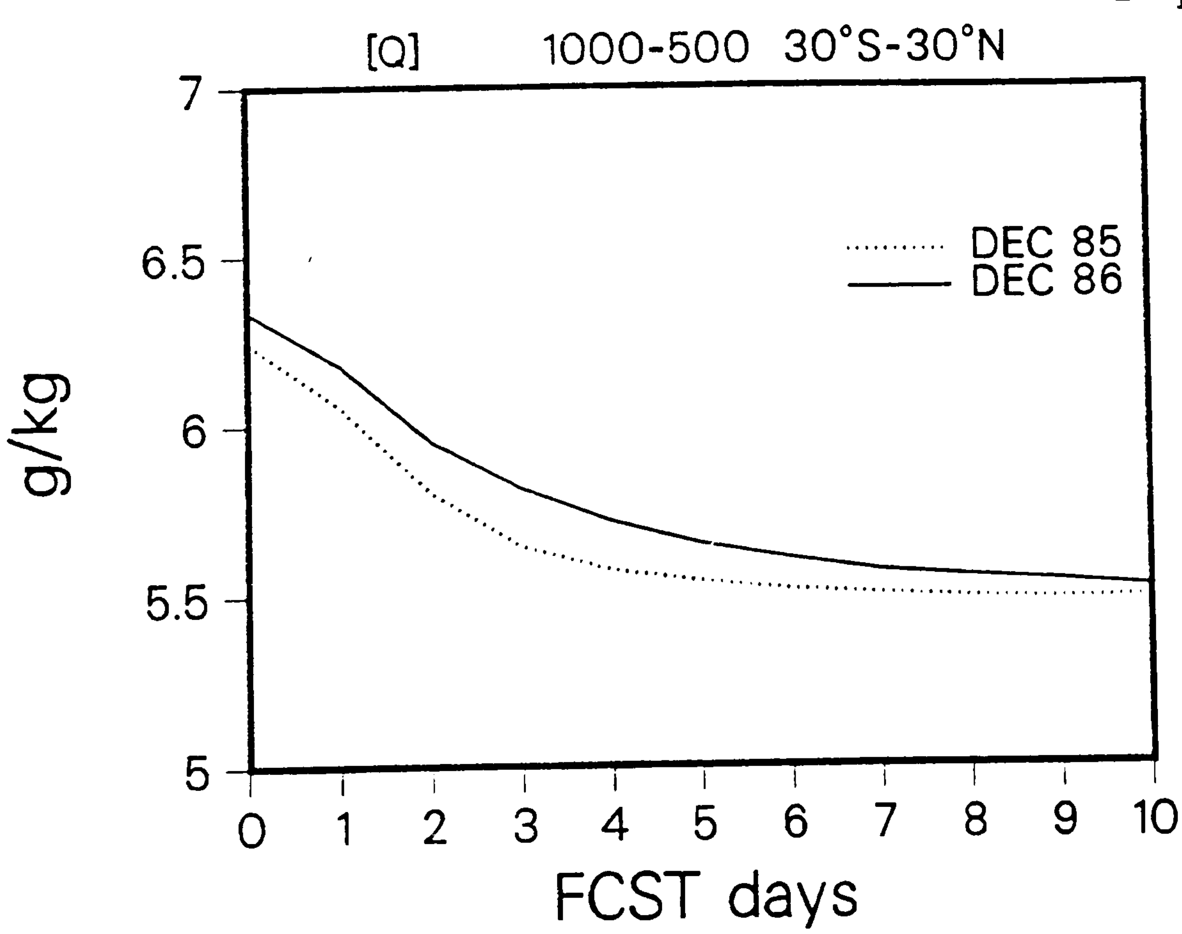

Fig. 1: The area averaged specific humidity as a function of forecast time over 30°S to 30°N and between 1000 and 500 mb.

Fig. 2 : A typical hydrological budget obtained from a forecast from 12 GMT, 15.12.85.

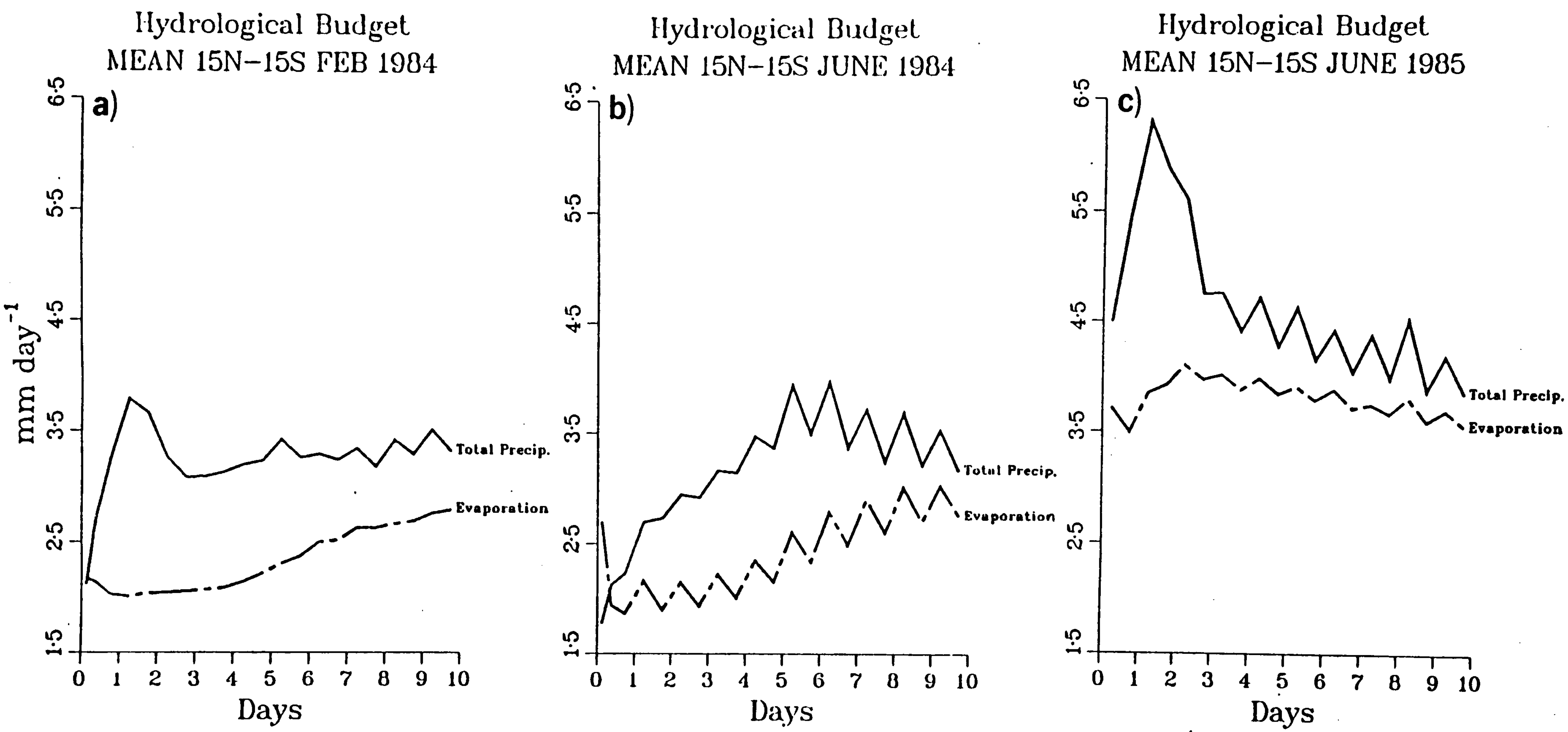

Fig. 3: Precipitation and evaporation budgets (mm/day) in the Tropics (15°N to 15°S) a) February 1984 - T63 old physics, b) June 1984 - T63 old physics and enhanced horizontal diffusion, c) June 1985 - T106 new physics and reduced horizontal diffusion (from Brankovic, 1986).

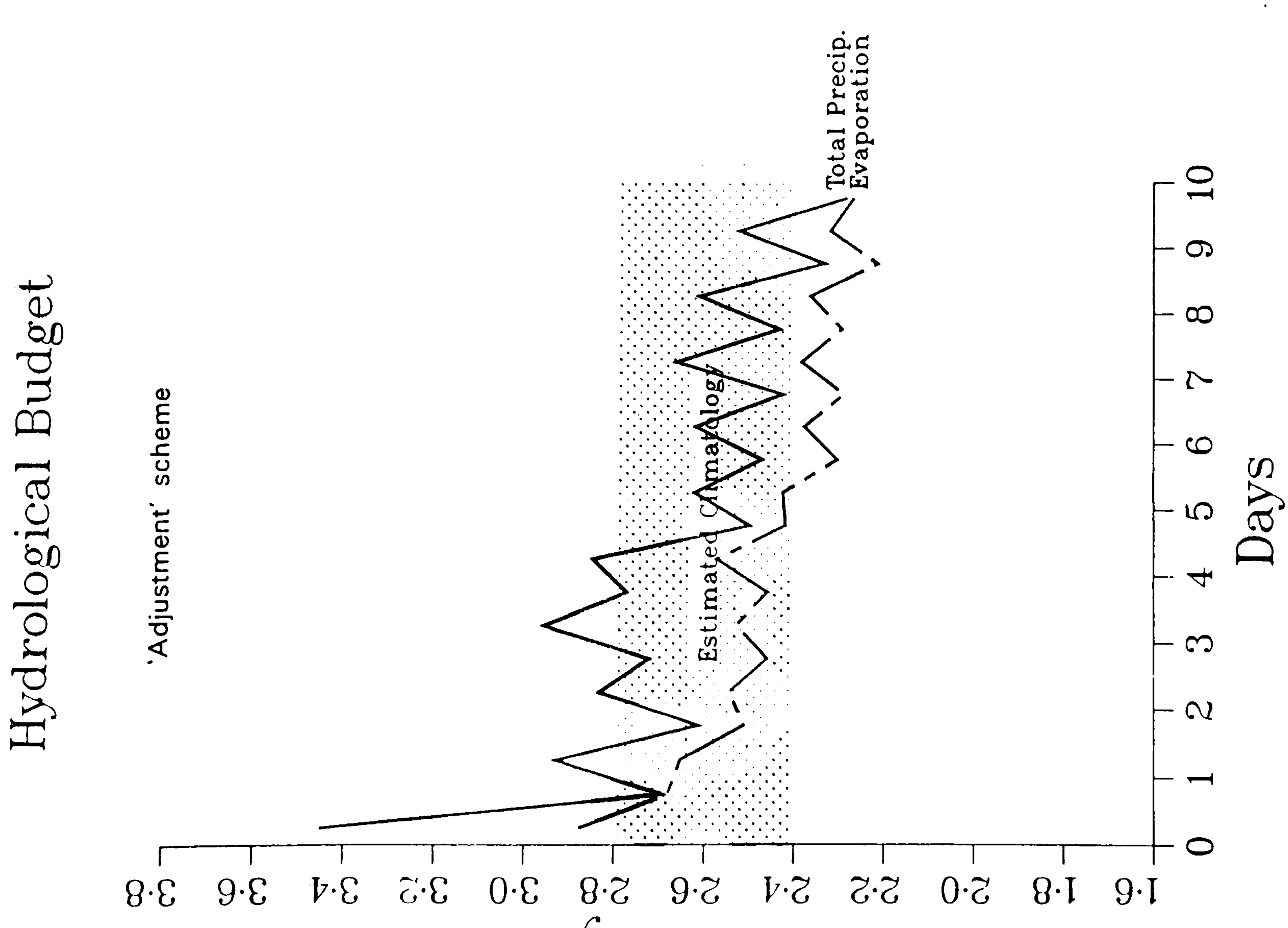

Fig. 4: The hydrological budget for a forecast from 12 GMT on 15.12.86 using the "adjustment" convection scheme.

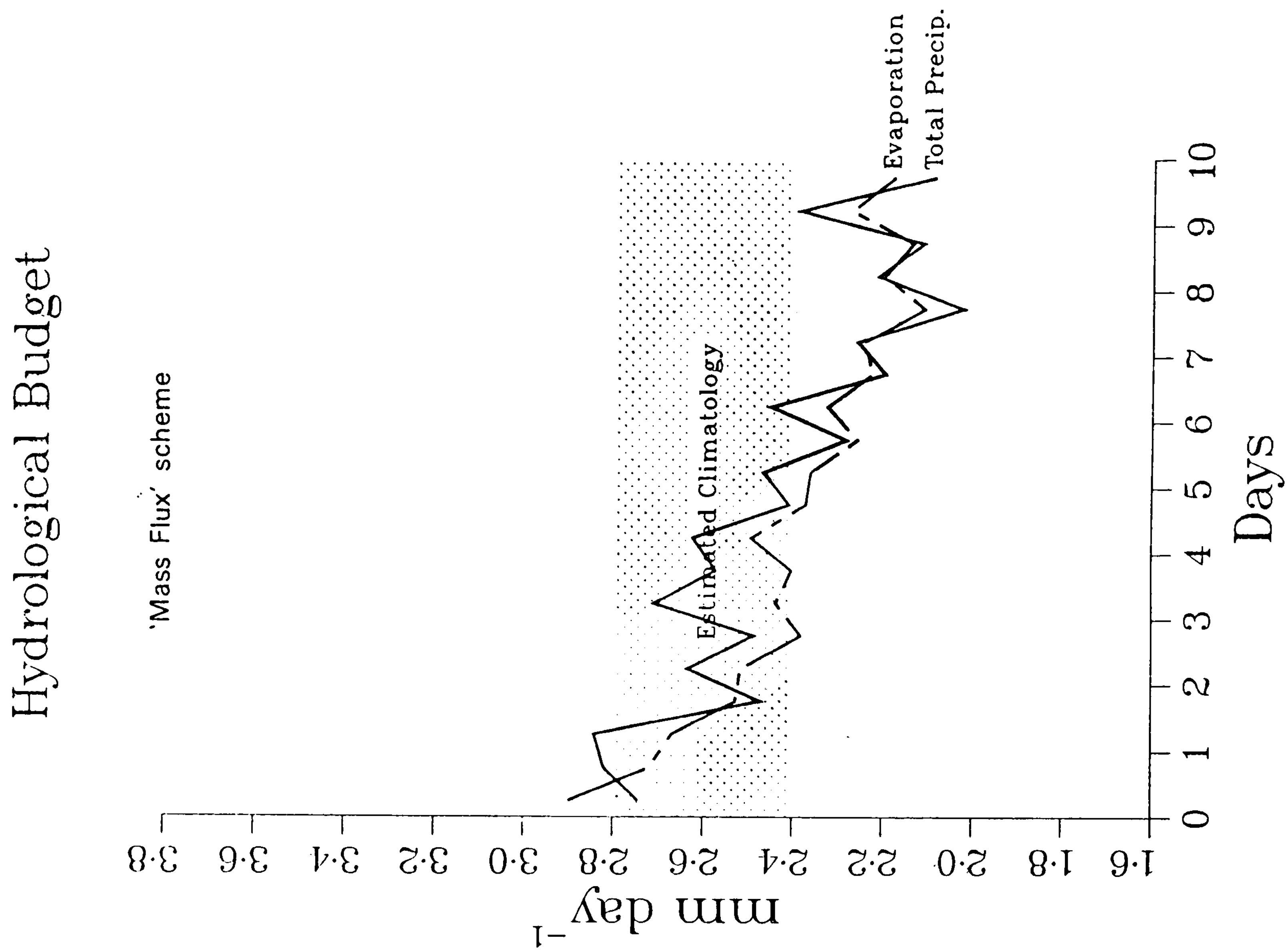

Fig. 5: As in Fig. 4, but for the "mass flux" convection scheme.

THE DATA HANDLING SYSTEM, PHASE 2

New data handling hardware was installed at the end of June, as a result of a tendering exercise which took place at the end of 1986/beginning of 1987 and following Council approval of the equipment selected, at its 25th session (11-12 June). Contracts for the acquisition of the new systems were signed on 22 June. The equipment comprises an IBM 3090 model 150E processor with a vector facility, an IBM 3380 disk system and an IBM 3480 cartridge tape system; a diagram of the new configuration is given overleaf.

IBM 3090 model 150E processor with a vector facility

The single CPU model 150E processor has 16 channels and 32 Megabytes of memory and is rated at approximately 11.5 MIPS.

The vector facility is an attached array processor which will be used for the manipulation and conversion of MARS archive data. Initial calculations indicate that the vector facility should be capable of processing the MARS data at up to 70 MFLOPS.

IBM 3380 disk system

This comprises four double density disk units, giving a total capacity of 20 Gigabytes of disk storage, and two disk controllers.

IBM 3480 cartridge tape system

Eight of the newly available cartridge tape drives and two controllers comprise this system.

These 3480 cartridges contain 18 track tape with a linear density of 38,000 bytes per inch. Each cartridge measures 4 inches by 5 inches by 1 inch and has a data capacity of 200 Megabytes.

The new equipment was installed on 26 June and a 30 day acceptance period began on 29 June; it ended successfully on 29 July.

The new data handling processor and storage will provide the power and reliability required to support the full meteorological archiving and permanent file management which are planned for 1988.

The cartridge tapes are already being used via the IBM 4341 for all new MARS archive data. The 3090 processor and vector facility will be used for system trials until they fully replace the 4341 processor in October.

\- Tony Stanford

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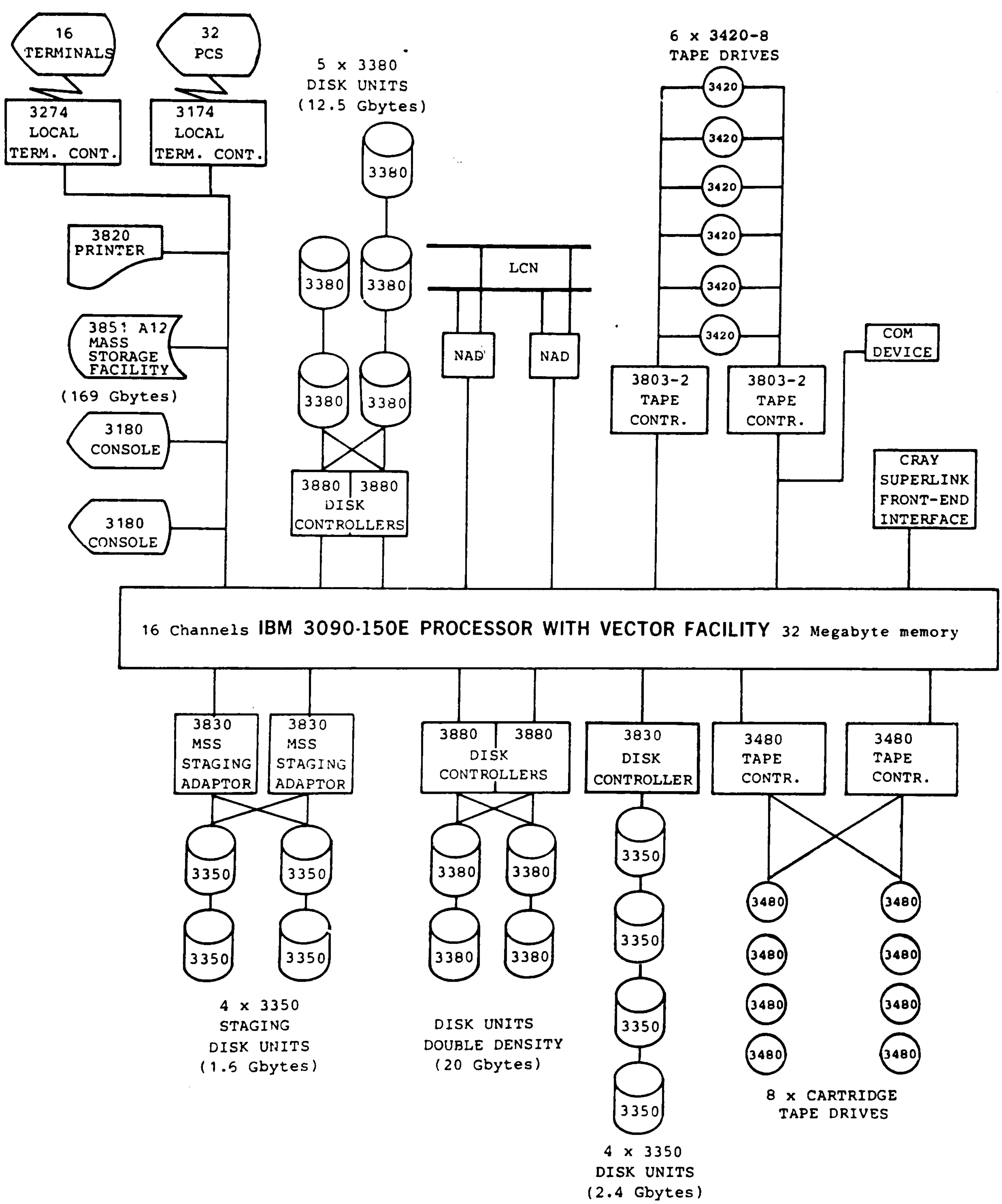

Data Handling System Configuration as in October 1987

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 207). All other News Sheets are redundant and can be thrown away.

No.	Still Valid Article
16	Checkpointing and program termination
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
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
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
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

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ECMWF CALENDAR 1987

7-11 September	Seminar: "The nature and prediction of extra tropical weather systems
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
14-16 December	ECMWF/WMO Workshop on Radiosonde Data Quality and Monitoring

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ECMWF PUBLICATIONS

TECHNICAL MEMORANDUM N° 133: ECMWF monitoring tools and their application to North American radiosonde data

TECHNICAL MEMORANDUM N° 134: Decoding data represented in FM 94 BUFR

FORECAST REPORT N° 37

Forecast and Verification Charts to 30 June 1987

Daily Global Analysis: January-March 1986 and April-June 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

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