European Centre for Medium Range Weather Forecasts

ECMWF NEWSLETTER

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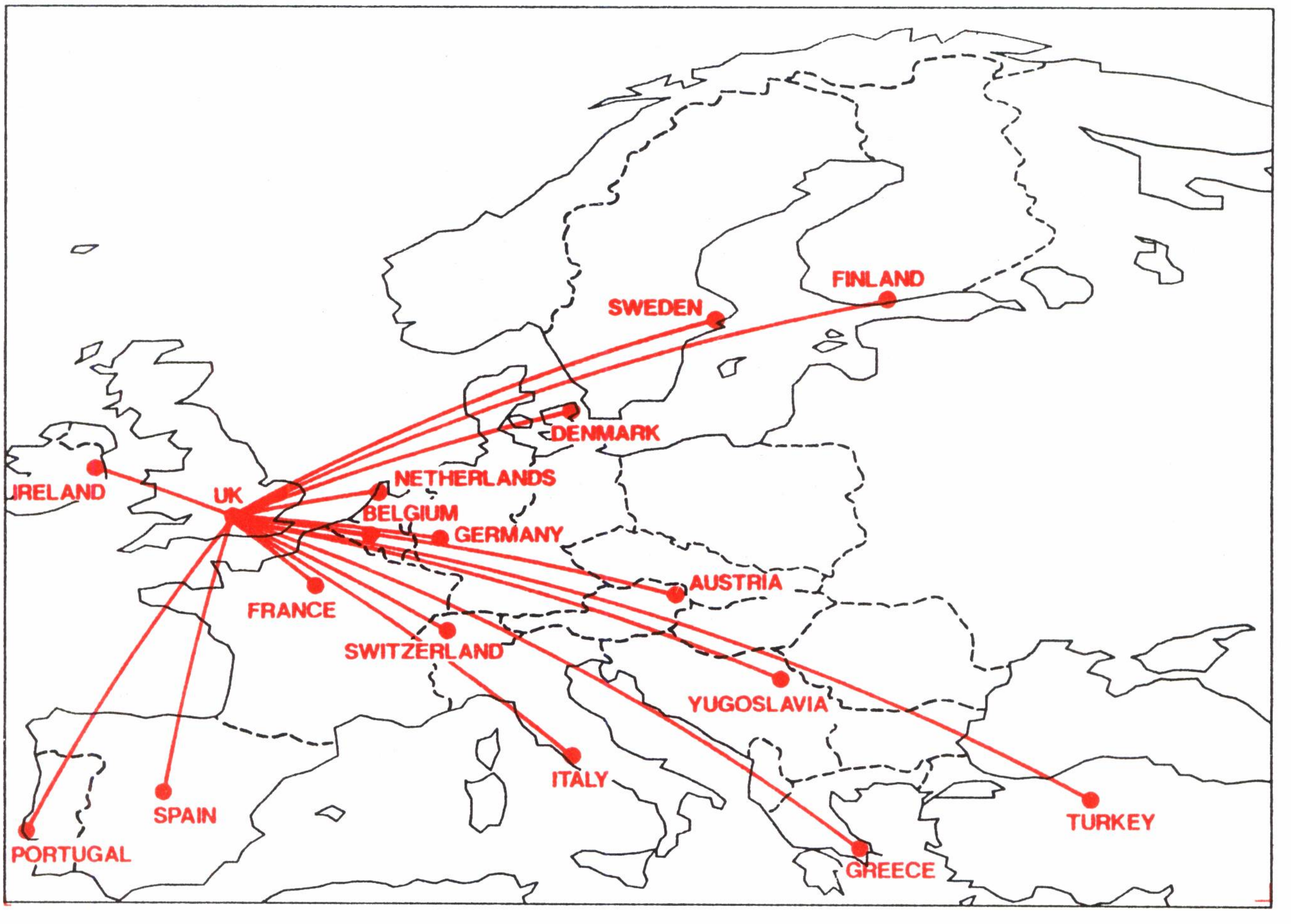
Number 43 - September 1988



IN THIS ISSUE

COVER: The cover illustration depicts the ECMWF telecommunications network, which is now comprised entirely of medium-speed lines, that is, lines of 2.4, 4.8, 9.6 or 14.4 kilobits per second.

This Newsletter is edited and produced by User Support.

The next issue will appear in December 1988.

The second generation of the ECMWF Meteorological Operational System (EMOS) is currently being developed. An article on page 3 gives a description of the design of the preprocessing element of the system.

An article on page 6 gives a brief background to research into the parametrisation of convection at ECMWF in the last few years and describes two schemes, one of which will replace the present Kuo scheme early next year.

On 5-9 December this year ECMWF will hold a workshop on the use of parallel processors in meteorology. Those interested will find brief information on the workshop on page 15.

CHANGES TO THE OPERATIONAL FORECASTING SYSTEM

Recent changes

On 12 July 1988, the following changes to the analysis were introduced:

(i) modification of the structure functions, resulting in an increased effective horizontal and vertical analysis resolution, which produces a more detailed analysis of synoptic features such as cyclones and jets, compared with the previous operational scheme;

(ii) complete revision of observation and forecast error statistics;

(iii) more efficient OI check of SATEMs in areas with sufficient non-SATEM data;

(iv) general tuning of first-guess and OI rejection limits;

(v) conditional first-guess rejection limits depending on the observing system, the magnitude and sign of difference between observation and six hour forecast and on flow type.

These changes in the analysis are a necessary prerequisite for the planned analysis of high resolution satellite data sets.

Experiments with the modified analysis have indicated that the changes have an overall positive impact on the forecast quality in the Northern Hemisphere, particularly in the early stages, where significant improvements were noted as early as 12 hours into the forecast. In the Southern Hemisphere moderate positive impact on the forecast skill is expected for the whole forecast range. The forecast sensitivity to the quality of data, in particular satellite thicknesses, has increased considerably with improved analysis resolution; however, the modified quality control algorithms minimise the impact of bad data.

Planned changes

(i) The surface analysis code will be replaced by a new one. It is mainly a technical development consisting in performing the analysis of surface variables inside the context of the main analysis program (rewritten in September 1986) rather than in a separate step. Little meteorological impact is expected on the SST and snow analysis (the only surface variables currently analysed). However, the SST computations will use as input the 2 degree mesh SST analysis from NMC, Washington, (instead of the 5 degree mesh). Thus more detail is expected on the initial SST field used to run the ECMWF operational model.

(ii) In order to correct some of the deficiencies of the 2m temperature forecast, a modification of the surface scheme will be implemented. It consists in decreasing the depth at which the roots of the vegetation cover take up the soil water, thus decreasing in dry conditions the moisture available for evaporation.

(iii) The adoption of the vertical finite element scheme and of new radiation and convection schemes is planned for early 1989.

- Bernard Strauss

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THE NEW ECMWF PREPROCESSING SCHEME

Preprocessing

Meteorological data are received at ECMWF as relayed from the GTS by the Deutscher Wetterdienst at Offenbach and the United Kingdom Meteorological Office at Bracknell. The purpose of the preprocessing subsystem is to decode, reformat, check and prepare data for use within the computing environment and, in particular, as input to the data assimilation. The advent of FM 92 GRIB (GRid In Binary), and FM 94 BUFR (Binary Universal Form for the Representation of meteorological data) has provided an unique opportunity to design meteorological applications to interface to standard binary forms that are completely machine independent. ECMWF plans to make the most of this opportunity by redesigning and redeveloping the preprocessing subsystem as part of the move to a second generation EMOS (ECMWF Meteorological Operational System).

Requirements of the new preprocessing

The prime objective is to provide the best set of data for the data assimilation scheme in a dependable and timely manner. It is also required that reports data be available for other applications, including monitoring and plotting, that an archive of reports be supported, that erroneous character messages be manually inspected and corrected, and that difference statistics and quality feedback from the analysis be accommodated.

Experience during nearly 9 years of daily operations at ECMWF has shown that the reports presented to the data assimilation could be enhanced by

- better monitoring of quality in near real-time
- improved quality checks
- more flexible blacklisting.

Additionally, the new subsystem will be required to accommodate efficiently the increase in reports data resulting from enhanced availability of satellite data and data derived from automated observing systems likely to be developed over the next 10 years.

Design and development

Data are received as meteorological messages. Each message may be classified into one of a set of broad data types without decoding the main body of the message. An enhanced data acquisition system will accomplish this classification, producing a message data base (MDB) to serve as input to the new preprocessing.

Preprocessing results will be delivered in terms of fields of products, formatted in FM 92 GRIB, for insertion into the fields data base (FDB); validated reports, formatted in FM 94 BUFR, will be written to a reports data base (RDB).

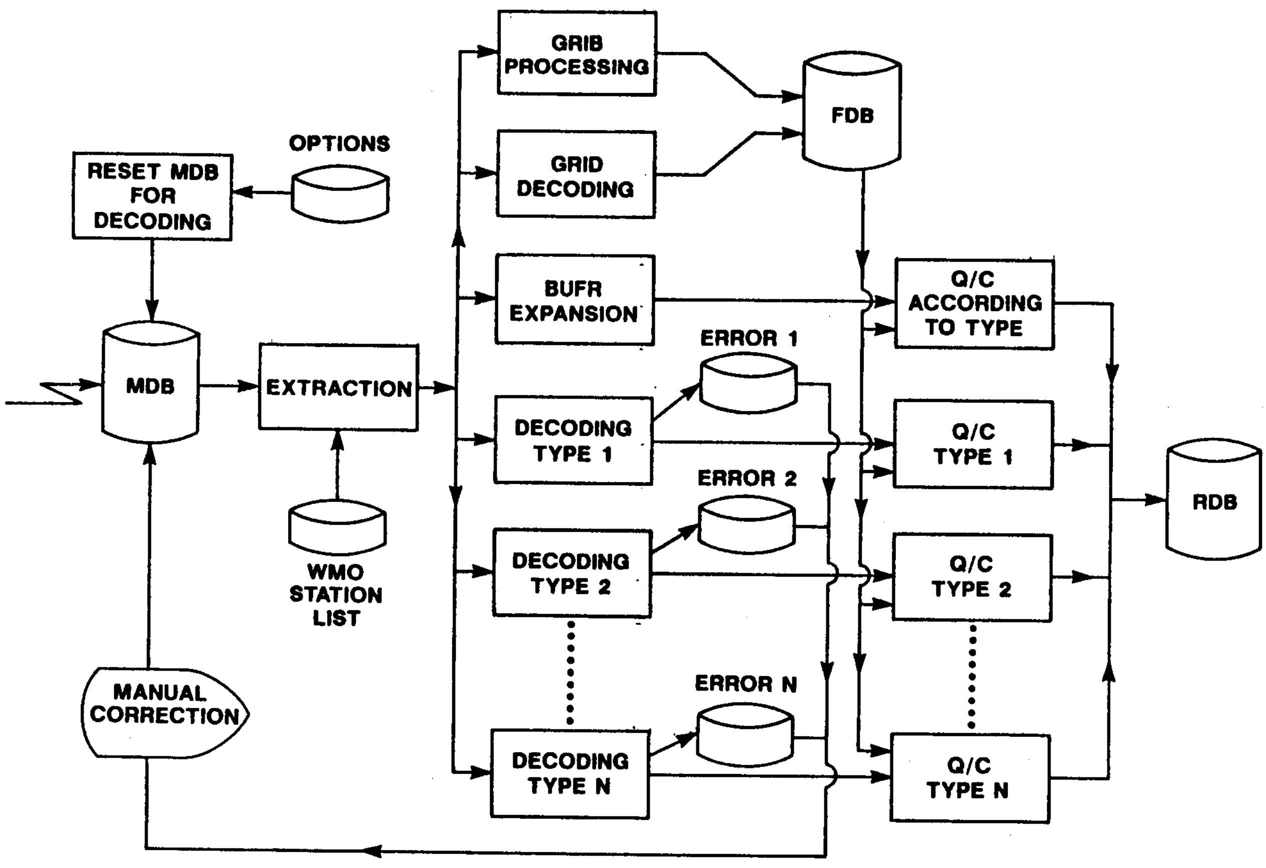
An overview of the design of the new preprocessing subsystem is given in Fig. 1. Note that the separation into approximately 10 types of data during the enhanced data acquisition enables a similar classification and partitioning to be extended to the structure of the MDB and RDB and allows the preprocessing to be divided between a corresponding number of processes, each using a common library of routines, but each able to execute independently of the others.

The preprocessing processes will be developed as semi-continuous processes, decoding and validating data in near real-time. For products received from other centres, data will be reformatted into GRIB, adding full grid descriptions, and made ready for addition to the FDB. Coded observations will first be decoded into an expanded BUFR form, then checked and validated. Initially, checks similar to those currently in use will be maintained; at a later date these will be revised and extended to include additional temporal checks, and possibly initial checks against fields of first-guess data. Errors detected within the character codes will be fed to error files for manual correction and resubmission, after all possible information has been extracted and retained for checking. Observational data received in BUFR will require only a simple expansion process before being passed to appropriate validation and checking routines; thus, as binary forms gradually replace character codes, the work to be done at the decoding stage will gradually decrease.

In addition to being structured according to the report types, the RDB will be structured by time. This will assist the extraction process for the analysis and enable other applications efficiently to identity data relating to synoptic hours.

Blacklisting will be applied as data are extracted for the analysis, rather than as data are validated, as was previously the case; this will ensure that blacklist changes have full effect, and will provide a flexible tool for experimentation.

The new subsystem will be developed to use the VAX configuration, enhanced by the addition of a VAX 6210; this will enable the data to be processed within the environment of its acquisition and will ensure preprocessing continuity when the Centre's mainframe computers have to be replaced. Much of the present decoding software will be adapted, rather than being completely rewritten. The validation and checking software, currently written in FORTRAN 66 will be upgraded to FORTRAN 77. Standard VAX VMS features will be used, where possible, as a foundation for the data base software. It is hoped to meet the urgent requirement to process high resolution satellite data with the new subsystem by the end of this year, and to migrate gradually to the new subsystem, reports type by reports type, during 1989.



\- Rex Gibson

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Fig. 1: The new preprocessing subsystem

THE PARAMETRISATION OF CONVECTION IN THE ECMWF FORECASTING MODEL

Introduction

A fundamental component of the Centre's forecast model physics is the convective parametrisation scheme, and the development and testing of new, more comprehensive schemes has been a major aspect of the research work in the past few years.

The importance of diabatic heating by cumulus convection has long been recognised, not only in the maintenance of the tropical energy budget and mean flow but also as the primary energy source for tropical disturbances. Accurate modelling of the dynamics of the atmospheric general circulation depends crucially on our ability to represent the interactions between the large-scale circulations and the major convective heat sources.

The rôle of deep convection in the extra-tropics is less well documented historically but has been a major research area in the last decade. A variety of convectively dominated phenomena which contain complex partitioning of convective and stratiform rain-producing structures have been identified. Many observational and theoretical studies have shown that convective precipitation is an important component of most baroclinic systems either as 'upright' convective ascent or 'slantwise' ascent in zones of strong vertical and/or horizontal shears. The presence of strong wind shear, mid-level cloud bases and 'slantwise' instability complicate the convective parametrisation problem in extra-tropical latitudes. The new schemes described below allow mid-level convection and have been extended to include slantwise convection, but only in a preliminary research context. One of the two schemes will be introduced into operation early next year.

Parametrisation of cumulus convection

Parametrisation of cumulus convection in large-scale models implies the interaction of the synoptic flow, individual clouds and possible organisation in meso-scale cloud complexes with well developed circulations. Although there seems to be sufficient evidence from observational and numerical studies that cumulus convection is basically parametrisable, in spite of the existence of meso-scale organisation, large uncertainties exist. Currently applied schemes fall into one of two categories:

(i) Specification of convective warming and moistening to maintain equilibrium states

This type of scheme implies that convection exerts a strong influence on the large-scale flow such that under convective situations the thermal structures rapidly approach certain equilibrium states. It is applied in adjustment schemes.

(ii) Coupling of convective heating and moistening to advective (and boundary layer) processes

Here the assumption is that penetrative convection occurs in response to large-scale processes, in particular the low level large-scale moisture convergence, as for example in the Kuo scheme which is widely used in large-scale models.

Both schemes seem to be supported by observational data and it is not currently possible to give preference to one against the other. Nor is it even clear whether they are sufficient to describe properly the range of convective phenomena requiring parametrisation. In view of these and other uncertainties the Centre has assessed a number of convection schemes during recent years. We found that none of them has significant advantages over the operationally used Kuo-scheme and consequently the only change to the operational model in May 1985 consisted of a modification to the Kuo-scheme together with the introduction of a new scheme for shallow convection. Although these changes led to significant improvements in the Centre's forecasts and analyses in various aspects, there still exist large deficiencies in the simulated flow, which in all likelihood are connected to cumulus parametrisation, so there remains a strong motivation for further studies in this area.

Since the changes in May 1985 we have concentrated on the development of two schemes:

the generalised adjustment scheme
a massflux scheme in connection with a moisture convergence closure.

Generalised adjustment scheme

The scheme is based on the observational evidence that in convective situations there exists a quasi-equilibrium between the cloud fields and the large-scale forcing. This implies the existence of characteristic temperature and moisture profiles which can be observed and used as the basis for adjustment schemes for shallow (non-precipitating), deep and middle-level convection. Given suitable profiles, the large-scale temperature and moisture fields can then be simply adjusted as for instance

$$\left(\frac{\partial \bar{T}}{\partial t}\right)_{cu} = \frac{T_{ref} - \bar{T}}{t}$$

In our scheme the lapse rates of the reference profiles of temperature T_{ref} and moisture q_{ref} are defined from observational data in the Tropics and are applied over the whole globe. The relaxation time is a disposable parameter which has been determined from one-dimensional experiments using special observational data sets. An important aspect which is central to the adjustment philosophy is that the difficulties in representing the wide range of cloud and subcloudscale processes are effectively bypassed. However, the scheme relies heavily on observational data to provide realistic reference profiles and relaxation times under various conditions.

Massflux scheme
The interaction between the large-scale flow and the cumulus cloud fields is explicitly modelled. The conceptual idea of the cumulus clouds is that adopted in many diagnostic studies. Cumulus clouds are assumed to be embedded in the large-scale environment. They share the same cloud base but extend to various heights. They are defined by updraft and downdraft mass fluxes and by their thermal properties as dry static energy, moisture and cloud water content. The bulk of the clouds is assumed to be in a steady state and is represented by a one-dimensional model. In representing the clouds as a bulk we follow earlier diagnostic studies prior to the introduction of spectral cloud ensembles, which show that realistic contributions from convection to the large-scale budgets of heat and moisture can be obtained.

A simple scheme for the parametrisation of cumulus momentum transports where cumulus effects are expressed in terms of convective massfluxes has been adopted in the massflux scheme and has been found to be beneficial in reducing the errors in the mean tropical flow.

Results

Experimentation
Both new schemes have been comprehensively tested in global forecasts on a large number (35 and 28 respectively) of initial dates during the last two years. In addition, extended integrations (T63, 30 days) were made from two summer and two winter dates. Both schemes were also tested in the data assimilation suite for short periods during the Australian Monsoon Experiment (AMEX, Jan/Feb 1987) where the data coverage in the convectively active area north of Australia was enhanced.

Convective forcing and time-mean tropical flow
The primary aim of convection parametrisation is to produce realistic profiles of convective heating. Unfortunately, adequate data to verify these profiles are not available and therefore convection is often assessed in terms of zonal means of the time averaged heating. The zonal mean values obtained from the three convection schemes (i.e. operational scheme and the two new schemes) show distinctly different profiles. The heating over the tropical sea obtained with the two new schemes is more intense at higher levels than with the operational Kuo-scheme which appears rather too low. The effect of convective heating on the large-scale flow is most pronounced in the divergent part and consequently it is there that we see the largest impact from the two new schemes. In agreement with the stronger heating extending over a deeper layer we find that the divergent flow at higher levels is much stronger in the integrations with the two new schemes (Fig. 1). In particular we notice that the collapse of the circulation over the Indonesian area and West Pacific, which is typical for the operational model, disappears and there is now better agreement with the analysed divergent flow. However, the impact on the rotational flow is much smaller, leaving the errors in the zonal wind in winter, for example, rather unaffected by cumulus parametrisation. However, the error seems to be more sensitive to momentum forcing by cumulus convection, as we infer from the extended summer integrations where the massflux scheme was run with and without momentum transports. When momentum transport is included, the wind errors are much reduced, most noticeably over the western Atlantic, South America and the Pacific.

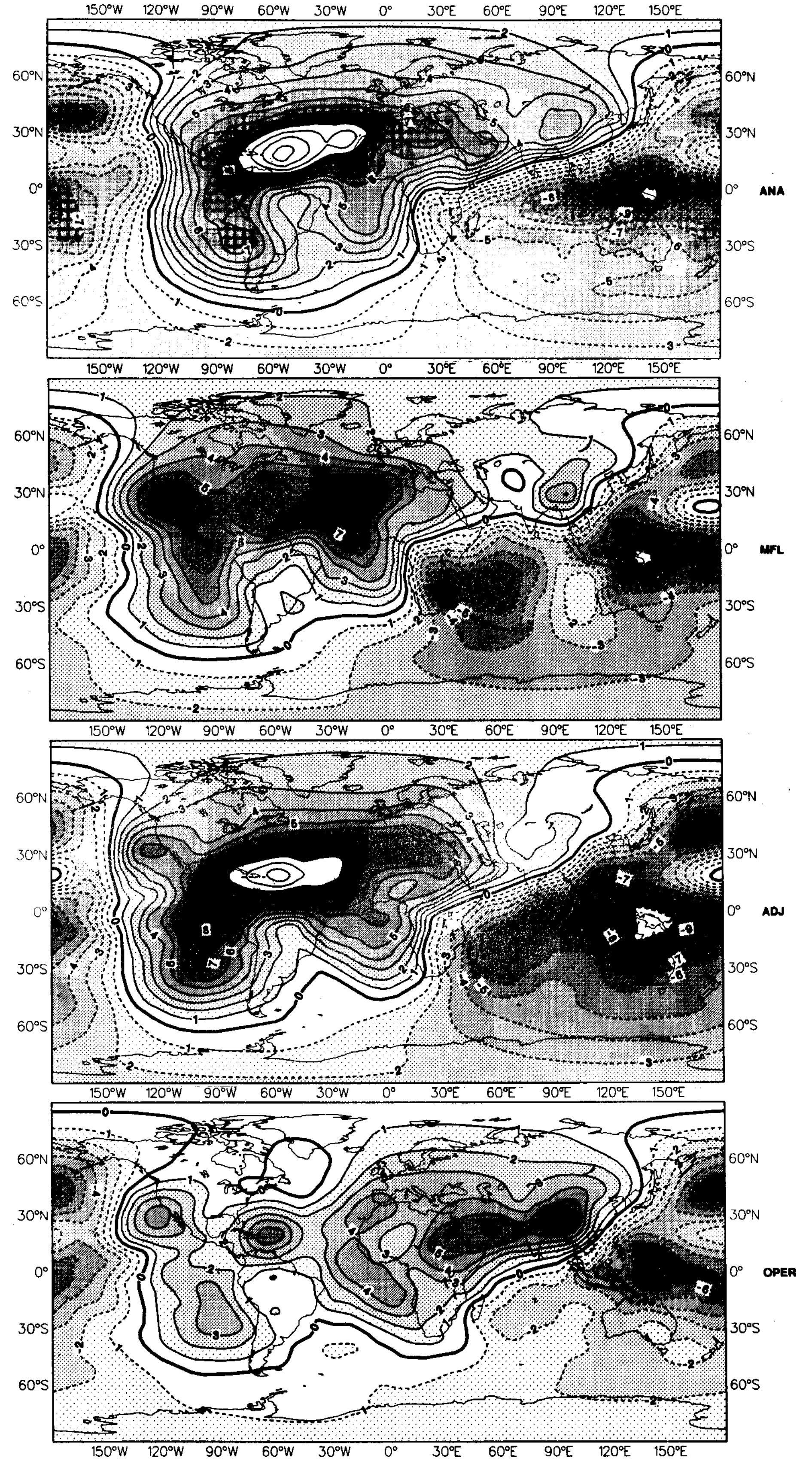

Fig. 1: 30 day mean velocity potential $10^6 m^2/sec$) at 200 hPa for the integrations from 17.1.88, 12Z, with the operational scheme (H3M), the adjustment scheme (HRP) and the massflux scheme (HIV) plus analysed field.

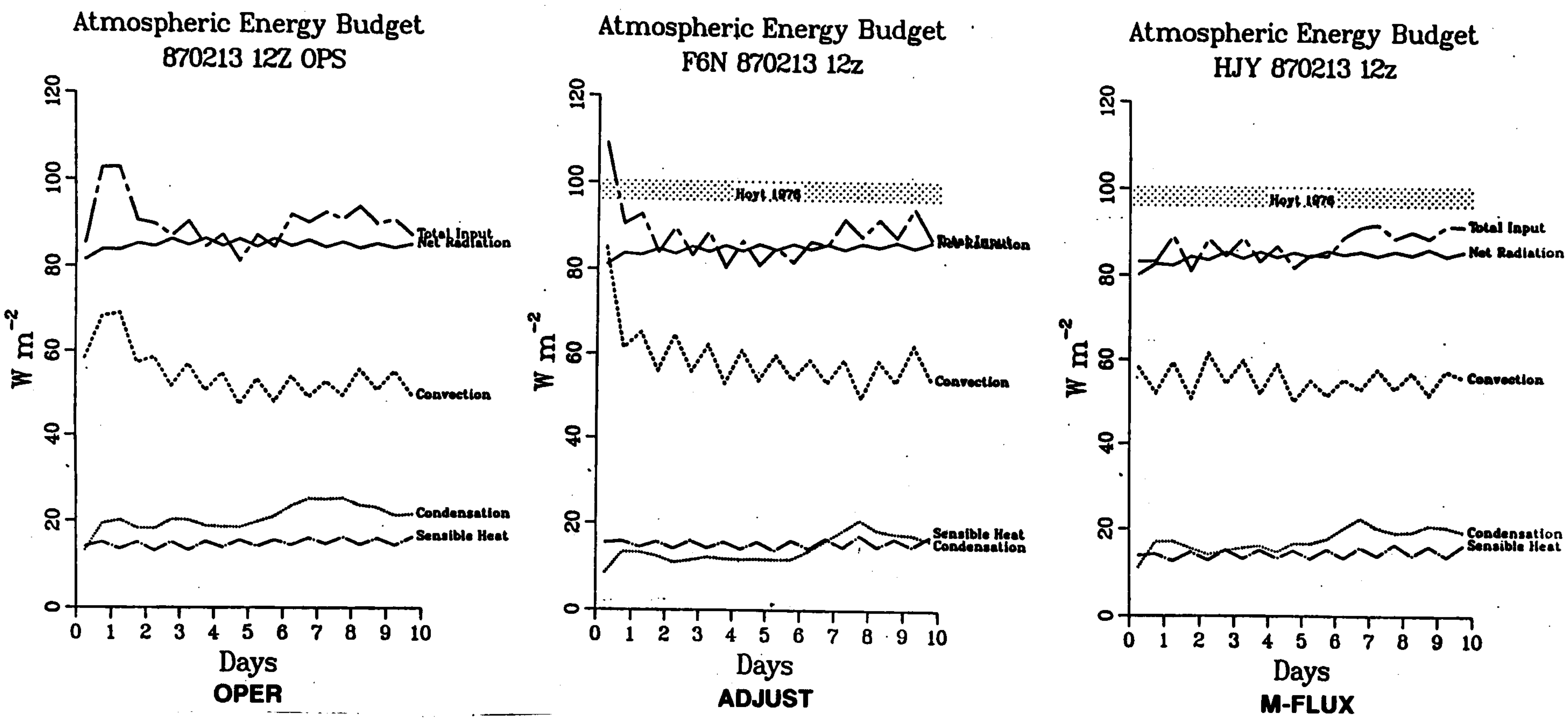

Fig. 2: Time evolution of diabatic heating due to radiation, cumulus convection, large-scale condensation and turbulent heat flux for whole globe for operational forecast and forecasts with adjustment scheme and massflux scheme (initial date 13.2.87, 12Z).

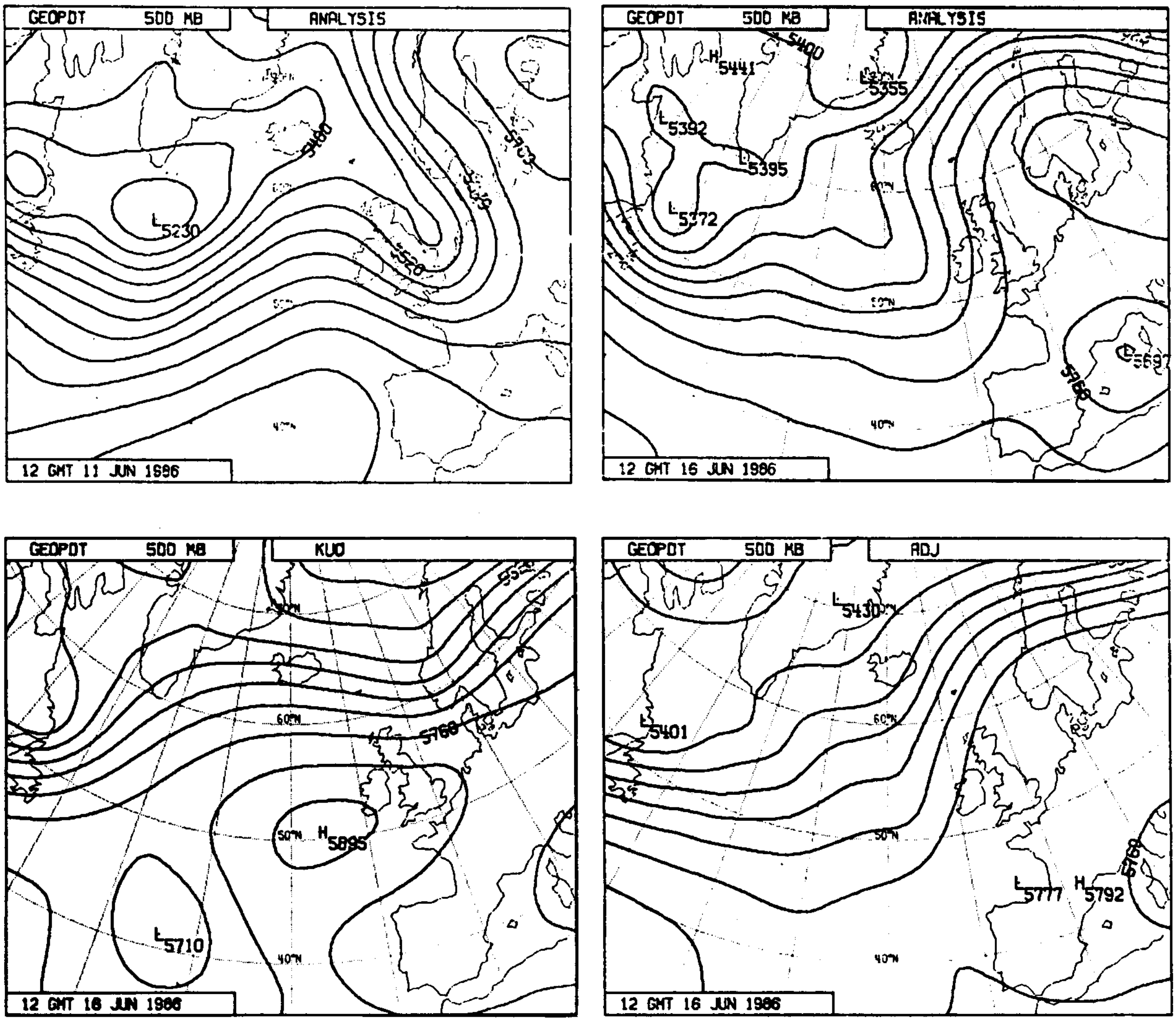

Fig. 3: 500 hPa height analyses and forecasts (contour interval 60m) for day 5 starting from 12Z, 11 June 1986, using the Kuo convection scheme and the adjustment scheme.

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 220). 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

214	NAG Fortran Library Mark 12
	News Sheets on-line
215	MARS - data retrievals and model changes
217	NOS/VE Level 1.3.1.
219	MARS-Retrieval of most recent fields extraction utility

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WORKSHOP ON USE OF PARALLEL PROCESSORS IN METEOROLOGY

5-9 December 1988

ECMWF has made use of vector processors for a long time and has always followed latest developments in the field with keen interest. In 1984 and 1986 ECMWF organised and hosted workshops on the use of multiprocessors in meteorology; computer manufacturers and meteorological users came together to review the state of the art in supercomputers, assess the computer requirements of meteorological applications, discuss the consequences, and get a glimpse of future perspectives.

The proceedings of those two workshops were recently made available to a wider audience in book form ("Multiprocessing in Meteorological Models", Springer Verlag, 1988, ISBN 3-540-18457-0).

The third "Workshop on the use of parallel processors in meteorology" will be held on 5-9 December 1988 at ECMWF, the emphasis this time being on highly parallel architectures. It will follow the pattern of the previous workshops with talks by two invited speakers setting the scene (B. Buzbee, NCAR, and C. Jesshope, University of Southampton), and presentations by computer manufacturers and users on novel architectures and products,on experience, requirements and expectations. The workshop will end with a general round-table discussion.

The programme of the workshop is now being finalised and will shortly be sent, together with registration forms, to all those who have expressed interest. It is hoped that the proceedings of the workshop will again be published in book form.

\- Geerd Hoffmann

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ECMWF CALENDAR 1988

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
24 - 26 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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ECMWF PUBLICATIONS

TECHNICAL MEMORANDUM NO. 145: Verification of FGGE assimilations of the tropical wind field: the effect of model and data bias

FORECAST REPORT NO. 42 (March-May 1988)

ECMWF Forecast Model Documentation Manual Vol. 3 - 2nd edition

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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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