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European Centre for Medium Range Weather Forecasts

ECMWF NEWSLETTER

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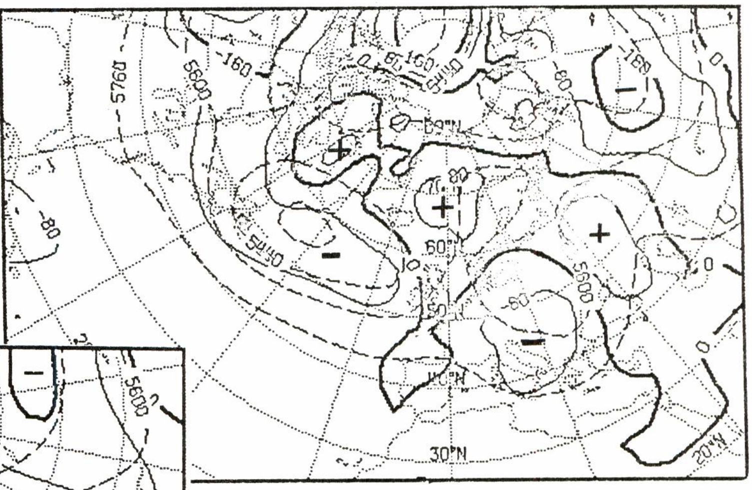
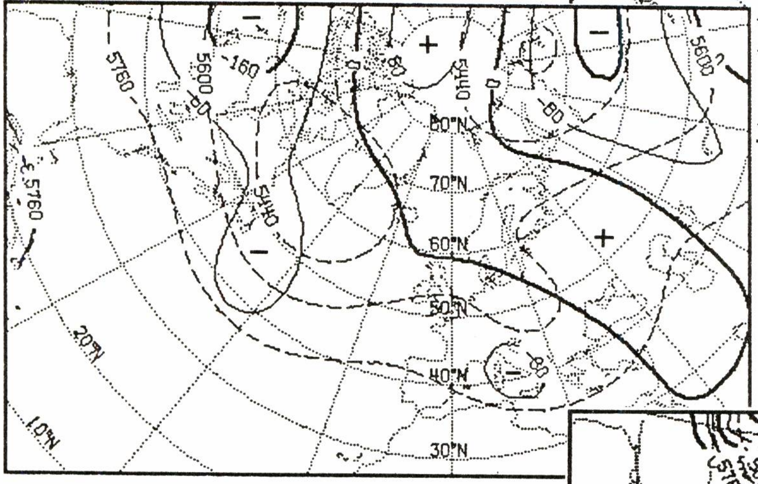
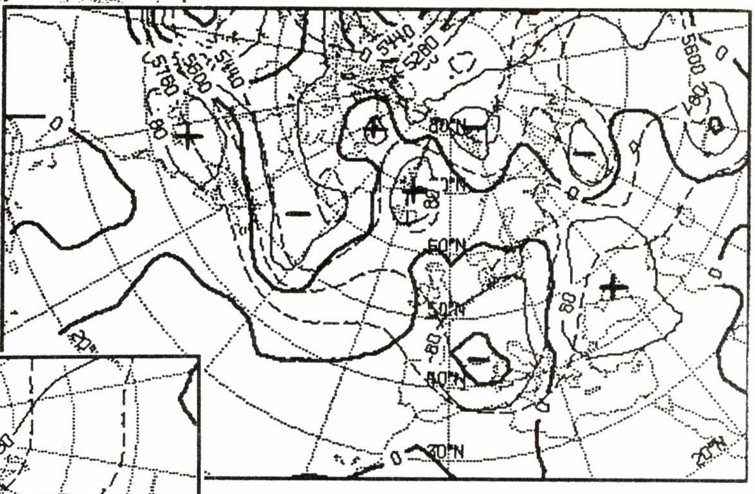
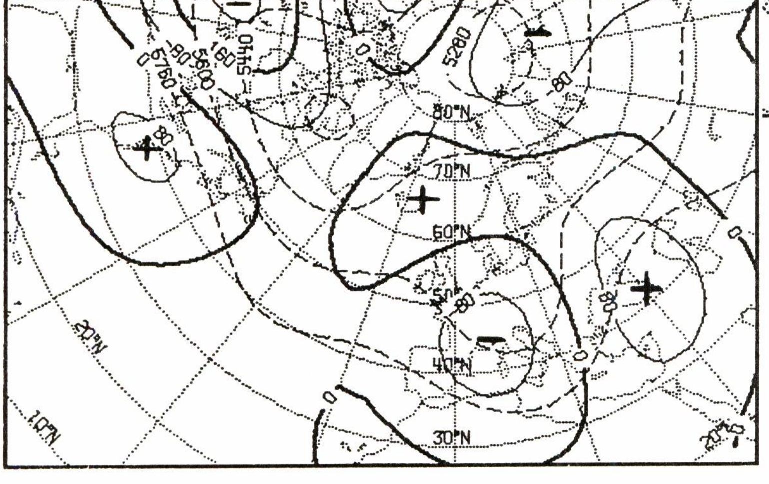
Number 28 - December 1984









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GENERAL

COVER: A comparison of ECMWF D+8 forecast of 500mb height (dashed lines) and the thickness (1000/500mb) anomaly from climate (full lines) in full model resolution (Fig. 1 from top of page) and with truncation at 10, i.e. after the first 10 spectral components (Fig. 2 from top). Zero anomaly is indicated by a heavy line and the centres of the deviation from climate are marked accordingly (+, -). The forecast is valid on 25 September 1984. The verification charts are shown at the bottom of the page. For further detail see article of A. Persson, page 7.

This Newsletter is edited and produced by User Support.

The next issue will appear in March 1985.

This Newsletter contains a summary of three changes to the operational forecasting system which have been, or will shortly be, implemented, followed by three articles which describe the detail of and background to those changes. It should be noted that the products filtered by truncation at spectral component T10 will be disseminated to Member States with experimental status only: the more users who try these products, evaluate them and inform us of their findings, the more valid will be our evaluation of their usefulness.

Another modular meteorological training course will take place at ECMWF from 29 April - 21 June 1985. Details of the course content and methods of application are given on page 27.

At its meeting in September this year the Technical Advisory Committee endorsed the Centre's four year plan of activity, which was later approved by Council at its November session, as were allocations of computer resources to the Member States, details of which appear on p. 21 and 22. The Centre's proposal to make limited experimental use of the binary format GRIB code recently adopted experimentally by the World Meteorological Organisation, was strongly supported by the Technical Advisory Committee and approved by Council. It was felt that if this experiment proves successful and the code is eventually adopted by the Centre as a basis for archiving, it would be a great step towards standardisation.

The problem posed by the growth of the Centre's archive and the consequent problem of physical storage space for the magnetic tapes involved were discussed, and in this connection, the Council has requested that an analysis of the Centre's archiving policy be presented to the Scientific Advisory Committee at its session in September 1985.

Finally, looking somewhat further into the future, the Council was presented with a draft proposal for a ten year plan. This document engendered a fruitful and thorough discussion, with the result that the Centre has been requested to produce an enhanced version of the plan for the Council at its next session, in May 1985.

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CHANGES TO THE ECMWF OPERATIONAL FORECASTING SYSTEM

Recent Changes

(i) A modification to the analysis was introduced operationally on 13 November 1984. The analysis increment calculation at standard pressure levels using discrete vertical forecast error correlations between the 15 standard pressure levels was changed to the evaluation of the increments at model hybrid levels using continuous formulations for error variances and correlations. Details of the modifications are described in an article by Per Undén in this Newsletter, page 3.

Planned Changes

(i) A modified radiation scheme making use of a different approach to the treatment of gaseous effects in the solution of the longwave radiative transfer problem will be introduced operationally on 4 December 1984.

A modest improvement in forecast skill can be expected from the new scheme. More important is the impact of the new radiation scheme on the model mean errors. In ten day integrations, the largest effect of the modifications is found in the mid-troposphere. Deficiencies in the present radiation scheme resulted in a strong infrared cooling of layers containing minor cloud amounts. The more realistic response of the new scheme reduces this error considerably.

Another noteworthy feature is the change of sign in the stratospheric temperature bias. Whereas the operational radiation scheme exhibits a pronounced global cooling of the top model layer, the new scheme warms the upper stratosphere in the tropics and the summer hemisphere. As the height scores indicated, the impact of the new scheme on the wind errors is not as pronounced as on the temperature field. The case to case variation is larger, although a small overall reduction is observed.

(ii) The dissemination of new experimental products is planned from early 1985:

The fields are	1000 mb geopotential
	500 mb geopotential
	850 mb temperature
	850 mb temperature anomaly
	1000/500 mb thickness
	1000/500 mb thickness anomaly

for the analysis and forecast day 1, 2, 3, ... 10, all valid at 12 GMT. The fields will be filtered by truncation at the spectral component T10; this triangular truncation gives a horizontal resolution of wavenumber ten in any direction on the globe.

The products are described by A. Persson in an ECMWF Technical Memorandum (to be published soon); see also the article in this Newsletter by A. Persson, page 7.

- Horst Böttger

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ANALYSIS EVALUATION AT MODEL LEVELS USING CONTINUOUS VERTICAL STRUCTURE FUNCTIONS

The ECMWF data assimilation system utilises data at,or interpolated to, standard pressure levels, and analysis increments are calculated for the same pressure levels using discrete vertical forecast error correlations between the 15 standard pressure levels. The increments are then interpolated to model levels. Experiments have been carried out in which the analysis is modified so as to evaluate those increments directly at model hybrid levels using continuous formulations of the error variances and correlations. The data are still used in the same way at pressure levels, so the pre-analysis and data checking remain intact; only the grid-point evaluation and post-analysis are modified. Heights are evaluated at model "half" levels (geopotential levels) and the hydrostatic relation then gives virtual temperature increments of "full" model levels. A correction to ensure that layers intersecting vertical analysis slab boundaries have consistently analysed thicknesses is applied for these heights. The winds are evaluated directly at the "full" model levels.

The vertical interpolation of increments is thus eliminated, except for humidity analysis and stratospheric corrections which still give pressure level increments.

The forecast error variances are expressed as 6th degree polynomials in ln(p) since continuous variances are needed for thickness correlations and for renormalisation of the increments. The vertical correlations use an exponential function, not of pressure directly, but using a coordinate transformation so as to take into account the variation in correlation scales between different parts of the atmosphere. The correlation between levels i and j is then given by

$$C_{ij} = e^{-a(x_i - x_j)^2} \qquad (1)$$

where a is a fitting constant and x_i and x_j define the transformations of pressure at levels i and j (x is also expressed as a 6th degree polynomial in ln(p)). This transformation is defined so as to give correct thickness error variances (from observation minus first guess statistics) between adjacent levels and is also used as a basis for the current operational discrete correlations.

The new formulation was tested against the operational scheme being used at the time, and the benchmark scheme which subsequently became operational in May 1984.

The analyses were generally very similar to those of the benchmark. However, a reduction of the negative height biases in the higher troposphere was obtained throughout the assimilation. This was especially marked in the tropics as shown in Fig. 1 (note that the analysis fit in Fig. 1 is the pressure level analysis which is not used for the initialisation and not carried forward in the assimilation). Also the initialised and first guess heights and winds have a slightly better fit to TEMP data.

Nine forecasts were run from this assimilation and the results are summarised below in terms of the time when the northern hemisphere 1000-200 mb total height anomaly scores fall below 60%.

Initial date	60% Predictability	Gain vs. benchmark	Gain vs. operations
26.11.1983	5d 1h	+8h	-3h
27.11.1983	5d 8h	-½h	-4h
28.11.1983	4d 15h	-5h	+4h
29.11.1983	4d 21h	-2h	-3h
30.11.1983	5d 10h	-4h	+7h
01.12.1983	5d 5h	-4h	-2h
02.12.1983	5d 6h	+½h	+3h
03.12.1983	4d 18h	+8h	+15h
04.12.1983	4d 4h	+4h	-11h
	mean	+½h(±1h)	+½(±1h)

The scores indicate a slight improvement but it cannot be regarded as significant.

As shown in Fig. 1 (middle) the stratospheric height fits to TEMP data have increased biases and there were some extra TEMP heights rejected by the optimum interpolation data checking mainly in the stratosphere (at some 12Z-analyses up to 10-12). The structure function (1) gave rise to thickness-thickness correlations which were too broad and thickness information was less closely drawn to. Therefore an alternative correlation function was used:

$$C_{ij} = \frac{1}{e-1}\, e^{\frac{a}{a+(x_i-x_j)^2}} - \frac{1}{e-1} \qquad (2)$$

The correlation model according to (2) was found to work better with regard to the stratospheric bias and another assimilation for the same period showed an improvement of the biases (see Fig. 1 bottom); also the rejections were almost reduced to the same number as in the benchmark.

For technical reasons this assimilation was interrupted after 4 days and only three forecasts could be run. The results are summarised below.

Initial Date	60% Predictability	Gain vs. benchmark	Gain vs. operations
26.11.1983	5d 2h	+9h	-2h
27.11.1983	5d 10h	+2h	-2h
28.11.1983	4d 12h	-8h	+1h

There is thus a positive impact of the improved structure function. Also there is a tendency to make the scores less variable compared to the then operational forecasts using the old data assimilation system.

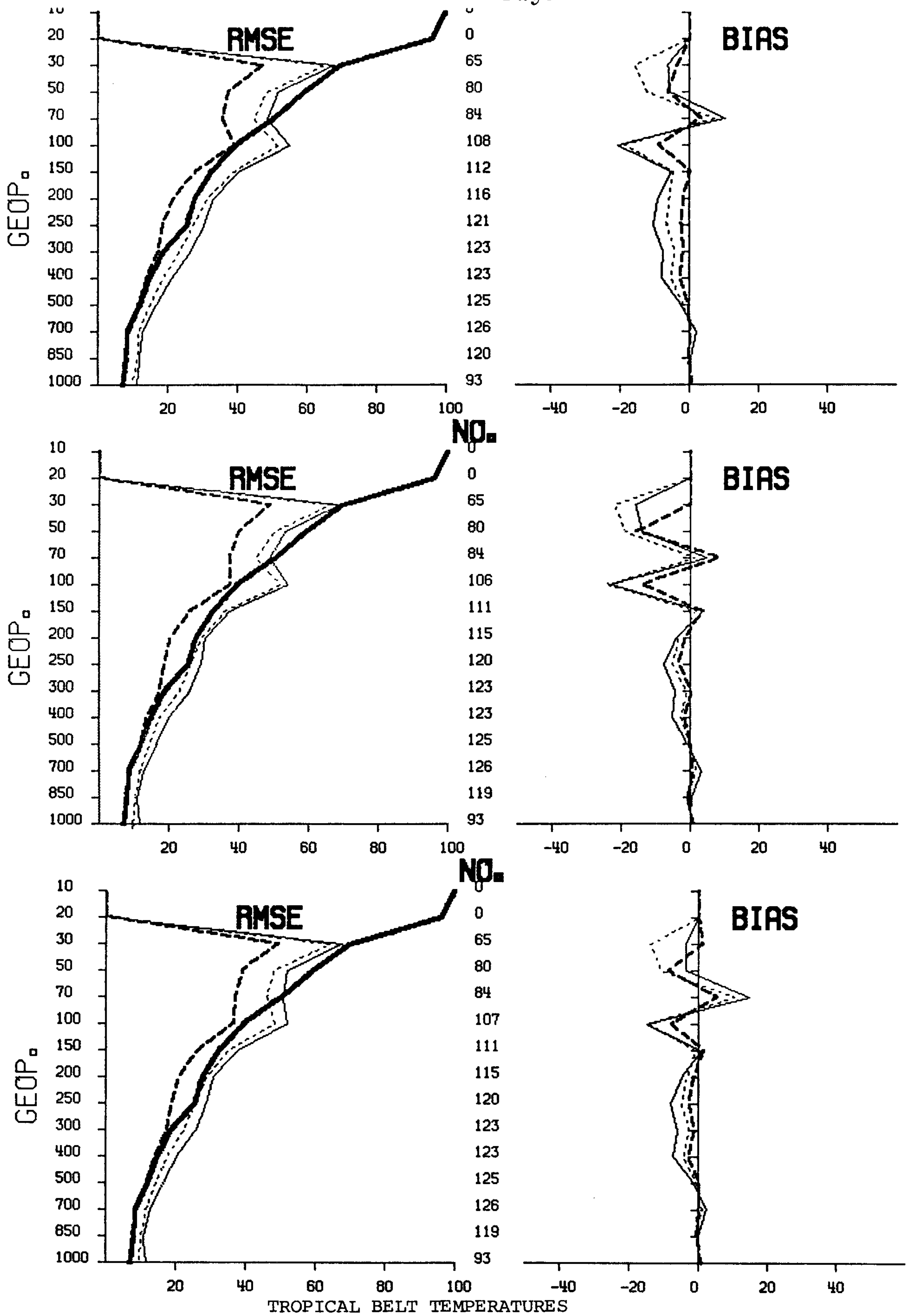

Fig. 1: RMS deviations and biases between TEMP heights (m) and first guess (full line), analysis (thick dashed) and initialised height (thin dashed line) at 12Z 1983-11-28. The top graph shows baseline, middle- the first experiment with correlation function (1) and at the bottom the second using (2).

Finally, a more recent summer period (19-26 August 1984) was selected for another test assimilation. For this case the comparison was made with the present spectral assimilation system. Again the analyses agreed well with the operational analyses and the negative height biases were reduced in the same way. The forecast results from this assimilation are shown below.

Initial date	60% Predictability	Gain vs. operations
21.08.1984	6d 12h	+4h
22.08.1984	6d 19h	±0h
12.08.1984	5d 19h	-1h
24.08.1984	5d 1h	-1h
25.08.1984	4d 15h	-1h
26.08.1984	4d 20h	-1h
	mean	±0h(±1h)

From these experiments it can be concluded that the evaluation of the analyses at model levels using continuous structure functions gives analyses in good agreement with current operational ones. The main gain is in the reduced height biases for the model level evaluated analyses and the first guess forecasts. The impact in the medium range is, on average, very small.

The technique described here for the direct evaluation of analysis increments at model levels using continuous vertical structure functions became operational on 13 November 1984. A more comprehensive description of the technique and discussion of the results will be published as a Technical Memorandum.

- Per Undén

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FILTERED FORECASTS - NEW EXPERIMENTAL PRODUCTS FROM ECMWF

The demand from the public and specialised customers (for example agriculture, transport and the energy industry) for extended forecasts has always been great. In the 1960s, many national weather services started issuing five-day forecasts, which were found to be useful.

Many Member States now issue operational weather forecasts to the public for a five or seven day period. Some customers with special interests may even be provided with outlooks beyond a week, on request. These forecasts for the later stage of the medium range do not contain detailed weather information, but describe the trend in the general weather pattern.

Results from recent studies carried out at ECMWF in order to investigate the means for extracting useful information from the numerical products at the later stage of the forecast indicate that the Member States should try to establish a regular forecast service for the 7 day range or even beyond, based on the ECMWF products.

There is evidence that the longer wave components are more predictable that the synoptic scale disturbances. It should therefore be possible to predict the general weather type, not the weather details, even for the later stage of the 10-day forecast, as far as it is dependent on the configuration of the longest atmospheric waves.

Constructing time mean charts over several consecutive days has long been the practical approach to creating a picture of the large scale flow, the preferred time span for averaging being five days. ECMWF has for some time issued forecasts for 500 mb height fields as time means fields for days 6-10 as an experimental product to its Member States.

Time averaging, however, has some deficiencies, since it not only removes the small scale features, but also distorts the large scale pattern when the positions and intensities of the zonal flow and long wave pattern undergo significant changes. Large scale trough and ridge movements, which are usually well predicted by the model, are more or less lost in a five day time average.

In contrast to time averaging, smoothing in space at individual time steps does not obliterate the positions of the longest waves and is therefore more useful for studying the large scale pattern.

An investigation recently made at ECMWF (see Technical Memorandum No. 90) showed that by truncating the operational ECMWF forecasts of temperature and geopotential around spectral component T10 (T10 gives a horizontal resolution of ten wave numbers in any direction on the globe) in the troposphere the objective verification scores improve and the fields provide enhanced guidance for the prediction of weather types and trends in the later stage of the medium range.

The objective verifications of truncated fields were performed against the full resolution model analysis in T63. Compared to the operational T63 forecasts, the predictive skill of the smoothed fields as given by the objective scores seems to have increased by almost one day. The filtered products also give better results when used as predictors in statistical interpretation schemes.

The use of filtered fields in operational forecasting has also been assessed (Technical Memorandum to be published soon). Filtered charts may help the forecaster to concentrate on the large scale flow pattern in later stages of medium range forecasting (4 < days):

- The forecaster can easily get a picture of the large scale pattern and detect important changes in the long wave pattern.

- Details in the forecasts which have a lower predictability do not distract the forecaster.

- Well known systematic errors in the model are more easily recognised and may in many cases be adjusted for, e.g. the Mediterranean troughs are often displaced too far to the east and troughs over central Europe extend too far to the south.

- Since the long wave components are more predictable, the filtered maps will generally appear to be more consistent from one forecast run to the next.

In operational weather forecasting, filtered maps should always be used together with the non-filtered forecasts, since the "lost" details, though not correct in time and place, might give valuable information about the weather events that could take place (small secondary depressions, sharp fronts, orographic effects etc.).

Examples of filtered forecast charts are shown in Fig. 1-3 together with the maps giving the full model resolution. Fig. 1 shows the +216h ECMWF forecast of thickness anomaly (solid line) and 500 mb geopotential (dashed line) from 16 September 1984 12z. They may be compared to next day's ECMWF forecast of +192h also valid on 25 September (Fig. 2). The two truncated charts show a more apparent consistency then the non-truncated and should have encouraged forecasters to make statements up to almost ten days, concerning the deviation of the mean temperatures from the normal.

As the verification charts indicate (Fig. 3), the relevant features of the non-truncated forecast charts, the negative anomaly over southern Europe and the positive anomalies from southern USSR to the Arctic, were the essential features of the T10-truncated charts. The routine ECMWF verification for this period shows a general predictability of 6-7 days (anomaly correlation being < .6), for the European area, which could be further extended by the filtering process as shown above.

Forecasters will need to adjust themselves to the use of filtered fields, which do not contain the model predicted details they need to look at and take into consideration for forecasting in the early medium range. Filtered products are intended to be a useful complement, showing the whole 10 day forecast, in which only the long wave motions are visible. The simplified and compressed information makes it easier to see long term trends in weather type and local temperature, which could lead to an extension of the range currently employed in operational weather forecasting in the Member States.

The following products will be available, as experimental products to Member States, truncated at spectral component T10, 1000 - 500 mb of thickness anomaly (solid lines) and 500 mb geopotential (dashed lines), from early 1985:

1000 mb geopotential
500 mb geopotential
850 mb temperature
850 mb temperature anomaly
1000/500 mb thickness
1000/500 mb thickness anomaly.

- Anders Persson

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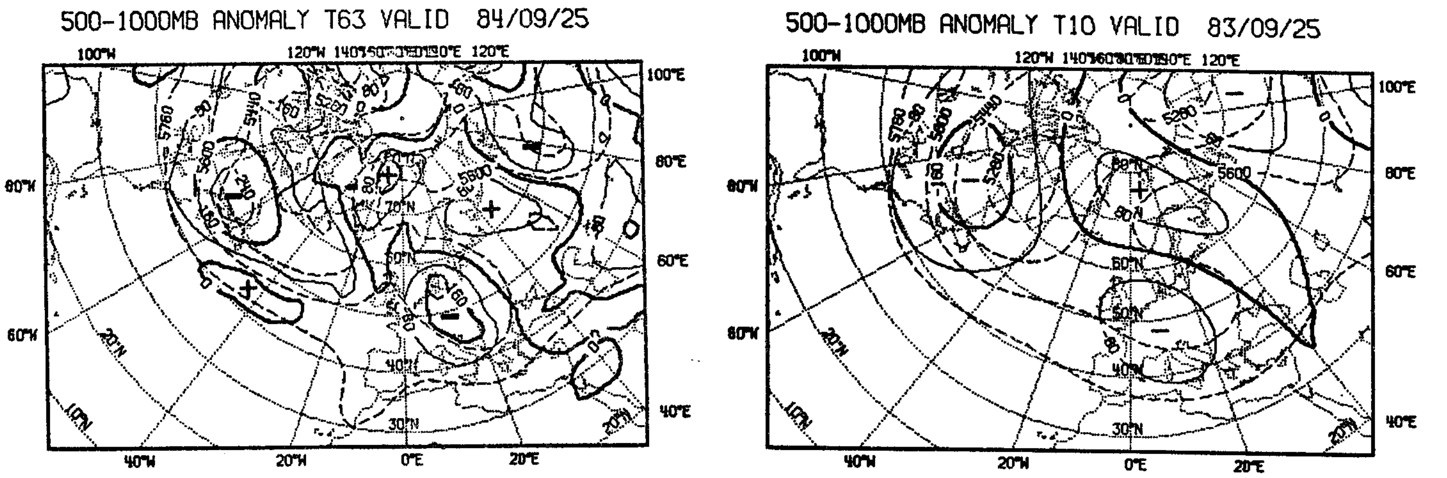

Fig. 1: D+9 forecast of thickness (1000/500) anomaly valid 25 September 1984 with full model resolution (left) and truncated at T10 (right).

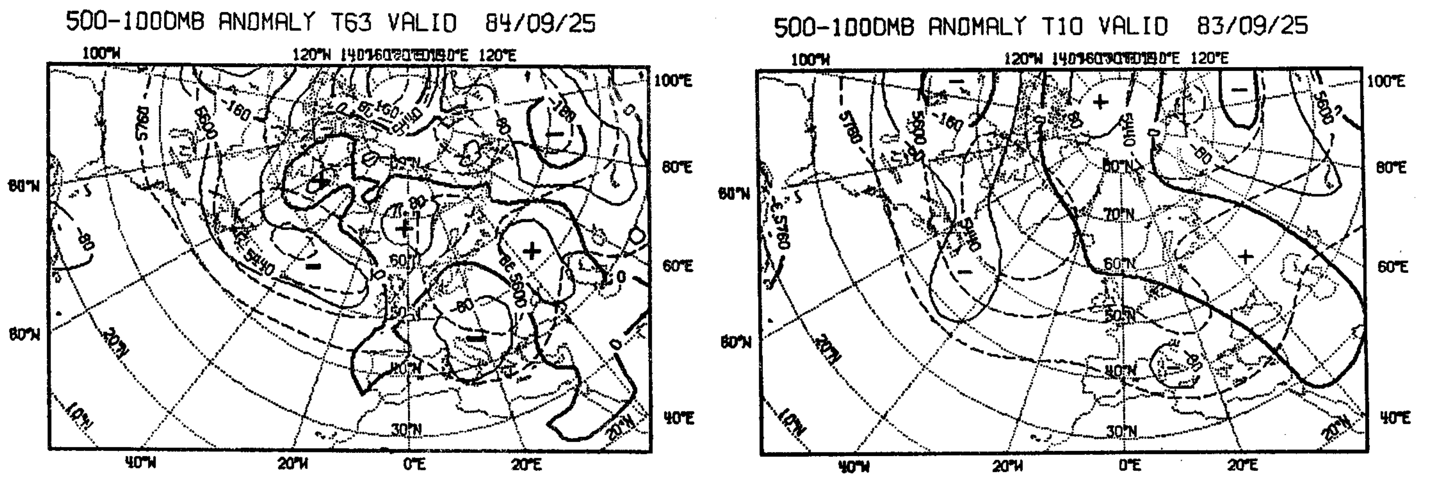

Fig. 2: As Fig. 1, but D+8 forecast valid 25 September 1984.

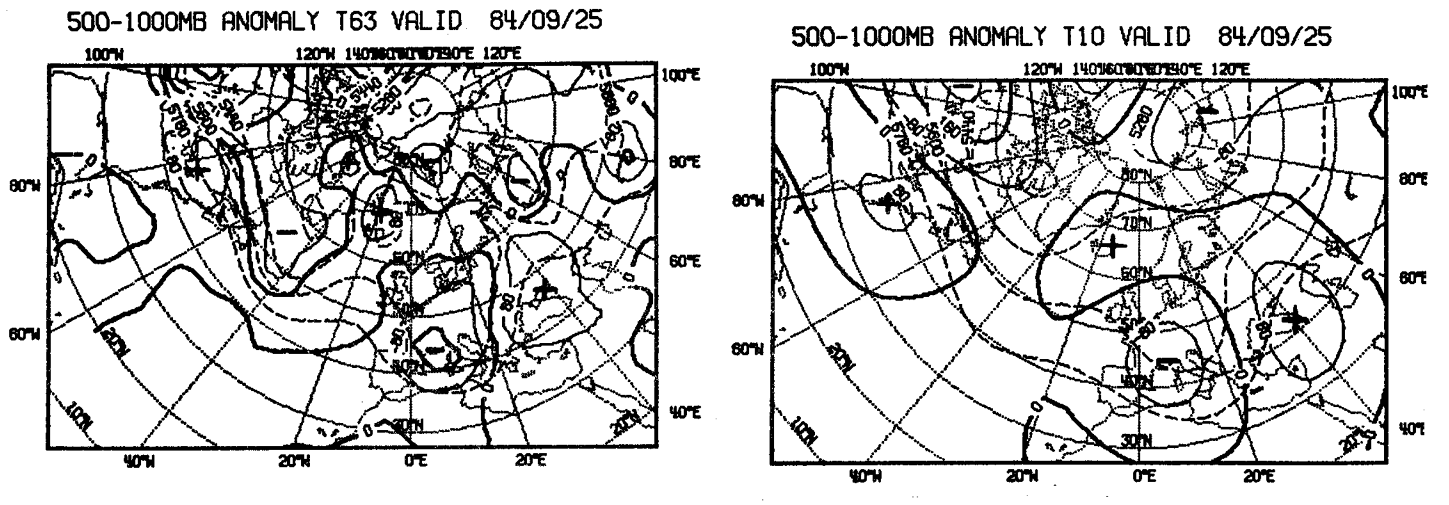

Fig. 3: Verifying analysis of thickness (1000/500) anomaly on 25 September 1984 with full model resolution (left) and truncated at T10 (right).

A NEW CONVECTIVE ADJUSTMENT SCHEME

At the end of November 1983 the Centre held a Workshop on Convection in Large-Scale Models. One of the lecturers, Dr. Alan Betts, described some of his recent ideas on the analysis and representation of atmospheric thermodynamic structure, and suggested a possible way in which these ideas could be incorporated into a parameterisation scheme for representing the sub-grid-scale transports of heat and moisture by convective clouds.

During the following three months, while Dr. Betts was working at the Centre as a visiting scientist, these original ideas were put into practice and a new convective parameterisation scheme (for both deep precipitating clouds and shallow non-precipitating clouds) was created. ECMWF Technical Report No. 43 contains a detailed description of this new scheme and preliminary tests; this article will, however, attempt to summarise the basic principles involved, and show a few selected results to demonstrate its potential.

As the title suggests, the new scheme is based on the concept of adjustment. The very first attempts at convective parameterisation were similarly based; dry and moist adiabatic adjustment schemes tested model layers for convective instability each time-step and, where necessary, adjusted the lapse rates of temperature to the dry or wet adiabats with corresponding moisture adjustments. Since these early ideas, the approach to the parameterisation problem has become much more sophisticated; and with our increasing appreciation of the complexity of tropical mesoscale convection, the phenomenological approach to parameterisation (whereby each significant sub-grid-scale process must be represented) becomes ever more taxing.

The new convective adjustment scheme represents a marked divergence from this philosophy. Its primary objective is to ensure that the local vertical structure of temperature and moisture in the model is realistically constrained in the presence of convection. The concept of quasi-equilibrium between the cloud fields (deep and shallow) and the larger-scale forcing is well established in the literature, and the new scheme parameterises the sources/sinks of heat and moisture by simultaneously adjusting the model profiles <u>towards</u> observationally-based quasi-equilibrium structures, thus avoiding all the details of the sub-grid-scale processes which collectively maintain them. It is important to stress that these reference profiles are not fixed in space or time but are computed for each gridpoint at each time-step. The observational basis determines the stability and humidity structure of these profiles for both deep and shallow convection, but does not fix their precise values. Readers are referred to the Technical Report for details of this observational basis. The rate of adjustment (typically 1-2 hours) is a parameter of the new scheme whereas in moist adiabatic adjustment the rate is equal to one model time-step. Consequently, in ascending regions, the profiles are cooler and moister than the quasi-equilibrium ones.

The scheme was developed and tested in the Centre's single-column version of the global model, and Fig. 1 shows an example of the deep convection scheme's ability to reproduce GATE* easterly wave convective heating and drying when all other processes are prescribed. The performance of the new scheme is particularly good, since this data set describes a quasi-equilibrium between clouds and the wave forcing. In tests of the shallow convection scheme with BOMEX** and ATEX*** data sets, the scheme again performs well and maintains the trade-wind inversion against the large-scale subsidence.

A number of 10-day forecasts have been made with encouraging results. The present operational model physics does not include a parameterisation scheme for shallow, nonprecipitating convection, consequently the impact of the new adjustment scheme is very marked. In the operational model the tropical boundary layer tends to become too shallow and to saturate. There is a resultant underestimate of latent heat flux, too weak a hydrological cycle and a global cooling during the forecast. Inclusion of the new scheme corrects all these deficiencies and gives a much improved tropical thermodynamic structure. Fig. 2 illustrates how the boundary layer saturation is removed by establishing a proper trade-wind boundary layer and Fig. 3 shows how the deep convective transports, and the associated large-scale circulation changes, result in a warmer tropical mid- and lower troposphere, which leads to an improvement in the tropical mean thermal structure.

Although the present version of the new scheme is at its simplest, experience so far is very encouraging. The code is at present being optimised before a comprehensive series of experiments is begun. It seems likely that after a full evaluation, the scheme will provide the Centre's forecast system with a significantly better representation of convective fluxes and precipitation, leading to better analyses and forecasts.

- Martin Miller

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* GATE - Garp Atlantic Tropical Experiment

** BOMEX - Barbados Oceanographic and Met. Experiment

*** ATEX - Atlantic Trade-wind Experiment

Convective heating (K/day) | Convective drying (g/kg/day)

a) DATA | b) DATA

c) ADJUST | d) ADJUST

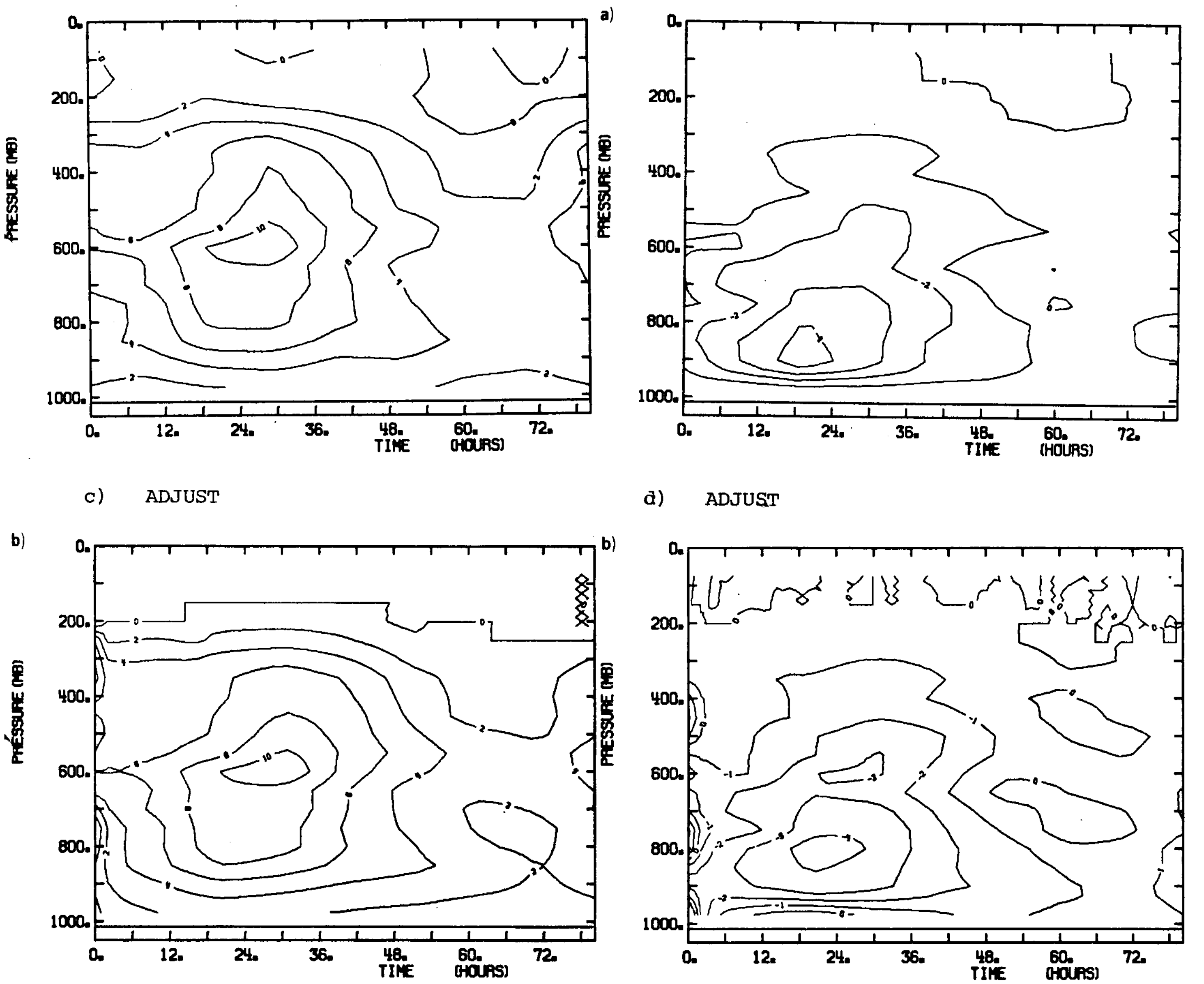
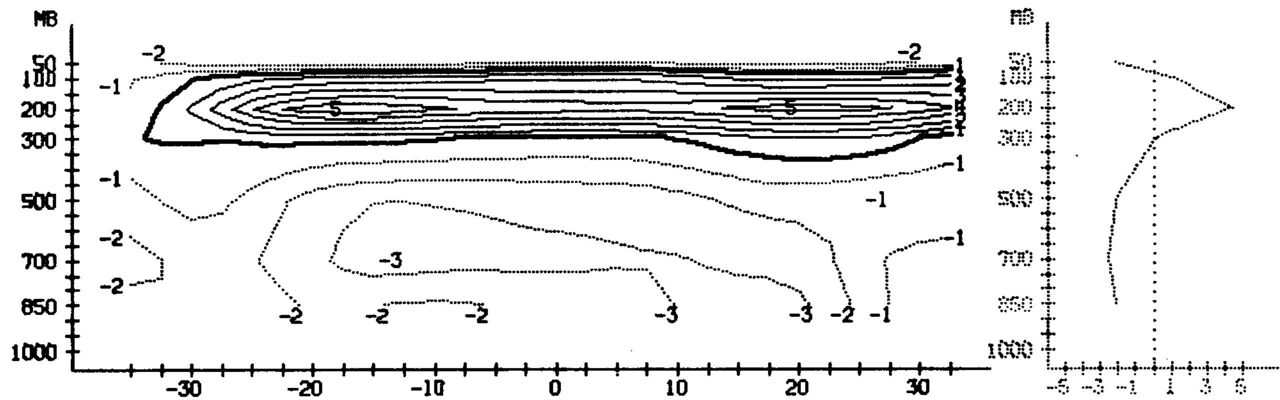


Fig. 1: Comparison between a) the diagnosed convective heating for GATE-wave data and c) the computed values using the adjustment scheme; b) and d) are the corresponding results for the convective drying.

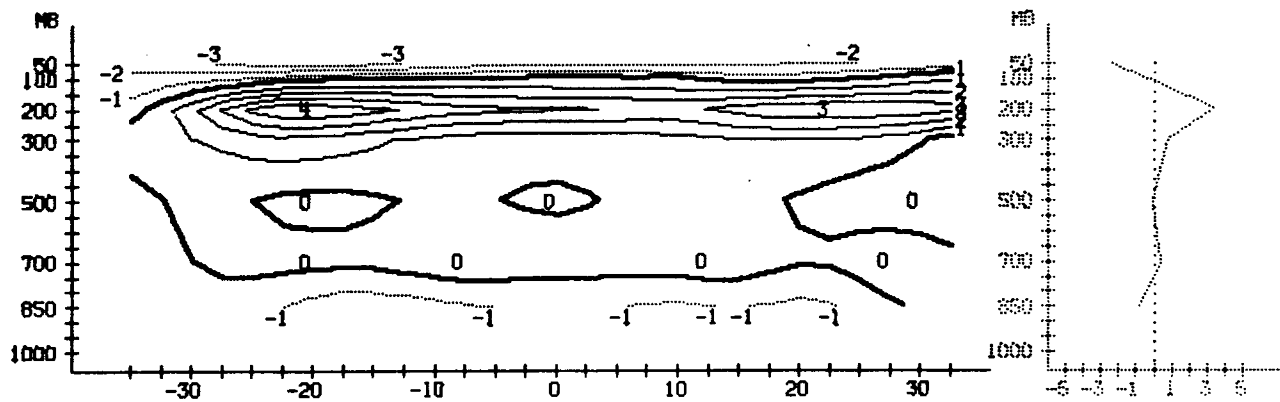
Fig. 2: The forecast day-10 relative humidity distribution for a vertical cross-section along the equator from 180°S to 0°W for a) the operational and b) the adjustment schemes.

Fig. 3: The zonal mean temperature deviation from the observed (days 5.5-10.0) for a sample forecast using a) the operational and b) the adjustment schemes.

a) OPERATIONAL



b) ADJUSTMENT



ECMWF SEMINAR AND WORKSHOP, 3-11 SEPTEMBER 1984

The seminar on "Data assimilation systems and observing systems experiments with particular emphasis on FGGE" was held at the Centre from 3-7 September. It was co-sponsored by WMO and formed part of a series of specialised scientific seminars held in preparation for the Conference on the Global Weather Experiment which takes place in 1985. The Seminar reviewed the characteristics of the FGGE observing system, provided an up-to-date review of 4-dimensional data assimilation, and considered recent results from observing system experiments (OSE's) and observing system simulation experiments (OSSE's).

Due to the co-sponsorship of WMO it was possible to have a wider selection of lecturers than was usual - there were 14 external lecturers from various Member States, USA, Australia and Japan. Also there were 32 other participants from 12 Member States.

After the seminar, many of the lecturers stayed at the Centre for a two day workshop. Two working groups were set up to consider data assimilation systems, and OSE's and OSSE's.

The deliberations of the working groups will eventually be published in full, along with the papers presented at the seminar. However, it is worth highlighting some of their conclusions here.

Data assimilation systems

(a) Although the incorporation of diabatic heating into initialisation can now be achieved, its proper specification remains a problem.

(b) Real progress has been made in the extraction of useful information from single level data, but there are many difficulties still to be overcome.

(c) From the perspective of the requirements of medium range weather forecasting, analysis of the large scale tropical circulation remains seriously deficient.

(d) A great deal of useful observational data is currently unavailable due to limitations in telecommunications capacity.

OSE's and OSSE's

(a) The tropical observing system has not been adequately evaluated, partly because of the poor performance of numerical analysis/forecast systems in tropical regions.

(b) Realistic observing system simulation experiments provide the only a priori quantitative assessment of the potential impact of future observing systems.

(c) Operational WWW System Evaluations (OWSE's) to test composite observing systems need to be carefully planned and executed in order to derive maximum information about the effectiveness of possible mixes of observing systems.

(d) A carefully selected set of rawindsonde stations are required to form a baseline rawindsonde network; the number and location of the stations needs to be the subject of numerical evaluations.

The seminar and workshop provided an opportunity to review the progress being made with data assimilation system and observing system experiments. It is hoped that events such as these will lead to an increased awareness of the problems to be solved and growing collaboration between the many research groups.

Bob Riddaway

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THE POSSIBLE USE OF SATELLITE COMMUNICATIONS FOR FORECAST DISSEMINATION

Outline

The principal role of ECMWF is not only to research into the production of more reliable medium-range forecasts, but also to make available to its Member States throughout Europe on a regular basis, the products of its operationally run forecasting model. The forecasts produced by ECMWF are better than any other currently available products in the medium-range, and the Member States have come to rely on them heavily in their forecasting work. This means not only that they must receive them regularly, but also that they must be received in time to be used within their own operational schedules. These requirements lead to a need for a very high throughput of very large volumes of data being sustained for a short period (4-5 hours) in each 24 hours. This requirement is one directional only, since, apart from continuous data acquisition on the lines from two Member States, the communications load from Member States (Remote Job Execution, access to ECMWF archives etc.) is relatively low.

ECMWF is now in the process of replacing its telecommunication system providing the data links to its Member States, and the factors mentioned above have led the Centre to consider the use of asymmetric satellite links for the dissemination of its products. With leased lines or IPSS (International Packet Switched Service) connections catering for transfer to the Centre. Thus a discussion group was held (8-9 May 1984) to give some insight into the feasibility of such a solution, through discussions with those who already have experience of satellite systems or who are planning systems similar to that envisaged by the Centre.

It began with descriptions of ECMWF's requirements and present telecommunication system. External experts then gave the benefit of their knowledge of, and experience in, various aspects of satellite communications, together with a presentation by the Centre of possible dissemination strategies using satellite links. The presentations were followed by various discussions, concluding with an agreement on the general kind of system which could satisfy ECMWF's requirements, and which should be given further consideration.

Given below are some of the principle points discussed, followed by the general conclusions.

Use of Meteosat

It soon became obvious that Meteosat was not technically capable of supporting the kind of service required by ECMWF. There are only eight 2.4 kbps channels available, no facilities for data concentration exist, and the bandwidth available would not be sufficient to handle Forward Error Correction. However, the facilities available would be extremely suitable for the acquisition of data from, and dissemination of products to, the World Meteorological Organisation's Global Telecommunication System (GTS). Since there is spare capacity on the satellite, and there appears to be nothing, in principle, against this possibility, it may be investigated further.

Error Rates

The Centre requires a very high degree of data reliability. An error rate of 10^{-9}, which would be acceptable for the Centre, could be achieved with Forward Error Correction. Assuming a 64 kbps data stream and a Bit Error Rate of 10^{-9}, one error would occur every four hours for each ground station, making a total of five errors which might require retransmission, per hour, per 20 stations. However, this technique requires a great deal of additional bandwidth, resulting in a requirement for double the normal power, i. e. satellite capacity. This in turn will have a substantial effect on the eventual cost of the system to be acquired.

Protocols

One-directional use of a satellite link will be possible, but will necessitate changes in the high level protocols used. At present, the Centre's system relies on positive acknowledgement of receipt of data. It would have to be established whether a system based on notification only of non-receipt could be implemented. Notification of non-receipt would be achieved via leased lines or on IPSS, whichever proved the more economical and practical. It was noted that, since X.25 protocols would not work with the 0.8 - 0.9 second delays inherent in satellite communication systems, extensions to the X.25 protocol would need to be implemented, which would necessitate very large buffers.

Encryption

While it is possible to achieve a secure satellite system, there was some concern as to the degree of overhead which encryption might add to an implementation. It was not considered necessary truly to encrypt the whole code. It was suggested that the most suitable solution might be to add a "bother factor" to the code, that is, adding synchronisation words etc. which could be changed regularly and which would render it not worthwhile for illicit receivers to attempt decoding. This solution would avoid several potential problems. First, if all transmitted data are encrypted, error detection becomes impossible and even the source of error cannot always be traced. Secondly, there might be problems in obtaining permission to provide decoding chips to certain of the ECMWF Member States.

Dissemination strategies

It was expected that the dissemination strategies described would be feasible with a satellite system, and that the data rates dictated by these strategies would also be feasible, even allowing some considerable room for increases both in data volume and data rates. However, it was noted that the total requirements, including low Bit Error Rates, would demand very large satellite capacity and might, therefore, prove rather costly.

Member States' installations

The implementation of the dissemination strategies described would also depend on the computing power available at Member States' sites. For instance, the dissemination of spectral co-efficients may not be useful to some Member States who require grid point data; however, the conversion of spectral co-efficients into grid point data requires a great deal of computing capacity, and may well be beyond the power of some of those Member States.

Similarly, equipment in the Member States could not cope with bursts of data at 64 kbps, and therefore, each channel would need to be multiplexed at the Member States, thus necessitation additional equipment.

RJE and access facilities for Member States

It was confirmed that there would be capacity outside the dissemination schedule adequate to cope with the transmission of output from Member States' remotely submitted jobs and of data requested from the ECMWF archives. (Though it is possible to rent satellite channels for portions of a 24-hour period, charges are not pro rata, and therefore the financial savings made would not compensate for the loss of flexibility suffered).

Conclusions

Some general outlines of the kind of system required for the ECMWF specifications were given, along with some idea of costs, based on American prices. It was, however, noted that European prices may be considerably higher than those quoted.

(a) Total data transmission capacity nx64 kbps data streams ($n \geq 2$)

(b) Bit Error Rate : 10^{-9}

(c) ECMWF Ground Station to INTELSAT V or VI (European zonal beam) approx. $100,000

(d) Ground station at each Member State approx. $13,000 - $25,000

(e) Cost of INTELSAT per annum per data stream approx. $40,000 x n ($n \geq 2$)

Finally, the aspects remaining to be resolved were noted: levels of data protection, protocols to be implemented, data processing capabilities in Member States, and channel interfaces to Member States' facilities.

- Pam Prior

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COMPUTER RESOURCE ALLOCATION TO MEMBER STATES IN 1985

At its twentieth session (20-22 November 1984) Council approved the allocation of computer resources to Member States for 1985 as shown below. These allocations will come into effect on Monday, 31 December 1984.

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.

MEMBER STATE	1985 Allocations		
	Cray (Kunits)	Cyber (Kunits)	On-line Mass Storage (Mwords)
Belgium	140	24	2.1
Denmark	102	19	1.7
Germany	574	100	8.6
Spain	205	36	3.1
France	484	84	7.3
Greece	100	20	1.5
Ireland	80	14	1.3
Italy	118	33	4.1
Yugoslavia	119	23	1.8
Netherlands	120	35	2.6
Austria	120	21	1.8
Portugal	80	15	1.3
Switzerland	142	25	0.5
Finland	105	18	1.6
Sweden	200	39	2.2
Turkey	60	10	1.7
UK	450	75	6.3
Special Projects (1)	162	54	5.5
OVERALL TOTAL	3361	645	55.0

Notes:
(1) This allocation is distributed between 8 special projects as shown in the table overleaf.

SPECIAL PROJECTS 1985

Member State(s)	Institution undertaking the project	Project Title	1985 Resources allocated		
			Cray Kunits	Cyber Kunits	On-line storage Mwords
Continuation Projects					
Germany	Max Planck Institute for Meteorology, Hamburg	Third generation global wave model	20	5	0.3
	Institute for Geophysics and Meteorology, Cologne	Interpretation and calculation of energy budgets	10	17	0.2
	Meteorological Institute, University of Hamburg	Simulation of clouds in a general circulation model	20	3	2.6
France	Laboratory of Atmospheric Optics, University of Science & Technology, Lille	Climatic impact of aerosols	32	7	0.3
Finland	Finnish Meteorological Institute	CAS/NWP Intercomparison Project for WMO	15	10	1.0
United Kingdom	Meteorological Office	Model Intercomparison project	20	4	0.5
New Projects					
France	Fundamental Physics, University of Science & Technology, Lille	Intercomparison of radiation codes in the ECMWF model	30	6	0.3
United Kingdom	University of Reading	Normal modes of a 3-D atmospheric flow	15	2	0.3
		TOTAL	162	54	5.5

TELECOMMUNICATIONS SCHEDULE

Council approved a revised implementation schedule for the remaining 4 medium speed circuits, as shown below:

Member State	Speed (bps)	Line to be set up
Turkey	2400	January 1985
Switzerland	4800	July 1985
Italy	4800	August 1985
Yugoslavia	2400	April 1986

CFT 1.13 - STATIC, STACK, HEAP AND MULTI-TASKING

In this article the meaning of these various terms will be clarified in relation to the CFT 1.13 compiler and its libraries.

STATIC

This describes the method used to allocate local variables. The CFT control card option is ALLOC=STATIC (which is the default). Under this scheme all local variables which are allocated memory reside at the same addresses throughout the running of the program. No stack is used. Therefore no matter how many calls are made to a particular routine, the local variables within that routine always occupy the same memory locations. Code produced this way is non-re-entrant and cannot be multi-tasked.

STACK

This describes an alternative method used to allocate local variables. The CFT control card option is ALLOC=STACK. Under this scheme all local variables which are not named in SAVE, DATA, COMMON or NAMELIST statements are dynamically allocated memory on the stack when the routine is entered. The stack is an area of memory which expands and shrinks as these local variables are, respectively, added at entry time and deleted on a return. From this, it follows that the same memory location can be used for different variables belonging to different routines, and it is highly unlikely that a local variable will occupy the same memory location when a routine is called on one occasion, as it did on a previous call. Code produced this way is re-entrant and can be multi-tasked.

The amount of memory available for the stack is determined by the "STK=" parameter on the LDR control statement.

HEAP (or managed-memory)

This is memory (by default after blank common) which can be allocated and deallocated dynamically as the program runs, using the heap management subroutines in $UTLIB. The amount of memory available for the heap is determined by the "MM=" parameter on the LDR control card.

For STATIC programs, the heap is used for some of the system tables as well as for user-defined storage. For STACK programs the stack itself also resides on the heap.

B&T register usage

The "OPT=" parameter on the CFT control statement can be used to control the allocation of local variables to T-registers.

OPT=BTREG causes CFT to assign the first 24 local variables (not arrays and not mentioned in SAVE, DATA, COMMON or NAMELIST statements) to T-registers on entry to the routine.

OPT=NOBTREG causes CFT to assign all local variables to memory.
For STATIC allocation NOBTREG is the default.

For STACK allocation BTREG is the default.

LIBRARIES

There are 2 types of system libraries:

(i) STATIC - none of the routines use the stack or the heap. The heap-management routines are available, however, within the libraries for use by the program.

(ii) MULTI - all of the routines use the stack and some use the heap to store system tables.

LOCKs have been introduced into certain routines to control the updating of critical variables between different tasks.

RECOMMENDATIONS

(i) Use STATIC allocation if you can. This is the default and makes debugging simpler. Even if you want to use managed-memory, you can still do so from a program compiled in STATIC mode using the STATIC libraries, all that is required is the "MM=" parameter on the LDR control card. STACK is not required in order to use managed-memory.

(ii) Use STACK allocation only if you are multi-tasking or developing a multi-tasking program. It is not required for anything else.

For further details see the level 1.13 CFT & COS manuals.

- Neil Storer, Richard Fisker

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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 169). All other News Sheets are redundant and can be thrown away. The following News Sheets can be discarded since this list was last published: 162, 168.

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
147	(20.7.83) NOS/BE level 577
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
165	Maximum memory size for Cray jobs
166	Corrections to the Contouring Package
167	CFT 1.13 improvements
169	CFT 1.13

THE METEOROLOGICAL TRAINING COURSE - 29 APRIL-21 JUNE 1985

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

The course is divided into four modules:

M1: Dynamical meteorology and numerical methods (29 April-10 May)

M2: Numerical weather prediction - analysis, initialisation and adiabatic formulation (13-23 May)

M3: Numerical weather prediction - diabatic processes and the inclusion of orography (28 May-7 June)

M4: Use and interpretation of ECMWF products (10-21 June)

Modules M1, M2 and M3 will be of most interest to scientists who develop numerical models for operational forecasting or research. Module M4 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.

Students can attend any combination of the four modules. However, those attending only M2 are expected to have a good knowledge of the topics covered in M1. Attendance at the other modules is not a requirement for participation in M4.

In each module, there will be lectures, exercises and problem or laboratory sessions; in some modules, 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.

During January a booklet describing the course, and application forms, will be sent to the Meteorological Services of Member States and many universities and institutions. If you do not have access to one of these, copies can be obtained from me.

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.

- Bob Riddaway

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COMPUTER USER TRAINING COURSES

The Centre is offering another series of training courses for Member States personnel and ECMWF staff. Information will shortly be sent to the Member States. Nominations from ECMWF staff will be invited via Section Heads.

Course: Introduction to the facilities 18-21/22 March 1985

This is intended for anyone who will be programming the CRAY, to give them sufficient experience to run simple work. It will also introduce them to some of the CYBER facilities they may need to complement their CRAY activity. Prior knowledge of another computing system, plus a knowledge of Fortran is required. An optional fifth day (22 March) is devoted to explaining how to use ECMWF's meteorological database and archive system.

Course: CRAY in depth 25-29 March 1985

An in-depth course for those who will make heavy use of the CRAY and its many unique facilities. Intending participants will be expected to know how to run simple jobs on the CRAY.

- Andrew Lea

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CALENDAR OF EVENTS AT ECMWF

29-30 January 1985	Subgroup meeting on the New Telecommunications System
27-28 February 1985	8th session of Technical Advisory Committee
6-8 March 1985	33rd session of Finance Committee
18-29 March 1985	Computer user training courses (see above for details)
29 April - 21 June 1985	Meteorological training courses (see page 27 for details)
8-9 May 1985	21st session of Council
9-13 September 1985	Annual ECMWF seminar: "Physical Parameterisation for numerical models of the atmosphere"
16-18 September 1985	14th session of Scientific Advisory Committee
18-20 September 1985	9th session of Technical Advisory Committee
20-21 November 1985	22nd session of Council

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.

		Newsletter	
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CFT 1.11 Subroutine/function calling sequence change	19	Feb. 83	13
COS 1.12 and products	23	Oct. 83	17
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Buffering or non-buffering on Cyber?	15	June 82	10
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Dynamic file buffers for standard formatted/ unformatted data	3	June 80	17
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- making back-up copies	1	Feb. 80	9
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*T indicates the original Technical Newsletter series

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- telex (No. 847908)				
- COMFILE (See Bulletin B1.5/1)				
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Communications & Graphics Section Head	-	Peter Gray	OB 101	369
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Terminal Queries	-	Norman Wiggins	CB 035	209
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Deputy Ops. Section Head	-	Graham Holt	CB 024	306
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	-	Herbert Pümpel	OB 006	345
	-	Liam Campbell	OB 003	348
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