European Centre for Medium Range Weather Forecasts

ECMWF NEWSLETTER

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GENERAL

COVER: UBS-Switzerland, first across the finishing line in the 1985-1986 Whitbread Round the World Race, see article on page 3

This Newsletter is edited and produced by User Support.

The next issue will appear in December 1986.

The first article in this issue describes one of the more unusual and exciting uses to which ECMWF data have been put in recent years, in providing assistance in the determination of optimal routes, based on past years' observations, during the 1985-1986 Whitbread Round the World Race. ECMWF was particularly pleased to learn that the UBS-Switzerland was first over the finishing line and we would like to think that the additional information gained from the Centre's archives may have contributed to this success.

The next two articles will be of interest to operational meteorologists who use the Centre's products, as they describe recent changes to the ECMWF forecasting model and the affects which they have on the forecasts produced, as seen in these early stages. The first of the two articles describes the parameterisation of gravity wave drag, which was introduced on 15 July, and the second covers the implementation of the new analysis system on 9 September.

The article on computing matters describes the graphical facilities available to users at the Centre through the Meteorological Applications Graphics Integrated Colour System (MAGICS). This comprehensive and powerful tool is proving a considerable aid to both researchers and operational meteorologists in their work at the Centre.

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CHANGES TO THE ECMWF OPERATIONAL FORECASTING SYSTEM

Recent changes

(i) Gravity wave drag:

The parameterisation of the gravity wave drag was implemented on 15 July 1986. Experiments during the past year indicate that the modification has a positive impact on the model performance, especially in the northern hemisphere in winter, while the summer circulation is only marginally affected. In the tropics, the impact of the gravity wave drag is very small, and in the southern hemisphere the effect of considerable wave drag around the Antarctic plateau is difficult to evaluate.

Further information on this modification is given in an article on page 10 of this Newsletter.

(ii) New analysis system:

The new analysis system was implemented on 9 September 1986. The important new features are:

- better use of observations; data and differences from the first guess will be used at reported levels. This will effectively increase the actual vertical resolution of the analysis, in particular in the boundary layer and near the tropopause.
- Elimination of unnecessary vertical interpolation of analysis increments between the model and standard pressure levels.
- Evaluation of analysis increments on the Gaussian grid of the model (approx. 1.125 degree resolution).
- Better data selection in boxes of flexible size depending on data density and extending over the depth of the troposphere.

The modifications in the analysis system have a significant impact on the quality of the analysis and of the subsequent forecasts. Experiments with the new system indicated that the medium range forecasts are sensitive to the analysis differences. However, on average the old and the new system are very close to each other. For the southern hemisphere, the positive impact of the new analysis system is also reflected in higher mean tropospheric anomaly correlation score after day 4 of the forecast.

Further information on the new analysis system is given in the article on page 16.

Planned changes

No major changes to the ECMWF analysis and forecasting system are planned for the coming three months.

- Horst Böttger

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A STUDY OF OPTIMAL ROUTES FOR A SAILING BOAT

APPLICATION TO THE CASE OF UBS-SWITZERLAND DURING THE 1985-1986 WHITBREAD ROUND THE WORLD RACE

Introduction

In 1984, the skipper of the sailing boat UBS-Switzerland asked the authors about the possibility of meteorological assistance during the 1985-1986 Whitbread Round the World Race.

The rules of the race did not allow for the provision of private real-time forecast information to the competitors. This is the reason why we decided to compute routes on a climatological basis, which means using archives. To achieve this goal, ECMWF 10 metre-winds together with a simple numerical description of the ship's performance were introduced into an operational research model, in order to analyse the optimal strategies to be followed by UBS-Switzerland, the winner-to-be in real time of the race. This model was developed at the Swiss Meteorological Institute and was used during the four legs of the race from September 1985 until May 1986.

Method

The method used involves three components:

(i) A set of archive surface wind data related to each leg of the race.

(ii) A set of data describing the performance of the ship.

(iii) An operational research program computing an optimal route between departure and arrival points for each leg of the race.

Archive surface wind data

As basic meteorological input we decided to use analysed and initialised 10 metre-winds provided by ECMWF.

The retrieving parameters for the procedure FINDATA are:

type = RANA analysed and initialised
hour = 00z
parm = UAT10M & VAT10M zonal & meridional 10 metre-winds
grid = 2 grid spacing

and, for each leg,

Portsmouth - Cape Town : area = 30 N - 40 S / 30 W - 20 E
Cape Town - Auckland : area = 30 S - 56 S / 20 E - 180 E
Auckland - Punta d'el Este : area = 30 S - 60 S / 170 E - 50 W
Punta d'el Este - Portsmouth : area = 40 S - 50 N / 60 W - 0.

Fig. 1 shows for example the field of analysed and initialised winds on the Southern Pacific, the 22 February 1986 at 12z. Fig. 2 illustrates the same winds on the Atlantic, the 9 April 1986 at 12z.

The performance of the sailing boat

The sailing boat is described by a table giving its speed as a function of the wind forces and angles of incidence. The whole of this information can be displayed on a polar diagram similar to Fig. 3.

The algorithm

The region where a route is likely to be chosen is covered by a complete, oriented graph, as shown in Fig. 4a. This graph describes all the routes connecting the departure to the arrival vertex. Naturally, these two last vertices are fixed and unique; they correspond respectively to the departure and arrival locations of each leg. The graph is devised in such a way that it does not cover the continents.

The decision process we used, called 'dynamical programmation', is classical. It was developed in the sixties by Bellmann and allows the computation of the shortest route within the above graph. Let us explain the algorithm on the basis of Fig. 4. The whole calculation proceeds backwards, i.e. starting at the arrival vertex (called a on Fig. 4a). Then, for each vertex of a column, we look for the vertex in the previous column (closer to arrival) which provides the shortest duration to the arrival vertex. These iterations continue from right to left until the departure vertex (called d) is reached.

Each vertex x of the graph receives a record, including among others:

- the boat's time of passage at this vertex, called T(x);
- the index of the successor vertex of x, called succ(x). It is the vertex towards which the algorithm chooses to move the boat.

The time of arrival is fixed and is an initial condition of the problem. Call it E.

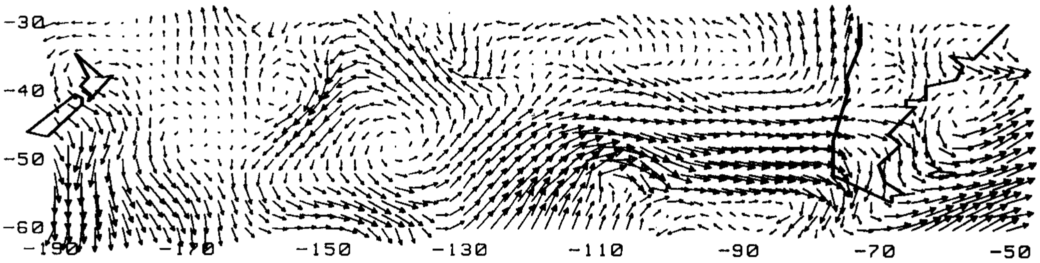

Fig. 1: Analysed and initialised winds on the Southern Pacific, 22 February 1986, 12z.

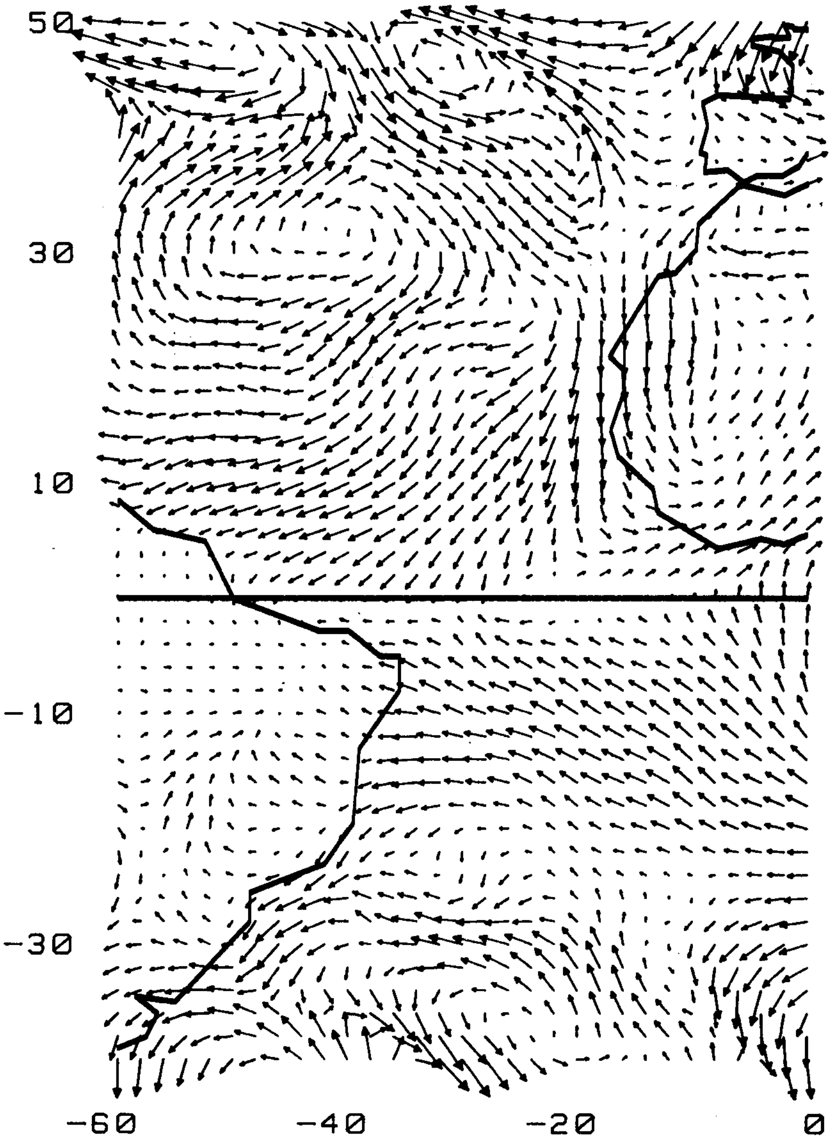

Fig. 2: Analysed and initialised winds on the Atlantic, 9 April 1986, 12z.

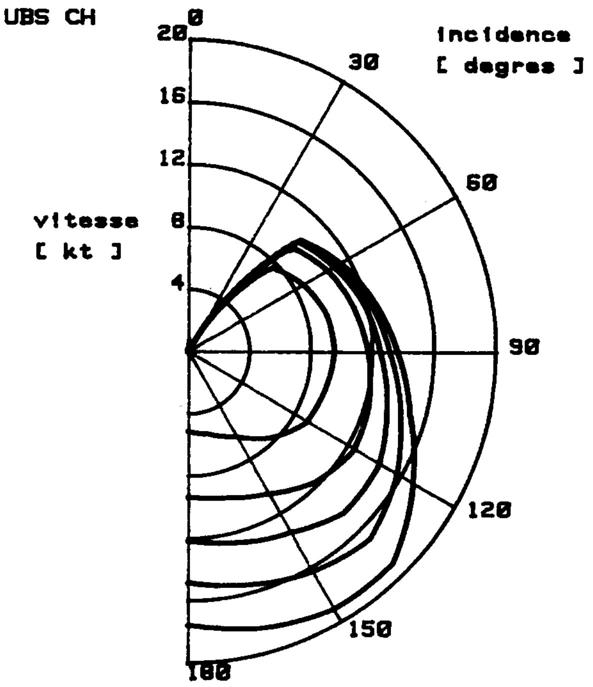

Fig. 3: An example of a polar diagram such as describes the speed of a sailing boat as a function of the wind forces and angles of incidence.

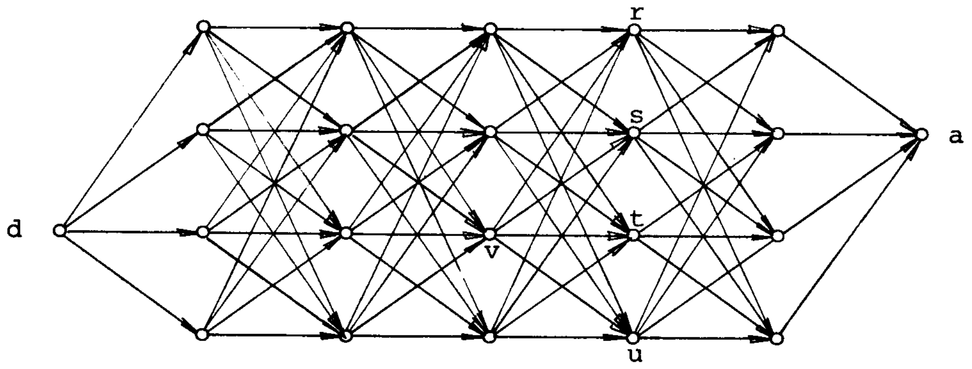

Fig. 4a: Graph describing all the routes connecting the departure to the arrival point.

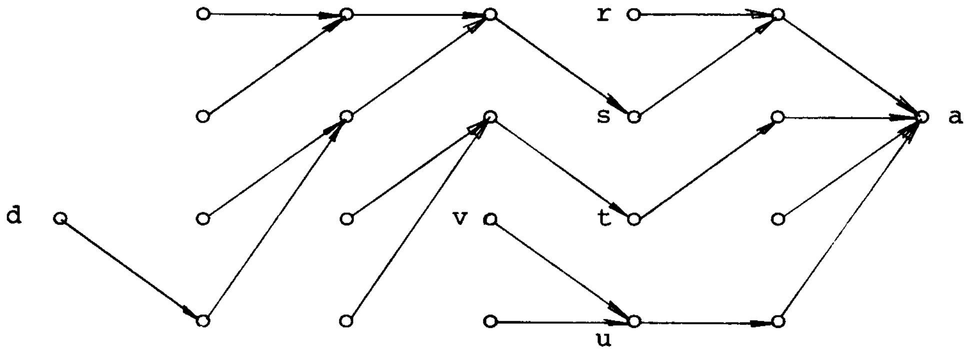

Fig. 4b: A tree constructed from the graph in Fig. 4a.

The vertex a is characterised by:

- T(a) = E; succ(a) is not defined.

Let us call D(x,y) the duration taken by the boat to sail from vertex x to vertex y, provided it passes y at time T(y). We shall deal with the computation of this duration later on. We proceed now with the description of the general level of the algorithm.

The process which determines the successor of any vertex of the graph, say v, can be described in the following manner:

- T(v) = max (T(r)-D(v,r), T(s)-D(v,s), T(t)-D(v,t), T(u)-D(v,u))

- succ(v) is the vertex r,s,t,u realising the above maximum.

The algorithm assigns a unique successor to each vertex (if it is not the arrival). However, each vertex can be the successor of several previous vertices. The structure created thus is a tree covering the whole graph, whose root is the arrival vertex. Fig. 4b exhibits a tree constructed from the graph of Fig. 4a.

This tree defines a unique route joining each vertex to the arrival. The route starting from the departure vertex globally minimises the time to the arrival and represents an answer to our problem.

Let us now turn to the computation of the duration D(x,y). For each segment xy of the graph, the duration D(x,y) of the journey from x to y is naturally the quotient of the length of the segment by the velocity of the sailing boat. If, on one hand, the computation of the length of an arc of great circle is rather easy, on the other hand the evaluation of the velocity is more tricky. It is estimated with the help of the polar diagram, once the angle of incidence and the mean wind blowing on the segment have been evaluated. The mean wind is simply the arithmetic mean of the winds blowing at the extremities of the arc at the time the boat passes at these vertices.

The time of passage at y is known. Thus, the wind blowing at this location and at this moment can be extracted from the ECMWF data. The wind at x is unknown since it has to be evaluated at time T(y)-D(x,y). Now, D(x,y) is exactly the object we are trying to compute. We are now facing a circularity, which is solved by relaxation consisting of an iteration of the form D(x,y)=F(D(x,y)). The conditions under which such a relaxation converges, or, more precisely, the conditions under which a fixed point of the above iteration exists, have been studied. We just notice here that the process diverges if the sailing boat is at rest, or generally if the wind is calm.

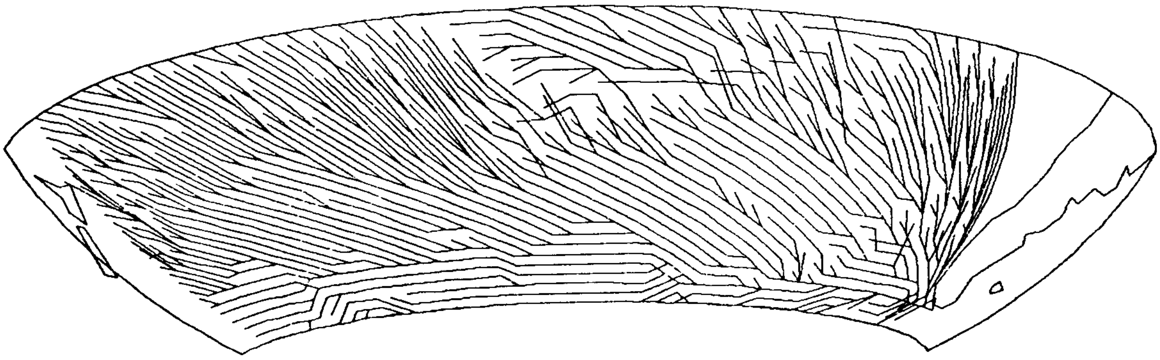

Fig. 5a: Tree generated for the third leg.

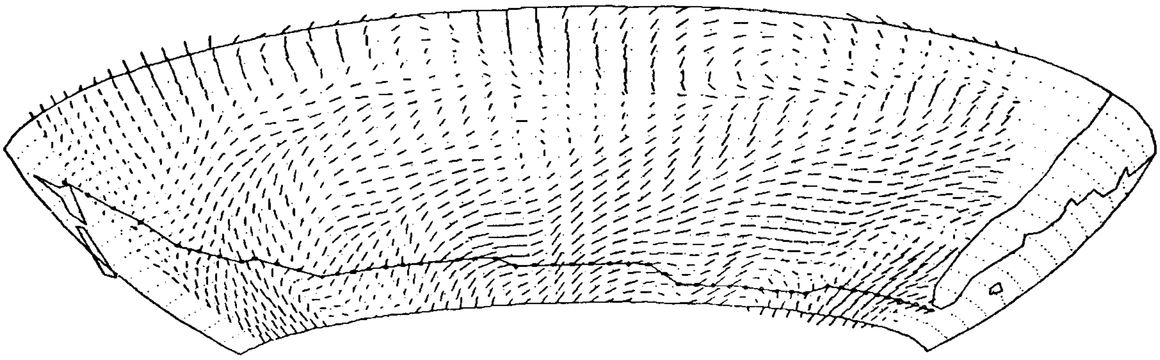

Fig. 5b: Winds computed at the time chosen by the algorithm for the passage of the ship at a given vertex (for the third leg).

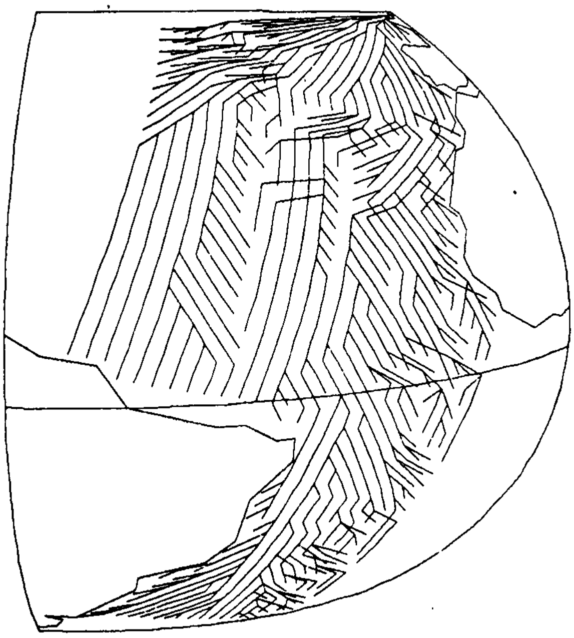

Fig. 6a: As Fig. 5a, for the fourth leg.

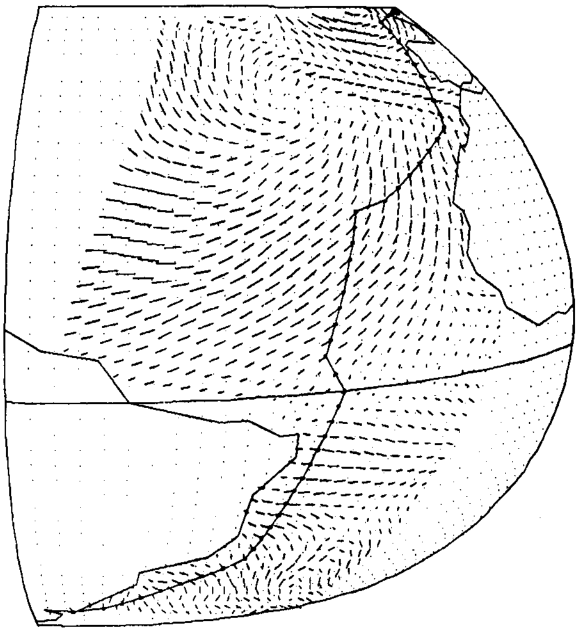

Fig. 6b: As Fig. 5b, for the fourth leg.

Operational use

The whole system has been applied to each leg of the race. The graphs generally included 50 x 27 vertices and the set of archive winds covered about 792 hours. The data have been chosen within the years 1981 to 1985 at a time of the year corresponding to the period during which each leg was contested. All the data were transported to the "Ecole Polytechnique Fédérale de Lausanne (EPFL)" via the direct link from Reading to the Swiss Meteorological Institute. All subsequent operations were run on the Cyber 855 of the EPFL. About 20 simulations were executed for each leg, by varying the date of arrival.

Before each leg, we analysed the whole of the material obtained, together with the skipper. The options most frequently generated by the computer were kept, a priori, as being the fastest for this ship (as described by the polar diagram of Fig. 3) and the season of the year in question.

Examples of the generated trees are presented in Fig. 5a for the third leg and Fig. 6a for the fourth leg. The corresponding winds are drawn on Figs. 5b and 6b. These are the winds computed at the time chosen by the algorithm for the passage of the ship at a given vertex.

On board, the skipper had at his disposal a thick folder containing all the routes and plots of the winds covering the leg during the four previous years. The reception of public meteorological data on a Nagra-Fax being allowed by the regulations of the race, the skipper could compare the actual situation with an analogous case of the past and then take a decision about the best option, thanks to the computed routes.

Conclusions

The system, as it was used during the 1985-1986 Whitbread race, is not an automatic decision tool. It is rather a device performing numerical simulations which allowed the skipper to refine his judgement and which was just a help for decision taking.

The implementation of the same system in real-time would not only violate the current regulations of the race, but would present a number of difficulties. The quality of the decision would automatically be affected by the quality of the operational forecast model. Since the predictability of the model seems for the moment to be bound by ten days, one would have to define intermediate goals "by hand", which would render the whole method sub-optimal.

The relaxation process on the other hand, which allows the duration of the journey between two vertices of the graph to be calculated, is, under certain conditions, numerically unstable, essentially due to the deep non-linearity of the polar diagram. A few controls have already been introduced into the algorithm in order to cure this shortcoming, but this solution would probably be too expensive for real-time operation.

Despite these difficulties, a real-time decision device using a computer ashore and the full power of the ECMWF forecast model could be considered, if the rules of the race were to be adapted. Lastly, it is clear that such a technique could be adjusted to the optimisation of routes in commercial shipping (if ever the world runs out of petrol!).

- Jacques Ambühl, Pierre Eckert
Swiss Meteorological Institute

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THE PARAMETERISATION OF GRAVITY WAVE DRAG IN THE OPERATIONAL FORECAST MODEL

Introduction

A parameterisation scheme for the momentum transports due to sub-gridscale gravity waves excited by stratified flow over irregular terrain was incorporated into the ECMWF operational forecast model on 15 July 1986.

Recent research at both the UKMO and at the Canadian Climate Center indicated a considerable impact of this previously unrepresented physical process, with a marked improvement in the global momentum balances. The present high resolution global models have too zonal and too strong a westerly flow particularly in wintertime with related stratospheric errors, prominent in the systematic errors of models, including that of the Centre. The importance of the global orography and its interaction with the flow on all scales has long been recognised and is a major modelling problem which has been the subject of much recent research, including the development of envelope orography used in the present operational model.

The parameterisation scheme

It is necessary to parameterise both the wave stress due to the orographically excited gravity waves and the variation of this stress with height. Depending on the atmospheric static stability and vertical wind shear, these gravity waves can propagate vertically to great heights, unless absorbed and/or reflected by critical layers, or unless they become convectively unstable, i.e. the gravity waves break. The vertical stress divergence acts as a deceleration of the flow at a particular level. The scheme can be considered in two parts a) the stress at the lower boundary and b) the determination of the vertical profile. The former is proportional to the low level windspeed and static stability, and to the orographic "wavemaking" ability; this is computed as four directional components of the subgridscale orographic variance. These directional components enable the dependence of wind direction relative to a mountain range to be taken into account.

The formulation for the low-level stress gives large geographical variations and strong temporal ones also. In particular, the dependence on windspeed and static stability implies a maximum in gravity wave drag (GWD) in winter and a minimum in summer. Figure 1 outlines the basic principles, Figure 2 shows an example of the directional variances and Figure 3 gives an example of a geographical distribution of wave stress. Much of the wave drag occurs in the stratosphere but there is also a significant low-level drag.

Experimentation

The scheme was tested at several horizontal resolutions with both 16 and 19 levels; a substantial series of 10-day T106 global forecasts was carried out together with a number of extended range and seasonal simulations. This article summmarises the 10-day forecast results and indicates the improvement in systematic errors.

T106L16 10-day forecasts

Twelve initial dates in the 12 months from Spring 1985-Spring 1986 were used with an envelope (one standard deviation) orography. No data assimilation with GWD was carried out. Figure 4a summarises the mean scores for the N. Hemisphere. This mean improvement over a year includes several summer cases with very little impact of GWD.

There is a systematic improvement in all variables on all scales in all areas (as far as has been ascertained) from relatively early in the forecast and Figure 4b shows anomaly correlations for seven winter cases over Europe.

T106L19 10-day forecasts

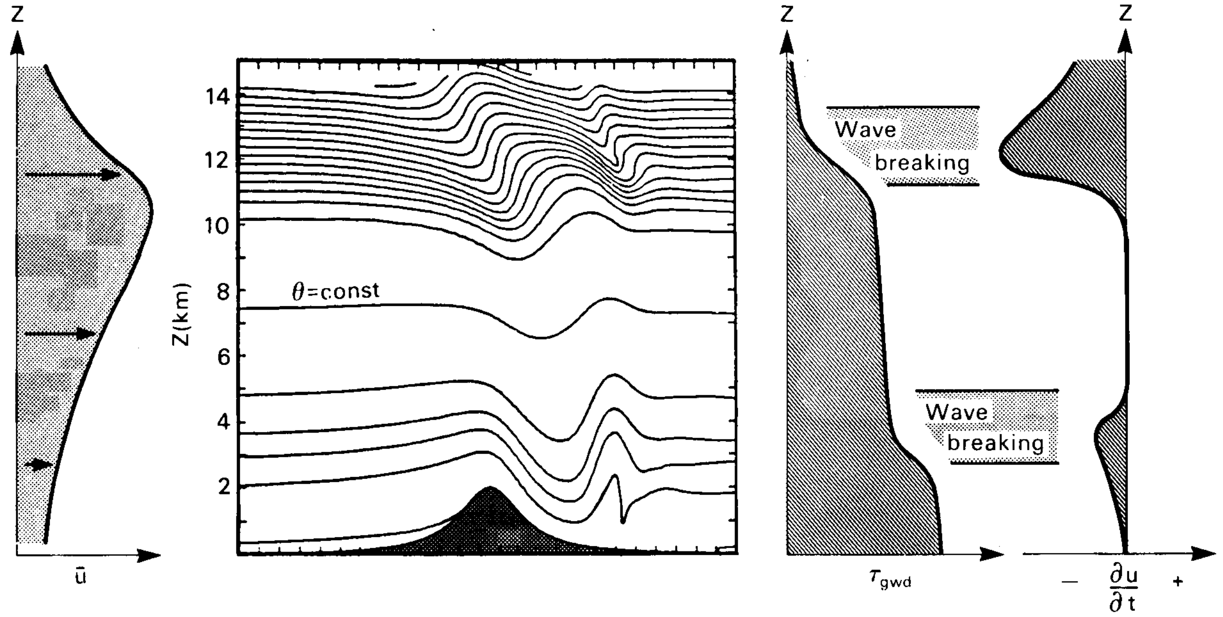
Since 19-level forecasts have only been operational since 13.5.86 and much of the 19-level forecast improvement is via the data assimilation, the potential for testing GWD was restricted to early summer only, when GWD is relatively weak. However, one six-day 19-level assimilation had also been carried out for the period 24.3.86-30.3.86 and a parallel assimilation was run with GWD included in the model cycling. This spring period has more gravity wave activity (although still less than in winter), and a small improvement was evident in the fits to data. 19-level forecasts with GWD were run from both six-day assimilations and compared to 19-level forecasts without GWD run from the original 19-level analysis and also to the then operational 16-level forecasts.

Four forecasts were run from 26th, 28th, 29th and 30th March 1986. Three further 19-level forecasts for 15.5.86, 11.6.86 and 15.6.86 gave modest but consistent improvements (not shown) despite the summer minimum in gravity wave activity. Figure 5 shows mean maps at day 10 for the four March forecasts. 19-level forecast improvements are enhanced by the addition of GWD.

Concluding remarks

The results presented here show that the parameterisation of GWD is a desirable addition to the forecast model. Its impact in extended range

Fig. 1 **Gravity wave drag (schematic)**



$\tau_{gwd} \propto N_{low} \, |V_{low}| \, |h'|^2$

$|h'|^2$ = Variance of sub-gridscale orography (directionally dependent)

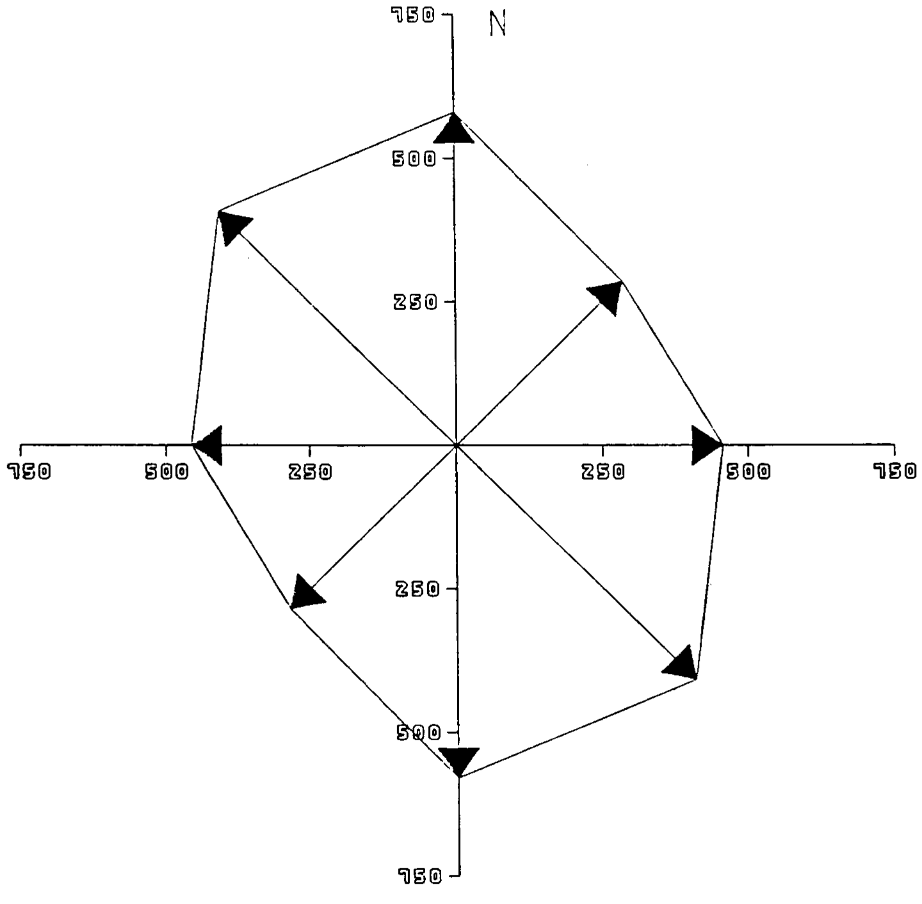


Fig. 2 The four components of subgridscale orographic standard deviation (in metres) showing the anisotropy of part of the Alps.

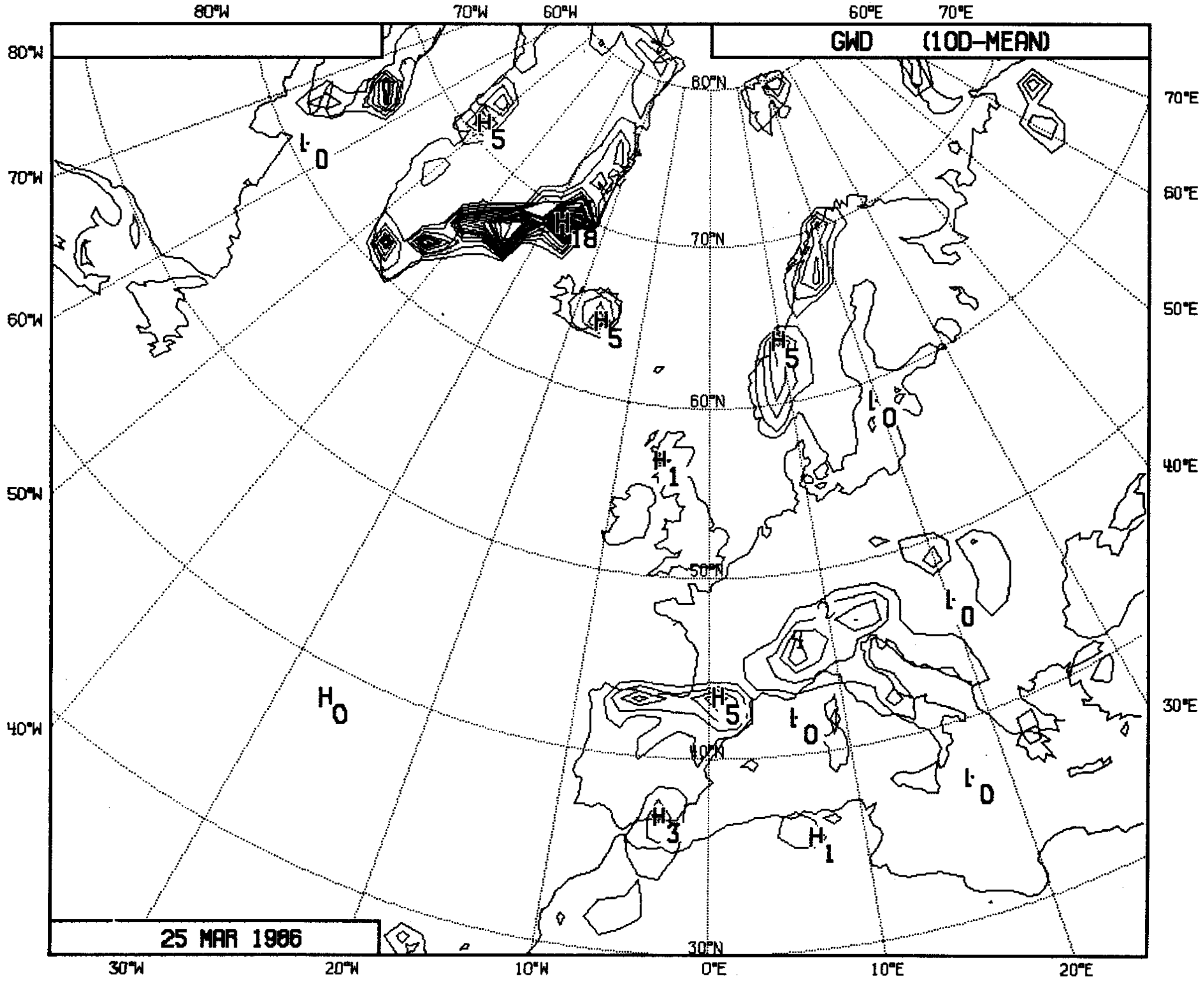


Fig. 3 Geographical distribution of gravity wave stress - a 10-day average (units as N/m^2 x 10).

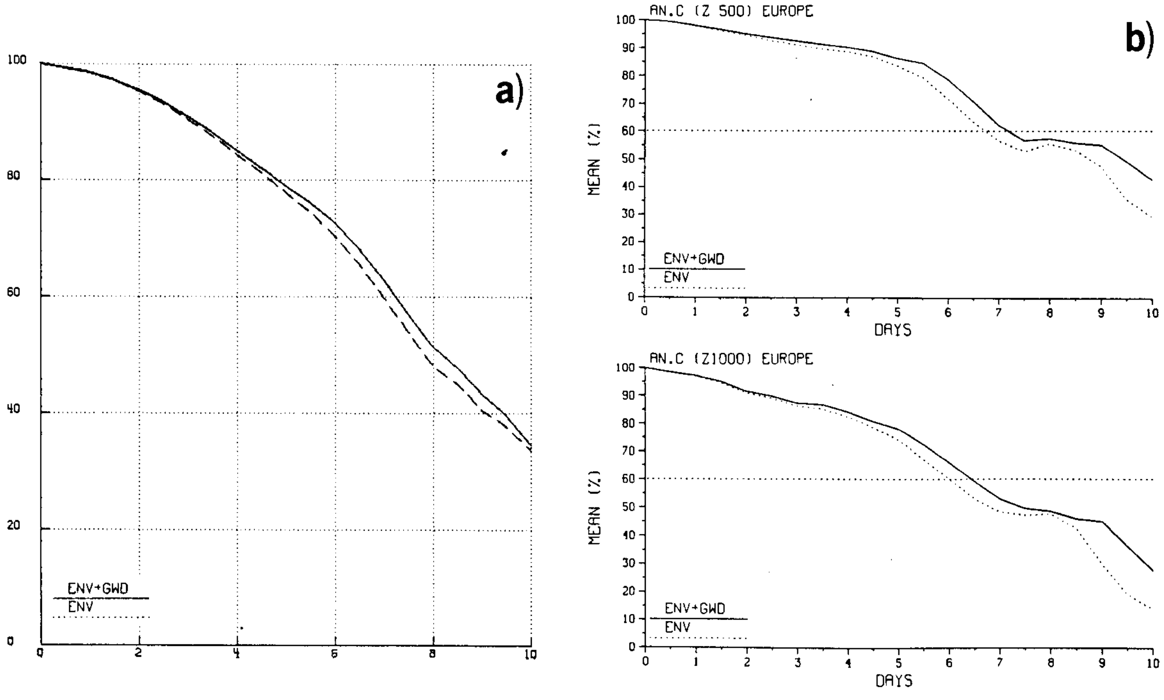


Fig. 4 Mean anomaly correlations for
(a) N. Hemisphere (1000 mb-200 mb) heights and
(b) European area 500 mb and 1000 mb heights.

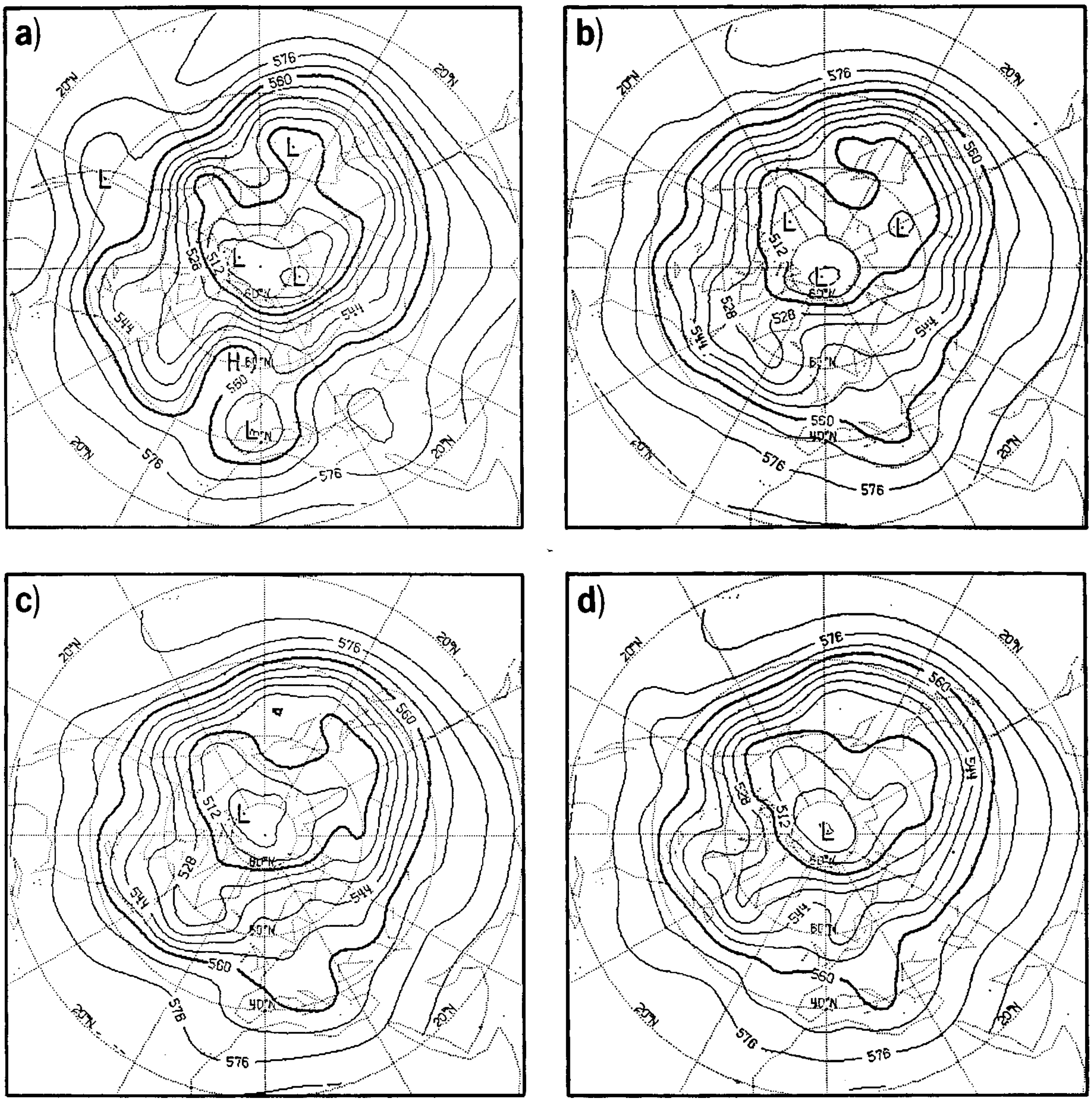


Fig. 5 500 mb N. Hemisphere height maps for a day 10 forecast. a) Analysis; b) 16-levels; c) 19-levels; d) 19-levels plus gravity wave drag.

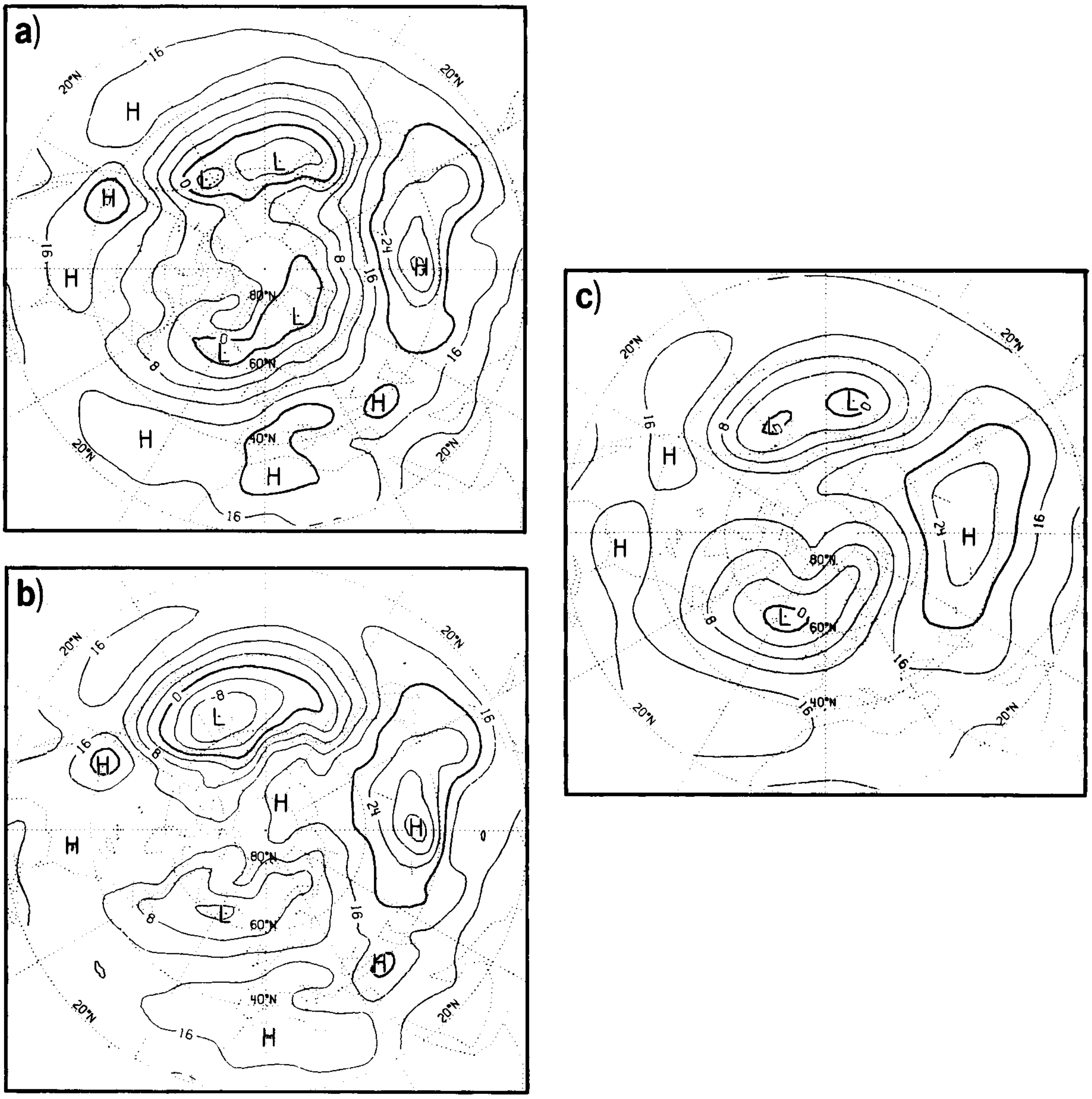


Fig. 6 90-day averages of the 1000 mb height fields from T42L19 simulations (initial date 6/12/84) compared with climate
a) $\sqrt{2}\sigma$ envelope orography, b) $\sqrt{2}\sigma$ envelope plus gravity wave drag, c) winter climate.

forecasts and seasonal simulations is large and considerably improves the model climate and the systematic errors, e.g. Fig. 6. Only results for the N.Hemisphere have been shown, as the impact of GWD is very small in the Tropics and mostly small and unsystematic in the S. Hemisphere, where the effect of considerable wave drag around the Antarctic plateau is difficult to verify against analyses.

The experimentation described here has been exclusively with the operational envelope orography; however, the set of T106L16 experiments was repeated with mean orography. Objective scores still indicated an advantage for the envelope over the mean, albeit a modest one. At this stage the envelope orography is retained but research continues into the dynamical relationships between the orography itself and the stress profiles provided by the GWD parameterisation scheme, with a view to further improvements in the future.

- Martin Miller

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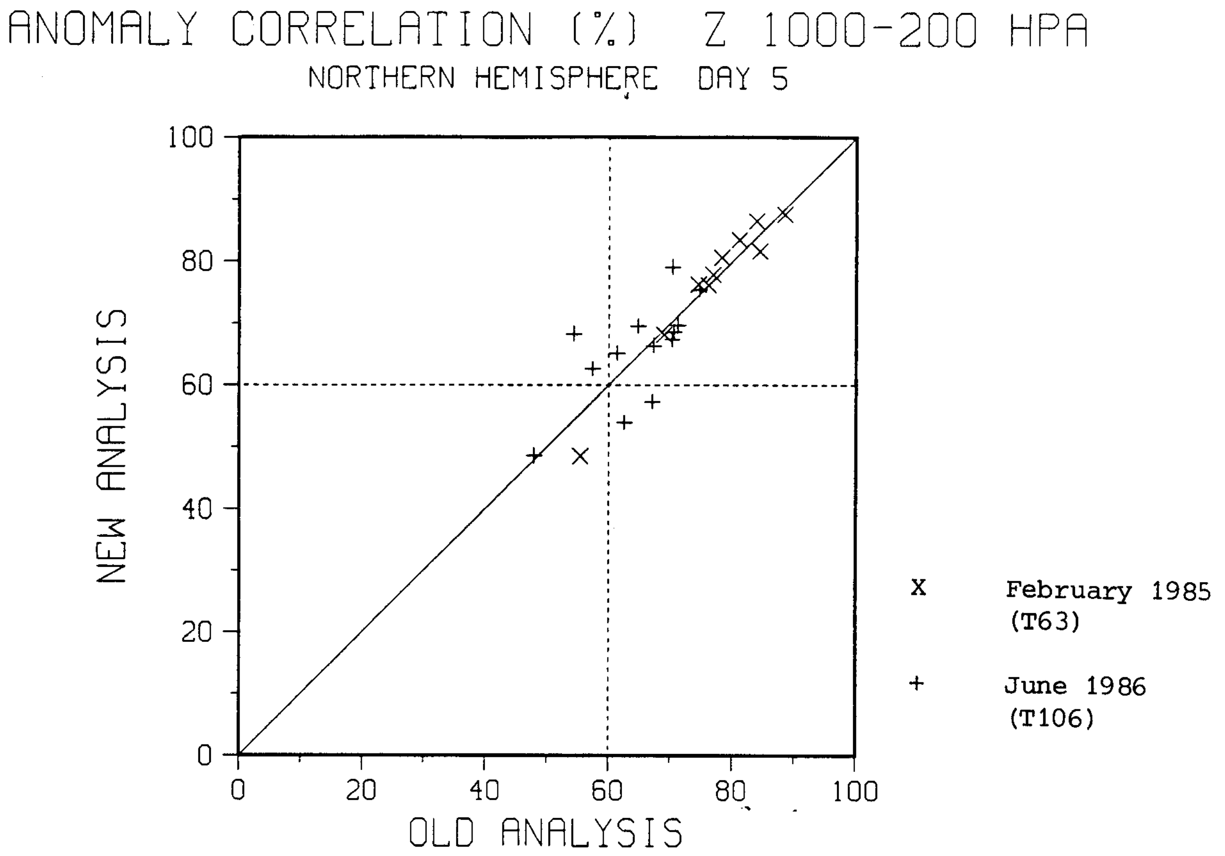
THE NEW ANALYSIS SYSTEM

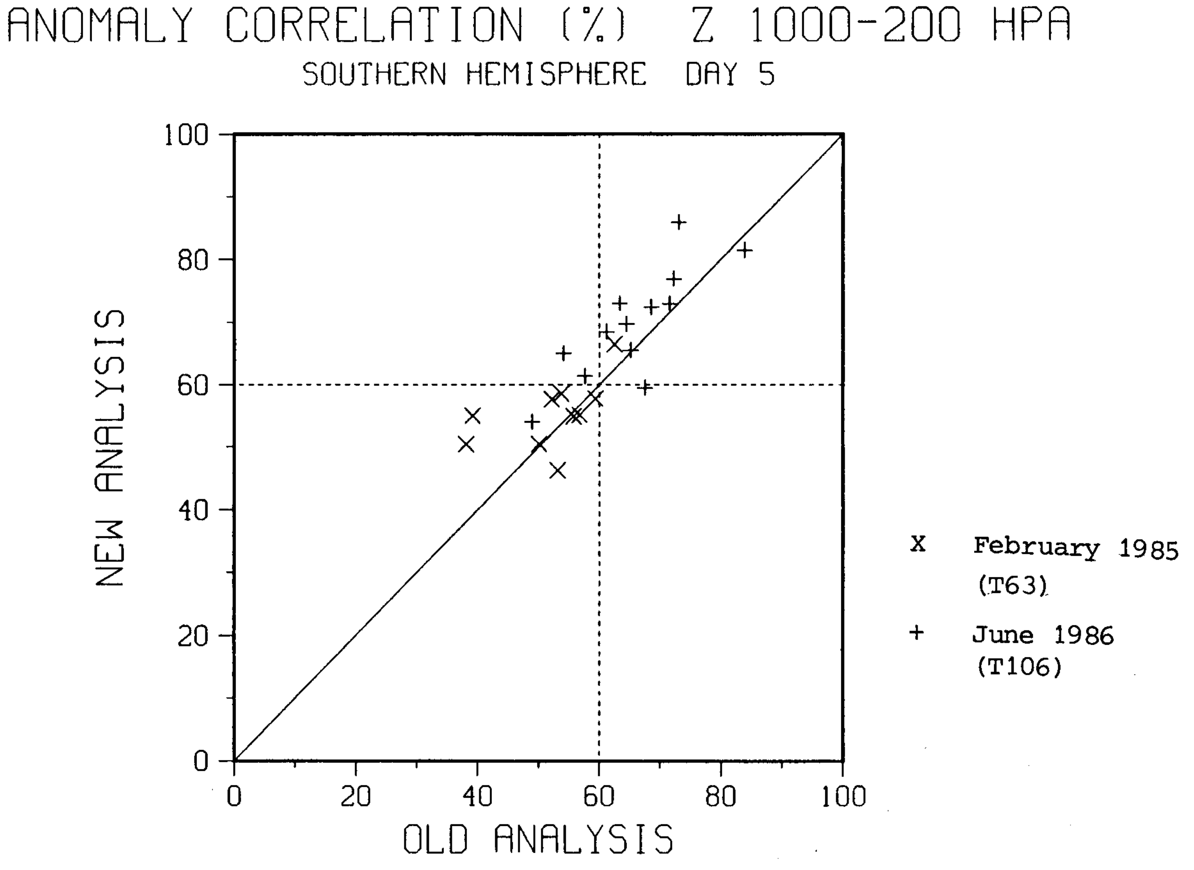
Rationale

The Centre's first analysis system has had an operational lifetime of seven years and was used to produce the Main and Final FGGE IIIB analyses. Its novel meteorological feature was the simultaneous analysis of several gridpoints and levels using the same, very extensive data set. On the Cray 1-A, Input/Output (I/O) was very expensive compared to "number crunching" and needed to be minimised. This problem was solved by grouping observations from an area of approximately 660 km square into a block. This rigid organisation of the observations, together with the N48 grid on which analysis changes were calculated, inhibited improvements of analysis resolution. Increases in vertical resolution were difficult, as data from at most 15 standard pressure levels could be used. Furthermore, central memory limitations on the Cray 1-A forced a partitioning of the analysis into several steps which communicated through extensive file handling. The enhancements of the mainframe computer since 1979 eliminated the need for the complex data and field handling. All these limitations gave ample justification for the re-design and re-programming of the analysis system.

The upgrading of the ECMWF assimilation system is being carried out in two phases. The 19-level model and the new analysis were implemented in the first phase. This new system provides the flexibility necessary for the implementation of the theoretical ideas that have been developed at the Centre in past years (Phase II).



Figs. 1 and 2: Scatter diagrams of height anomaly correlations (averaged over the levels 1000-200 hPa) verifying the Day 5 forecast starting from the new and the old analyses.



The aim of Phase I was to keep the meteorological changes to a minimum. However, significant impact was made both by the introduction of the 19-level model and by the new analysis system.

Main features of the new analysis

Much better use will be made of the observations. The data and the differences between the first guess and the observations will be used and evaluated directly at the reported levels. A consequence of this modification is an increase in the actual vertical resolution of the analysis, in particular in the boundary layer and near the tropopause, where many single level data are available.

Many unnecessary interpolations of analysis increments between model and standard pressure levels have been eliminated. In the horizontal, the increments are evaluated directly on the Gaussian grid of the model, which at present has a resolution of 1.125 degrees latitude/longitude.

The data selection has been changed. The whole troposphere is analysed simultaneously in horizontal boxes of flexible size. Use is made of an increased number of data items in each individual analysis box. The boxes are subdivided in data dense areas, e.g. over Europe and North America.

The experiments with the new system

The performance of the new analysis system and the response of the forecast was tested in a series of experiments. In total, 23 ten day forecasts were run, 10 from February 1985 with the T63 model and 13 from June 1986 with the T106 high resolution model. In all the experiments the 19-level forecast model was used both to provide the first guess fields and in the subsequent 10-day forecasts. In addition to the research experiments, the new analysis system was tested in parallel with the operational forecast suite during the two week period prior to operational implementation of the new analysis on 9 September 1986.

Results from the experiments and first impressions from the operational testing are given below.

The forecast response to the new analysis

The modifications in the analysis system have a significant impact on the quality of the analysis and of the subsequent forecast.

The first guess fields (6 hour forecast) appear to be more accurate globally. This is reflected in a better fit of the satellite sounding data, while a slightly reduced response to radiosonde observations is evident from the assimilation statistics.

The medium range forecasts exhibit a sensitivity towards the different analyses. In the northern hemisphere the forecast differences are confined to the mobile synoptic scale disturbances, while the long wave pattern remains comparable. The impact of the new analysis system is more evident in the southern hemisphere, where the differences in the phase and amplitude of the waves of all scales begin to develop between days 3 and 5 of the forecast. In some cases they affect the large scale pattern, resulting in quite a different hemispheric forecast of the tropospheric flow and temperature pattern.

This sensitivity of medium range forecasts, which is greater in the south than the north of the globe, is reflected in the scatter diagrams of the objective verification scores for the two hemispheres at day 5 of the forecast (Figs. 1 and 2). The smallest differences are found in the northern hemisphere winter cases (T63 model), while the June cases (T106) exhibit a larger variability at a lower predictability level. On average, however, the performance of the two systems is very close. More variability together with a tendency towards an improvement is found for the southern hemisphere. Only one T63 and one T106 case are clearly worse. On average, an increase of several hours in predictability as measured by the hemispheric anomaly correlation coefficient is obtained.

The first results from the parallel testing of the new analysis confirm the findings from the research experiments. Further into the forecast the rms errors of the 500 hPa height fields begin to show an increasing sensitivity of the forecast to the initial state. This effect is more pronounced in the southern hemisphere forecasts.

Differences are also evident in the precipitation and cloud fields in the early part of the forecast. In particular, convective rainfall appears to be sensitive to the analysis differences. In the forecasts from the new system, rainfall rates are, on average, smaller and closer to the evaporation rate. The cloud amount is significantly reduced in the analysis and the early hours of the forecast. Globally the new system is drier (approximately 2% in relative humidity) and more faithful to observations given by surface, radiosonde and satellite data.

\- Peter Lönnberg, Horst Böttger

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THE ECMWF METEOROLOGICAL APPLICATIONS GRAPHICS INTEGRATED COLOUR SYSTEM

Introduction

Since its establishment in 1984, the Graphics Project Group has worked on the development of a basic system known as MAGICS (Meteorological Applications Graphics Integrated Colour System) and then produced a series of enhancements and extensions to its facilities. A preliminary design of the next stage, a version interactively driven by command processor, has recently been prepared.

An overview of MAGICS

MAGICS is a software system that, starting with mapping, contouring, wind and text plotting, will grow to comprise all the general meteorological graphics applications at the Centre.

MAGICS contains some new and powerful features such as colour, which is supported throughout the package. Below follows a summary of the current implementation of MAGICS.

Elements of the design

MAGICS consists of a small number of subroutines and contains a comprehensive list of keywords, e.g. 'CONTOUR-LINE-COLOUR', which enable users to have full control over all graphical aspects in a very flexible way. This method allows easy-to-remember, plain-language keywords and the list of keywords can be easily extended.

A unique feature of MAGICS, which helps to reduce tedious and repetitious work, is the grouping of MAGICS parameter values. A group can be stored either internally in MAGICS or on a user-supplied file. These sets of parameter values can be used in later programs, thus avoiding the setting of MAGICS parameters. For example, all of the contouring parameter values used during a particular plot can be stored and used later for similar plots. This feature facilitates modular programming and makes programs more readable.

Data Input

MAGICS has been specifically designed to reduce the problems normally associated with passing data for fields to graphics packages. It has greatly simplified the extraction of areas to be contoured and conversion of data to polar stereographic projection.

MAGICS will accept GRIB[1] code fields as input and can produce contouring and wind plots from these fields with a minimum of user intervention. Any necessary conversion and scaling of GRIB code data can be performed by MAGICS.

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[1] GRIB - a WMO approved code for the international exchange of forecast and analysis products in GRIdded Binary format.

Data for contouring and wind plots may be passed to MAGICS in matrix form or, in the case of GRIB code data, in the form of an input file.

Mapping

The term 'mapping' in MAGICS refers to the selection of the geographical area desired and the placing or projection of this area. Mapping includes the drawing of coastlines, grid lines and latitude/longitude annotation. MAGICS has greatly simplified the mapping of fields onto the various projections for users. Initially, two types of projections are catered for, polar stereographic and cylindrical. The projection of both contouring and wind fields is done automatically by MAGICS and this allows users to easily change from one area to another and to zoom in on selected areas.

Contouring

The contouring is based on Conicon[2] and includes the plotting of highs and lows (see Figure 1). Conicon is an accurate high level package, which enables MAGICS to generate contours on the original grid and then project them onto a polar stereographic projection. This technique ensures, by avoiding unnecessary interpolations, that no distortion of data occurs. A facility which allows full control of shading between contour lines, in different colours and densities, is also available (see Figure 2).

Wind plotting

Wind fields may be presented to MAGICS as u and v velocity components or in the form of speed and direction. These wind fields may be plotted as wind arrows or WMO standard wind flags.

Winds are automatically projected onto polar stereographic projections, taking the necessary rotation into consideration. This means that wind arrows and wind flags will be plotted along lines of latitude and longitude on polar stereographic maps and not in columns and rows. A thinning procedure may be applied to wind flags and arrows close to the poles (see Figure 3).

Text plotting

MAGICS text facilities allow users to plot text anywhere within the plotting area. By default, text is plotted as a title over the plotted picture. When GRIB code data is used, the title will be created automatically by MAGICS. There are also facilities for plotting composed text strings, e.g. mathematical formulae or the special characters used in some of the European languages.

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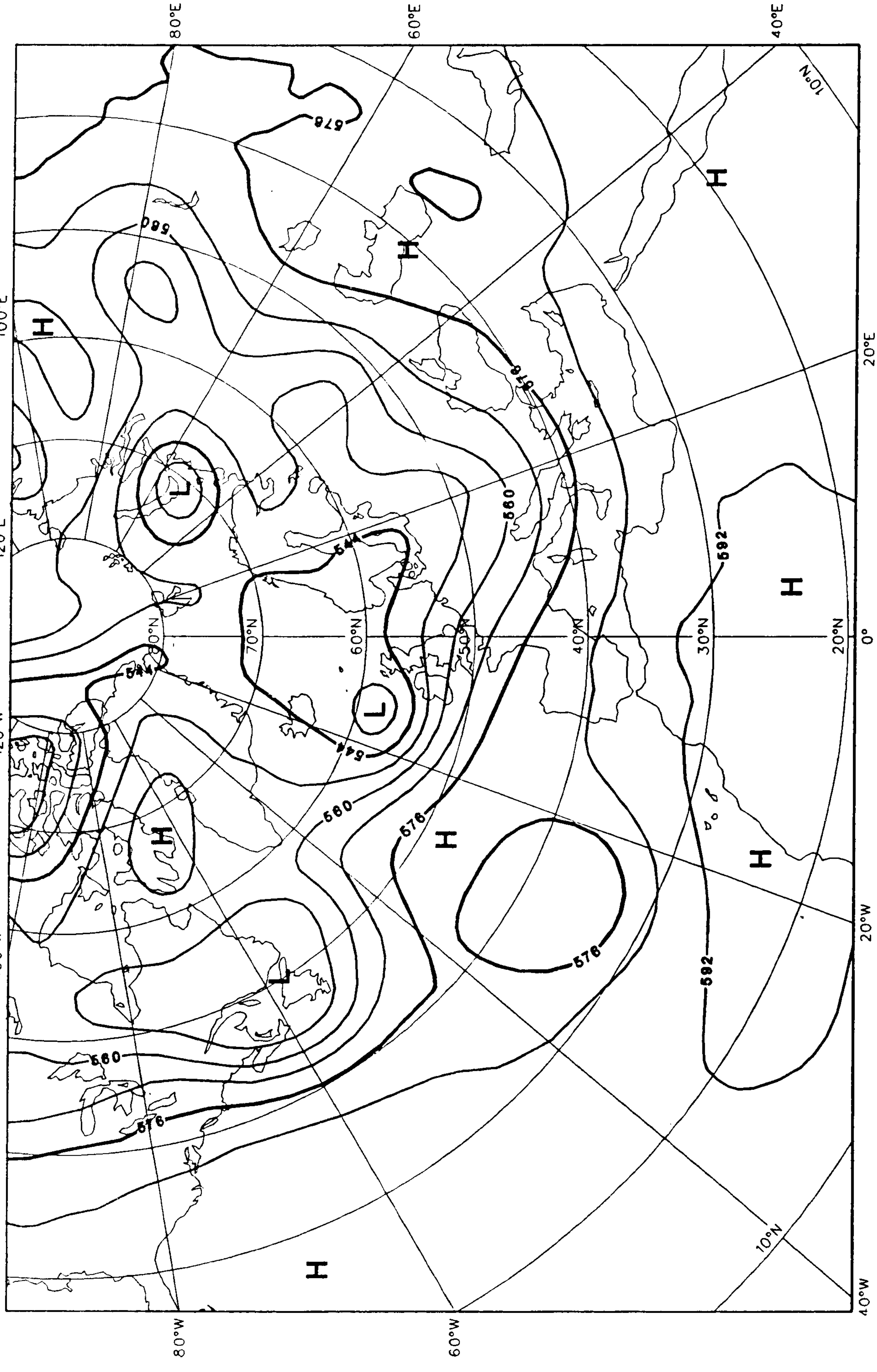
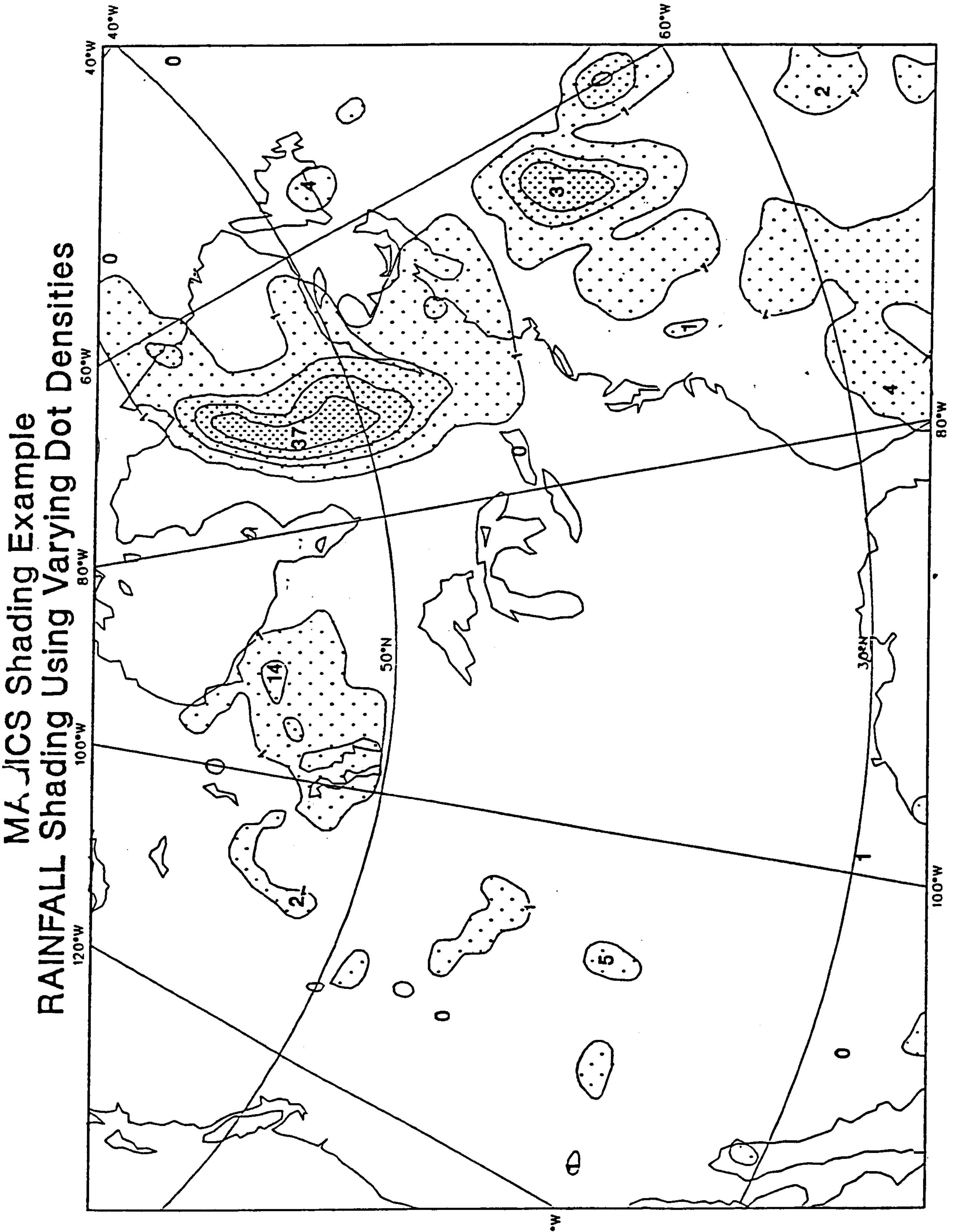
[2] Developed by the University of Bath, England



Polar Stereographic 500 hPa Geopotential Height
Projected from a Regular Global 1.5 degree LAT/LONG Field

Figure 1



MAGICS Shading Example
RAINFALL Shading Using Varying Dot Densities

Figure 2

Polar Stereographic Surface Wind Field
U and V Components on Gaussian Grid

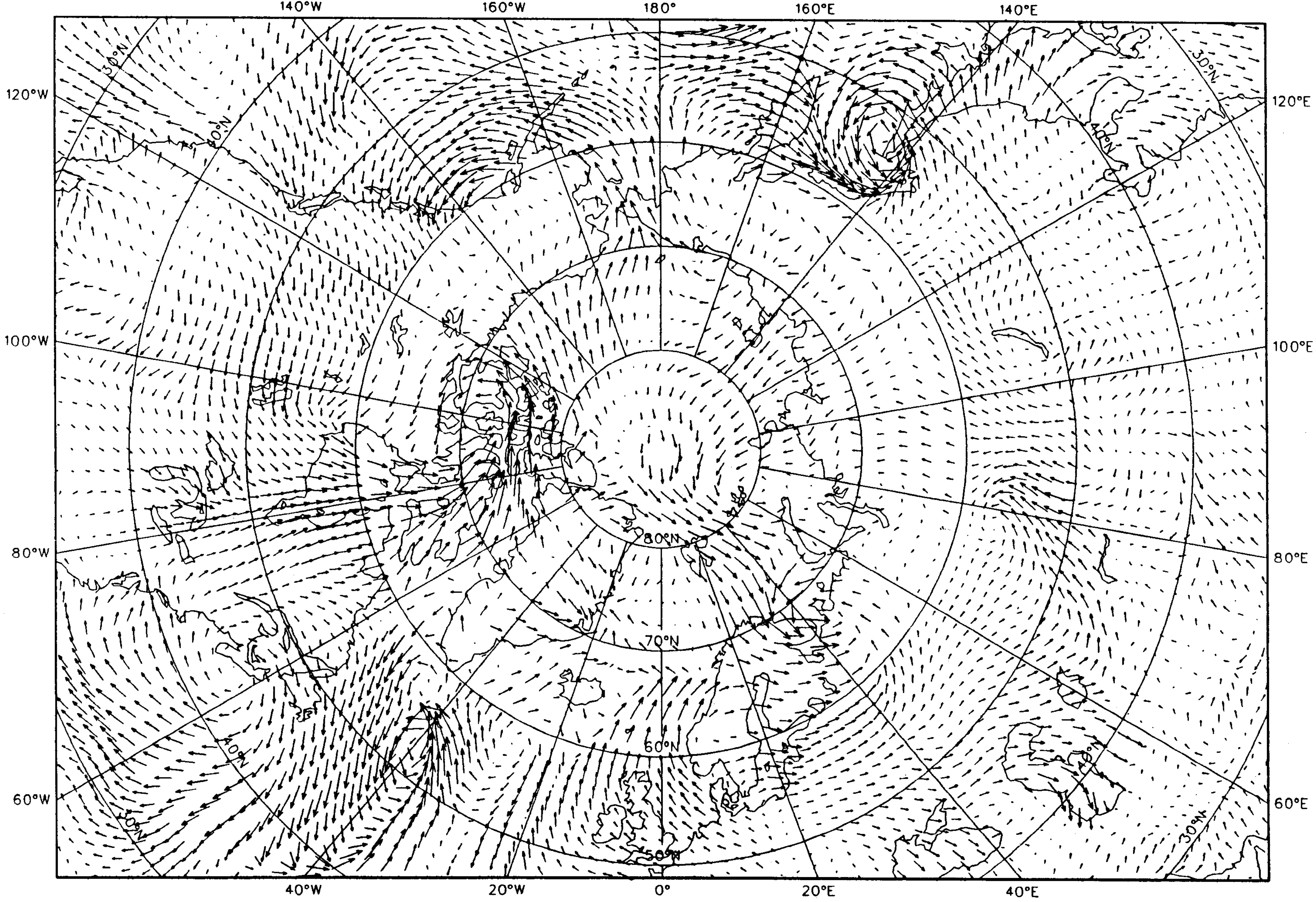


Figure 3

Graphics output

Graphics output is produced by DISSPLA[3] on the CRAY X-MP. It can either be sent to a specific device or stored in a device independent form that allows the user, at a later stage, to decide which graphics device is to be used.

Future enhancements

The following enhancements to the MAGICS system are planned:

1. Automatic or user-controlled plotting of map legends. In particular, this feature will enhance the appearance of shaded contour maps and coloured wind fields.

2. Plotting of streamlines, isotachs and isogons to be added to the wind plotting facilities.

3. Full and partial plotting of meteorological observations, including full synoptic plotting.

4. Facilities to allow plotting of symbols and numerical values at user selected positions.

5. Blanking of user-selected areas, including LAND/SEA blanking.

6. Plotting of tephigrams, cross-sections, graphs, thickness charts and cloud cover.

New up-to-date MAGICS Manuals will be distributed shortly and future enhancements will be notified in the form of News Sheets which may be inserted into the manuals.

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[3] Developed by ISSCO, USA

\- Jens Daabeck

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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 or republished in this Newsletter series (up to News Sheet 191). All other News Sheets are redundant and can be thrown away.

No.	Still Valid Article
16	Checkpointing and program termination
19	CRAY UPDATE (temporary datasets used)
56	DISP
67	Attention Cyber BUFFER IN users
73	Minimum Cyber field length
89	Minimum field length for Cray jobs
93	Stranger tapes
118	Terminal timeout
120	Non-permanent ACQUIRE to the Cray
121	Cyber job class structure
122	Mixing FTN4 and FTN5 compiled routines
127	(25.1.82) IMSL Library
130	Contouring package: addition of highs and lows
135	Local print file size limitations
136	Care of terminals in offices
140	PURGE policy change
141	AUTOLOGOUT - time limit increases
144	DISSPLA FTN5 version
152	Job information card
158	Change of behaviour of EDIT features SAVE, SAVEX. Reduction in maximum print size for AB and AC
164	CFT New Calling Sequence on the Cray X-MP
166	Corrections to the Contouring Package
167	CFT 1.13 improvements
172	Change to CFT Compiler default parameter (ON=A)
174	Warning against mixing FTN4 and FTN5 compiled routines.
176	Archival of Cyber permanent files onto IBM mass storage
177	RETURNX, REWINDX
178	TIDs on Cray include 2 chara. TID plus 3 chara source computer ID. Caution with ACQUIRE on RERUN jobs
182	NOS/BE level 627
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
191	Trial forecast based on 00z data

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ECMWF PUBLICATIONS

TECHNICAL MEMORANDUM N°. 118:	North Atlantic network studies using the ECMWF analysis system
TECHNICAL MEMORANDUM N°. 119:	A pilot study on the prediction of medium range forecast quality
TECHNICAL MEMORANDUM N°. 120:	Standards for software development and maintenance
TECHNICAL MEMORANDUM N°. 121:	Description of the ECMWF model post-processing system
TECHNICAL MEMORANDUM N°. 122:	Final report on comparisons between bulletins transmitted on the GTS and those received at ECMWF (period 1-5 October 1984)
TECHNICAL MEMORANDUM N°. 123:	Conceptual design for a WWW data management system
FORECAST REPORT N°. 34:	(March/May 1986)

Proceedings of the Seminar on Physical Parameterisation for Numerical Models of the Atmosphere, 9-13 September 1985, Vol. 1 and 2.

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ECMWF CALENDAR OF EVENTS

29 September- 1 October	14th session of the Scientific Advisory Committee
1-3 October	11th session of the Technical Advisory Committee
6-9 October	Information meetings on Archiving and Retrieval (MARS), Graphics (MAGICS) and new telecommunications system (NTC)
6-8 October	37th session of the Finance Committee
9-10 October	Member States' Computer Representatives meeting
3-4 December	24th session of the Council
8-10 December	Workshop: Using multiprocessing for meteorological applications

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INDEX OF STILL VALID NEWSLETTER ARTICLES

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