In this issue

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Cover

The front page shows the launch of the NOAA-15 spacecraft on 13th May 1998 and microwave radiance data produced by the new ATOVS instrument carried onboard.

Editorial

Variational assimilation provides opportunities for making more effective use of observational data. The article on page 2 describes recent changes to the operational system that enable the assimilation of raw radiances from the NOAA series of satellites, rather than radiance data that has been pre-processed by NESDIS. This allows more accurate representation of the scanning geometry and of the impact of cloudiness, better quality control, and the more immediate usage of data from newly launched satellites.

The increasing complexity of the integrated forecasting system (IFS) and the variety of options available for different applications can make it difficult for users to prepare and run their experiments. PrepIFS, described on page 7, has been designed to enable both remote users and internal reseach scientists to use and to modify different assimilation and forecast configurations without a detailed knowledge of the system itself.

Changes to the operational forecasting system

Recent changes

On 9 March 1999, the reference model's vertical resolution was increased from 31 to 50 levels (model cycle version 19r2) (a description of the changes was published in ECMWF Newsletter Number 82, 'Increased stratospheric resolution in the ECMWF forecasting model' by A. Untch et al.).

On 5 May 1999, processing and assimilation of raw TOVS/ATOVS radiance data from the NOAA-14/ NOAA-15 polar orbiting spacecraft became operational (model cycle version 21r1) (see article in this issue on page 2). The move to assimilating raw-radiance data (as opposed to the NESDIS pre-processed radiances that were previously used) has required a significant revision of the errors assigned to radiance obervations in the analysis, and of the quality-control procedures; other modifications introduced at the same time were mainly technical changes (re-coding of the sea and lakes temperature prescription software, and modification of the oceanic waves code). The meteorological impact is a moderate, but consistent, improvement in forecast skill at all ranges, the largest being observed in the southern hemisphere and lower stratosphere.

Planned changes

A new soil moisture and temperature analysis scheme is expected to become operational this summer. An increase from 50 to 60 levels (more resolution in the planetary boundary layer) is planned for the autumn.

François Lalaurette

The use of raw TOVS / ATOVS radiances in the ECMWF 4D-Var assimilation system

Radiance data from the NOAA polar orbiting satellites have been assimilated at ECMWF for a number of years and represent a major component of the global observing system. The analysis schemes used to assimilate the data have changed significantly in this time from the first 1D-Var in June 1992 (Eyre et al. 1993), to 3D-Var (Andersson et al. 1998) in January 1996 and most recently 4D-Var in November 1997 (Rabier et al. 1998). However, the basic form of the radiance data used in the analysis has remained unchanged from the original NESDIS pre-processed cloud-cleared (TOVS) radiance products. These data have undergone a number of significant pre-processing stages (at NESDIS) before they are distributed to NWP centres and it is known that some of these stages can introduce complicated random and systematic errors in the data that are not present in the original raw radiance observations. There are good historical reasons why the pre-processing is applied, related to the fact that the radiances were originally intended to be used in linear retrieval schemes. However, most of the pre-processing is not necessary to use the data in analysis schemes such as 3D or 4D-Var and, since it can introduce errors, it is in fact undesirable. Furthermore, when a new satellite is launched (e.g. the NOAA-15 spacecraft in April 1998 carrying the new ATOVS instruments), raw radiance data may be available for some considerable time (up to a year) before the pre-processed radiance products are distributed. This paper describes the recent modifications to the ECMWF assimilation scheme that allow the raw TOVS / ATOVS radiance observations to be used instead of the pre-processed data. The results of experiments carried out to test the meteorological impact of the change are also presented.

Changes to the assimilation system

Use of unmapped instrument data

The TOVS instrument actually consists of three completely independent radiometric units. The High-resolution Infra-Red Sounder (HIRS), the Microwave Sounding Unit (MSU) and (on alternate NOAA spacecraft) a Stratospheric Sounding Unit (SSU). The new ATOVS instrument replaces the MSU with two Advanced Microwave Sounding Units (AMSU-A and B). All of these measure radiation leaving the top of the atmosphere in different parts of the electromagnetic spectrum, but the individual instrument characteristics are very different. The most obvious difference is in the scanning geometry (i.e. the number of measurements taken per scan and the size of the area or "field of view" from which radiation is obtained). The instrument characteristics are described in Table 1.

Instrument	Spectral region measured	Size of field of view (FOV)	No. of FOV per scan line
HIRS	20 channels 3.7 - 15 microns	17 to 58 km (nadir to limb)	56
MSU	4 channels 50 - 57 GHz	109 to 323 km (nadir to limb)	11
SSU	3 channels at 15 microns	147 to 450 km (nadir to limb)	8
AMSU-A	15 channels 23 - 57 GHz	50 to 160 km (nadir to limb)	30
AMSU B	5 channels 89 - 183 GHz	17 to 55 km (nadir to limb)	90

Table 1: *TOVS / ATOVS instrument characteristics.*

The NESDIS pre-processing attempts to map radiance data from all the different instruments on to a single scanning geometry (in practice to the geometry of the HIRS) in order to combine the multi-spectral information at a single geo-location. Unfortunately the mapping is difficult to achieve accurately (requiring a very precise knowledge of the relative scanning and orbital characteristics) and even when done correctly can introduce spurious signals into the data (e.g. when a low resolution instrument such as the MSU is mapped to a high resolution HIRS geometry). The analysis has been modified to deal with each instrument as an independent source of radiance data that is assimilated on its natural scan geometry. Information from the different instruments is still combined implicitly by the 3/4D analysis, but in a more optimal way respecting the true information content of the data.

Limb and emissivity adjustment

As a satellite instrument scans away from the vertical (or nadir) viewing position the radiation that is measured originates from a slightly higher level in the atmosphere due to the increased absorption of a longer (so called limb) atmospheric path. For channels sensitive to the troposphere this results in colder measurements at the limb relative to nadir and for stratospheric channels measurements can be warmer at the limb due to the often reversed lapse rate. Furthermore, channels sensitive to the surface display a scan variation due to the changes in surface emissivity with viewing angle. The NESDIS pre-processing attempts to remove the radiance variation with scan position by a process called limb adjustment.

Non nadir measurements are statistically adjusted to estimate the radiance that would have been obtained from the same atmosphere and surface viewed at nadir. A significant proportion of the scan dependent systematic errors in the pre-processed data have been traced to problems in this limb adjustment process. ECMWF's analysis has been modified to assimilate the raw radiance data at the scan position it was actually measured by performing radiative transfer and emissivity calculations along slant paths. While these calculations are currently less accurate than those for nadir paths (but should improve as more experience is gained) the associated systematic errors are generally smoother, and smaller, than the limb adjustment errors. More importantly, errors are found to be more stable in time allowing a more effective bias correction to be applied.

Cloud and precipitation detection

Radiance data are used to specify the atmospheric temperature and humidity structure within the analysis, but in many cases the measurements may be strongly contaminated by other atmospheric phenomena such as cloud (in the infra-red) and precipitation (in the microwave part of the spectrum). Analysis schemes are not yet sophisticated enough to extract only the temperature and humidity information from contaminated radiances so, at present, these data must be identified and removed before the analysis. If this is not done the analysis will attempt to interpret signals in the radiance data that are due to e.g. cloud by making erroneous adjustments to the atmospheric temperature and humidity. In the pre-processed radiances NESDIS attempts to identify contaminated situations using a battery of tests that search for the characteristic statistical signatures of cloud and precipitation in the data. While these tests are generally quite effective and detect most contamination they are done in the absence of any up to date information about the particular state of the atmosphere and therefore cannot be applied too stringently. This has resulted in cases where significant residual cloud and precipitation are found in the NESDIS pre-processed data. The analysis screening (that uses a short-range forecast of the atmospheric state) has been modified to detect and reject contamination in the raw radiance data. The forecast is used to compute clear sky values of the window channel radiances (that are extremely sensitive to the presence of cloud and precipitation); if the measured values are found to differ significantly from these the situation is assumed to be contaminated. Results suggest that this approach is generally more stringent than the tests applied in the NESDIS pre-processing.

Bias correction

In the absence of the statistical adjustments applied to produce the pre-processed data and with a more stringent detection of cloud / precipitation contamination the raw radiance data are found to have smaller and more stable systematic differences from the background field that require less bias correction. Also, since many potential sources of systematic error have been eliminated it has been possible to gain a better understanding of the sources of bias that remain. It is now believed that the major source of systematic difference that remains is not in the data itself, but in our ability to simulate the radiances within the analysis. This is due to a combination of errors in the physics of the radiative transfer model and an insufficiently precise knowledge of the exact spectral intervals (or channels) in which the radiation is actually measured by the instruments. The exposure of these issues as a significant source of bias has resulted in some considerable effort directed towards improving the radiative transfer model. A particularly encouraging feature of the new AMSU instrument on NOAA-15 is that only very small biases are observed, suggesting that the radiative transfer and channel characteristics are better known than on previous spacecraft.

1D-Var

Before being supplied to the main 3D or 4D-Var analysis the pre-processed radiances data were passed through a 1D-Var retrieval scheme. This was used to extract information about the atmospheric temperature outside the domain covered by the main analysis (e.g. the stratosphere) and to quality control the radiance data. The recent implementation of the 50 level model (extending up to 0.1 hPa) removes the need to pre-specify the stratosphere with 1D-Var and a new quality control scheme has been developed such that the 1D-Var is no longer used.

Analysis quality control of radiances

Inside the analysis all observations (conventional and satellite) are checked against the forecast to detect and reject bad data. A desirable feature of such an approach is that an observation is less likely to be rejected in an area where we have less confidence in the quality of the short-range forecast (for example in data sparse regions or areas of rapid dynamic development). In the past this flexibility has not been possible for radiance observations since an estimate of forecast error in radiance space has not existed and the data had to be checked against essentially fixed thresholds. A method has now been developed to generate estimates of the forecast error in radiance space (Andersson et al. 1999) allowing the quality control of radiances to be dynamic and consistent with the treatment of conventional data.

Analysis and forecast impact experiments

Experiments have been conducted to test the performance of the new radiance assimilation scheme compared to that of the current operational configuration. It is important to note that there are two major differences between the experimental system (henceforth called EXPT) and the operational system (henceforth called OPS). The OPS system assimilates pre-processed TOVS radiance data from the NOAA-11 and NOAA-14 spacecraft. The EXPT system assimilates raw TOVS and ATOVS radiance data

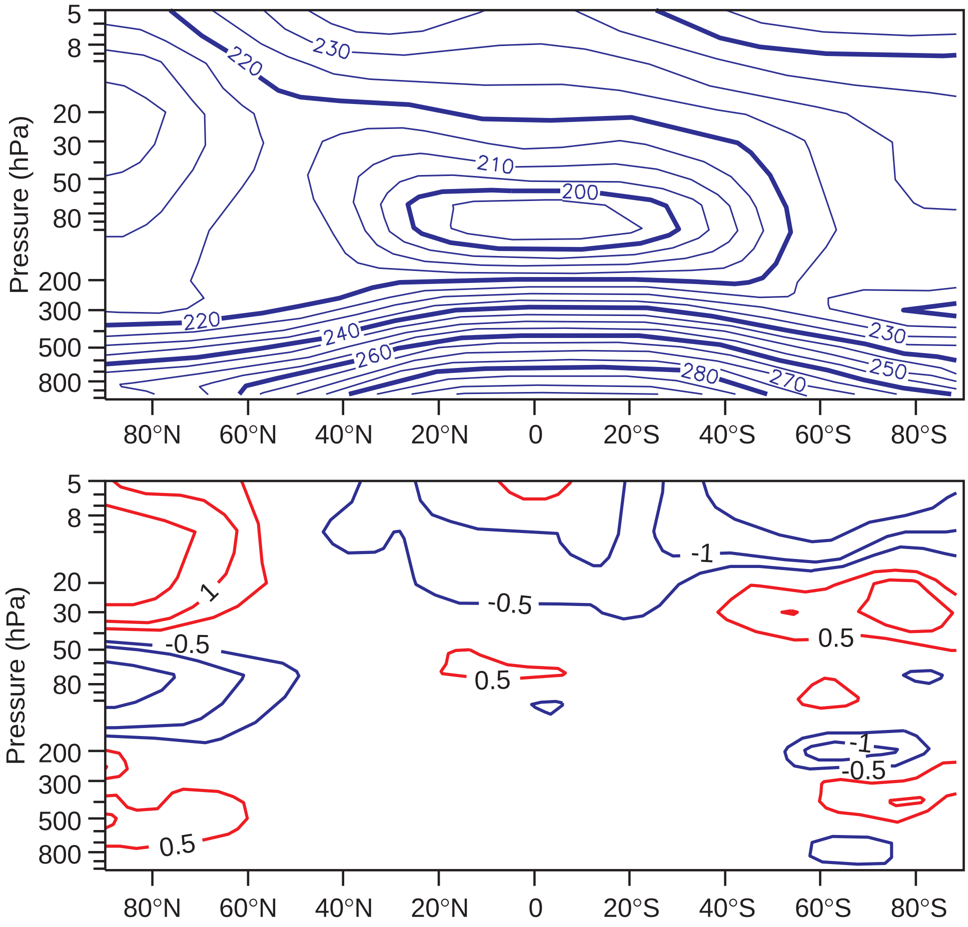

***Figure 1:** Zonally averaged monthly mean temperature analysis for the OPS assimilation in February 1999 (upper) and mean analysis differences (lower) defined as experiment minus control. Units are degrees Kelvin.*

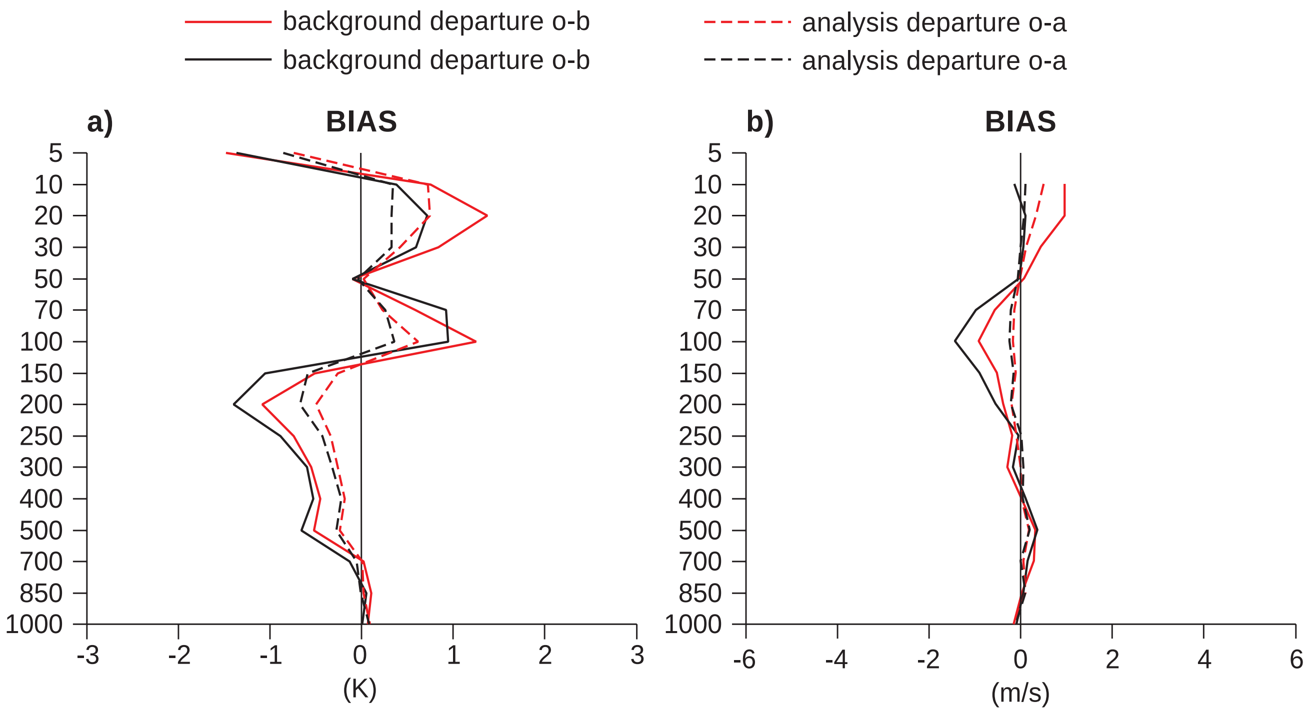

***Figure 2:** a) Mean fit of the background (solid lines) and analysis (dash lines) to radiosonde temperature observations (20°N to 20°S) for the OPS (black curves) and EXPT (red curves) assimilations. b) Mean fit of the background (solid lines) and analysis (dashed lines) to radiosonde observations of zonal wind (20°S to 90°S) for the OPS and EXPT assimilations.*

from the NOAA-14 and NOAA-15 spacecraft respectively. A cleaner comparison to test the raw radiance approach would have required pre-processed radiance data from NOAA-15 to be in the OPS assimilation, but this data is not expected to be available from NESDIS before the end of May 1999 (the raw data has been available since August 1998). Alternatively, the EXPT assimilation could have used raw TOVS radiances from NOAA-11 and NOAA-14 data, but as NOAA-11 was expected to become obsolete at the end of April 1999 it was not considered a worthwhile investment of effort to test a configuration with only a short anticipated lifetime (in fact the spacecraft failed at the end of February, 1999). Thus when comparing the results presented here it must be understood that there will be differences due to the extra microwave information provided by AMSU on NOAA- 15 and differences resulting from the use of raw radiances rather than pre-processed data.

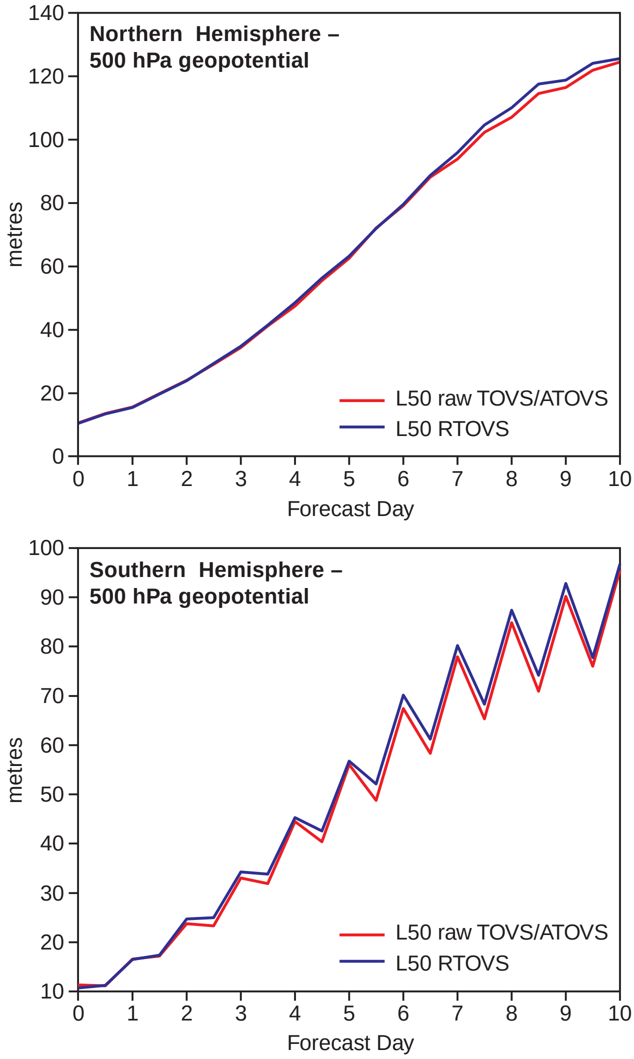

Figure 3: *Root mean square forecast errors in the northern and southern extra-tropical regions for the OPS (blue curves) and EXPT (red curves) verified against radiosonde observations of 500 hPa geopotential. The sample consists of 127 cases.*

Analysis impact

The changes to the assimilation system have resulted in some significant differences in the resulting analyses. Figure 1 shows the zonal mean temperature analysis for OPS, and the difference OPS-EXPT. The largest systematic differences are in the stratosphere and are due to the use of the AMSU-A radiances by the EXPT assimilation. This instrument has six channels that peak above 100 hPa, the highest being sensitive to the atmospheric temperature around 2 hPa. This is a significant addition to the information previously provided by the uppermost channels of the HIRS and SSU instruments can be exploited in the recent extension of the ECMWF forecast model in to the stratosphere. Mean changes in the troposphere are generally small, but are significant over the polar areas where there have been changes to the radiance data usage. The interpretation of raw radiance data in the analysis and the quality control procedures described earlier (that aim to detect cloud and precipitation) rely upon an accurate estimate of the underlying surface skin temperature and emissivity. Over the poles little is known about the quality of the model skin temperature (and even less about the surface emissivity) so it was decided to be cautious (at least initially) and not use any channels that have a significant sensitivity to the surface. Unfortunately most of the channels that provide mid to lower tropospheric information are also sensitive to the surface and this policy results in some considerable loss of data. However, results (from forecast comparisons presented later) suggest that it is safer not to use tropospheric radiances in these areas than to attempt to use radiance data that we do not fully understand.

Verification of analysis changes

A key quality indicator for any data assimilation system is the extent to which it draws to radiosonde and other conventional observations in the presence of (generally more numerous) satellite data. Experience has shown that the fit to conventional data (e.g. the root-mean-square temperature differences between the background/analysis and the radiosondes) are generally very stable quantities, but are often adversely affected when there are problems with the use of satellite data. An example of the fit of the EXPT and OPS assimilations to radiosonde temperature data is shown in figure 2a). It can be seen that the EXPT assimilation fits the tropical radiosonde data better than OPS at many levels but there is some degradation around 100 hPa and 20 hPa. There are improvements in the extra-tropical regions, but they are generally much smaller and are not shown here. Thus the radiosonde temperatures suggest an improved temperature analysis in the vicinity of the radiosonde data. It is also useful to examine wind statistics. These are sensitive to the correct specification of the horizontal gradient of temperature (particularly in the extra-tropics assuming a geostrophic balance) and thus represent a less local measure of the assimilation quality. Statistics for the southern hemisphere are shown in

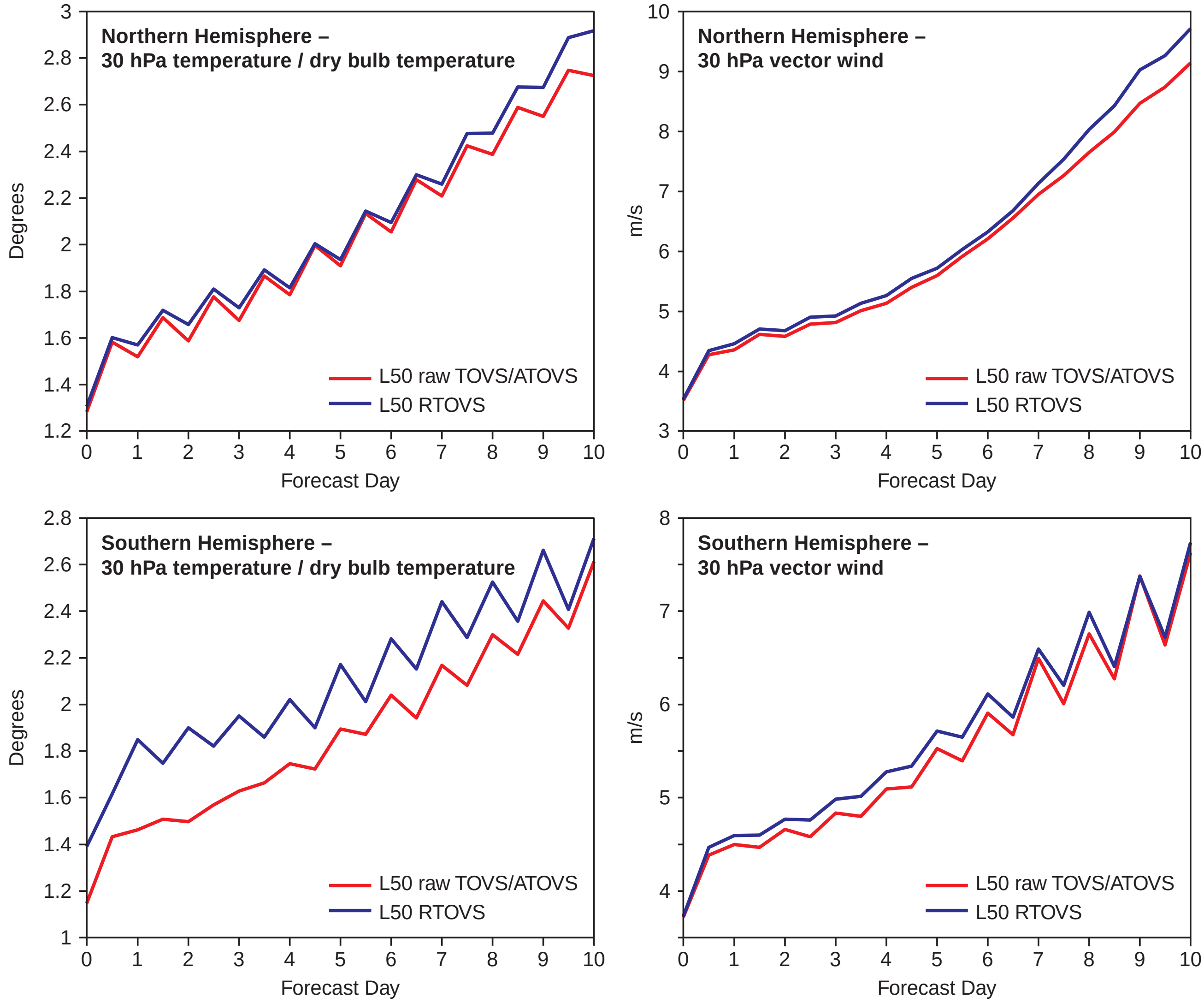

Figure 4: *Root mean square forecast errors in the northern and southern extra-tropical regions for the OPS (blue curves) and EXPT (red curves) verified against radiosonde observations of 30 hPa temperature and vector wind.*

figure 2b) and show a small, but consistent improvement in the wind fit of the EXPT assimilation compared to that of OPS.

Forecast impact

It is always difficult to relate the changes that have been made in the assimilation system to changes in the quality of forecasts. After a certain time (estimates vary between three and five days) it becomes impossible to trace forecast differences back to differences in the initial conditions (i.e. the analysis). Furthermore, before this so called non-linear stage of the forecast the choice of the truth against which we measure the quality of the forecast is significant. Usually the analysis is used, but if there are significant changes to the analysis for OPS and EXPT it must be remembered that there are two possible versions of the truth. An obvious compromise is to verify the forecasts from OPS and EXPT against radiosonde observations (which are not perfect but are the same for both experiments) and it is these results that are presented here. Figure 3 shows root-mean-square errors for the forecasts of 500 hPa height. It can be seen that the tropospheric impact of the EXPT is generally neutral in the extra-tropical northern hemisphere (although clearly positive after day 6) and positive at all ranges in the southern hemisphere, note that the differences in spatial and temporal coverage of southern hemisphere radiosondes give different statistics at 00 UTC and 12 UTC. No clear consistent impact was found in the tropical wind forecasts in the troposphere.

It was reported in Newsletter No. 82 that the stratospheric performance of the L50 forecast model (equivalent to the OPS in this context) showed a significant improvement over the previous L31 system. A small additional improvement has been found with the temperature and wind forecasts from the EXPT system relative to OPS (shown in figure 4 at 30 hPa as this was the level quoted in the previous newsletter).

Summary and future work

The ECMWF data assimilation has successfully been converted to use raw TOVS / ATOVS radiance data and has resulted in some useful improvements in the quality of analyses and forecasts. In the troposphere these are most likely due to the improved bias correction and quality control that are possible with the raw data. In the stratosphere the gain is almost certainly due to the extra information provided by the AMSU instrument.

The system described here must be considered only a first step in the direction of raw radiance assimilation. Since 1992 we have gained a great deal of experience with the use of pre-processed NESDIS data and it will take some time before our understanding of the raw radiances reaches maturity. The next step will be to extend our use of the raw data to the channels that are sensitive to the lower troposphere and surface. This is currently hindered by uncertainties in our knowledge of the physical characteristics of the surface and phenomena such as cloud and precipitation. Further in the future the challenge will be to extract valuable information on these processes and not regard them as contaminants to be removed.

The development of the raw radiance assimilation system is timely for the next ECMWF re-analysis project ERA- 40. The use of raw radiance data will not be subject to the many changes that have occurred over the years in the NESDIS pre-processing and thus allow a greater degree of time consistency in the analyses.

A.P. McNally, E. Andersson, G. Kelly, R.W. Saunders

PrepIFS - Global modelling via the Internet

PrepIFS is an interactive meteorological application for the preparation of research experiments based on the integrated forecasting system (IFS) at ECMWF. Researchers at ECMWF, as well as scientists in institutions anywhere in Europe (subject to prior permission), can access the complex computer environment at ECMWF via the INTERNET using the Java Applet PrepIFS and any standard WWW browser. Forecast/analysis experiments can be prepared and submitted remotely. The necessary tasks involving the preparation of initial data, the compilation/ incorporation of optionally provided modifications to the original setup, the actual forecast/analysis steps and subsequent postprocessing of the generated data are done on the current supercomputer and Origin servers at ECMWF. The IFS is a collection of Fortran90 source code routines capable of executing a global data assimilation and forecast in various configurations. Data produced by the experiments are stored in the meteorological archive and retrieval system (MARS). Supplementary data is stored in the data handling system (DHS). Using PrepIFS there is the possibility of modifying or adding to the source code in order to create desired experiments. There is also the possibility of accessing the (kornshell) scripts that are used to provide a convenient setup for the particular experiment. ClearCase, a comprehensive software configuration management system, is used to manage these sources. Furthermore, PrepIFS provides a debug environment for the researcher that allows a variety of options to modify the setup and the IFS usage.

Why do I need PrepIFS?

The IFS source code has grown over the years to incorporate different applications of numerical weather prediction. The various configurations require different setups, different initial data and different parts of the IFS. The variety of options makes it difficult to compare experiments if the same default setup is not used.

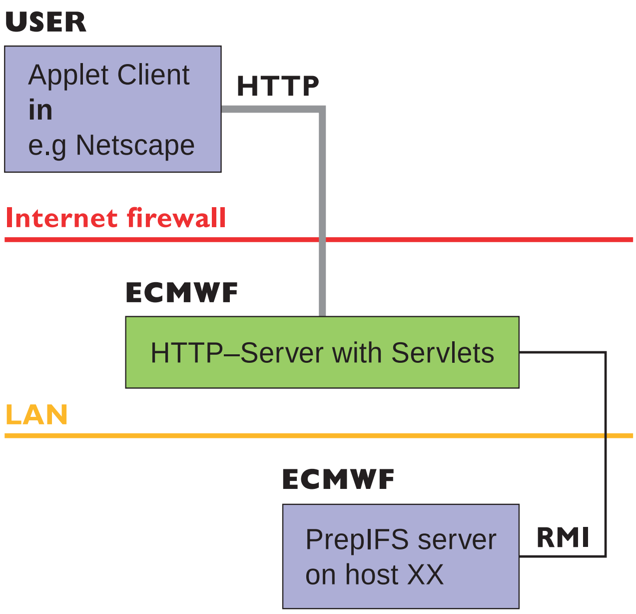

***Figure 1:** Overview of the communications involved between the WWW browser running the user applet and the actual task running at ECMWF in the local area network (LAN) by remote method invocation (RMI).*

PrepIFS ensures this required consistency of the performed experiments. It offers to the remote user and the internal research scientist the ability to use and modify those different configurations without sophisticated knowledge about the system itself, which on its own fits and optimizes the given task into the software and hardware framework of ECMWF. It is designed to provide a higher level of abstraction in order to make use of a complex system like the IFS at ECMWF easily available to a broader spectrum of users. The impact of some chosen parameters, or the impact of different data input on the data assimilation and forecast system, can easily be investigated using a tranparent user interface via a few mouse clicks. Impact studies of hazardous weather events in the past can be conducted by changing a single parameter in the default setup (the DATE), additional diagnostics can be switched on, and different resolutions, targeted areas, numerical schemes, and many more options are now also available to remote users.

In particular PrepIFS enables the research scientist to prepare:

- data assimilations
- forecasts
- singular vector computations
- ensemble predictions
- seasonal forecasts
- coupled ocean–atmosphere model experiments
- coupled wave model forecasts
- sensitivity studies
- . . .

Although sophisticated knowledge about the system is not required for the 'novice' researcher a brief description is given in the following sections.

The WWW gateway to ECMWF

ECMWF webservices are hosted by JavaServers (JS) (Figure 1). These are webservers based on object oriented JAVA code which support the Servlet applications programming interface and which are platform independent. They normally work as information providers serving documents to WWW browser clients. ECMWF's webservers communicate via the HTTP protocol which has the advantage of being able to pass through firewall software protecting the ECMWF environment against unauthorized access. PrepIFS is a client/server application using a Java enabled WWW browser such as Netscape as the client to visualize the User Interface. Communication is by means of HTTP and invokes actions on Java Objects located on remote servers (Java's remote method invocation (RMI)) for delivering data or computations. The time required to perform these are dependent on the status of the network such as available bandwidth and other users activities.

In order to use PrepIFS access to the ECMWF computer system is required. Scientists at ECMWF and member state users who are in group *ifs_users* can currently use PrepIFS. Additionally, a suitable *account* under which the jobs can run is needed. The external user normally goes through a login procedure starting at:

http://www.ecmwf.int/

After the successful authentication via a passcode ID the user has access to the WWW services at ECMWF. Within a short period, it is planned to add the PrepIFS service which will be accessible at:

http://www.ecmwf.int/ecmwf/PrepIFS

PrepIFS – Connection to SMS (Supervisor Monitor Scheduler)

When an experiment is prepared it involves various processes to setup a suitable working environment for a set of tasks. In an environment such as ECMWF tasks should make optimal use of the computer systems. This involves parallelism on the level of executing several tasks at the same time as well as tasks that contain parallel execution models themselves (e.g. the IFS forecast). Therefore, PrepIFS makes use of the supervisor monitor

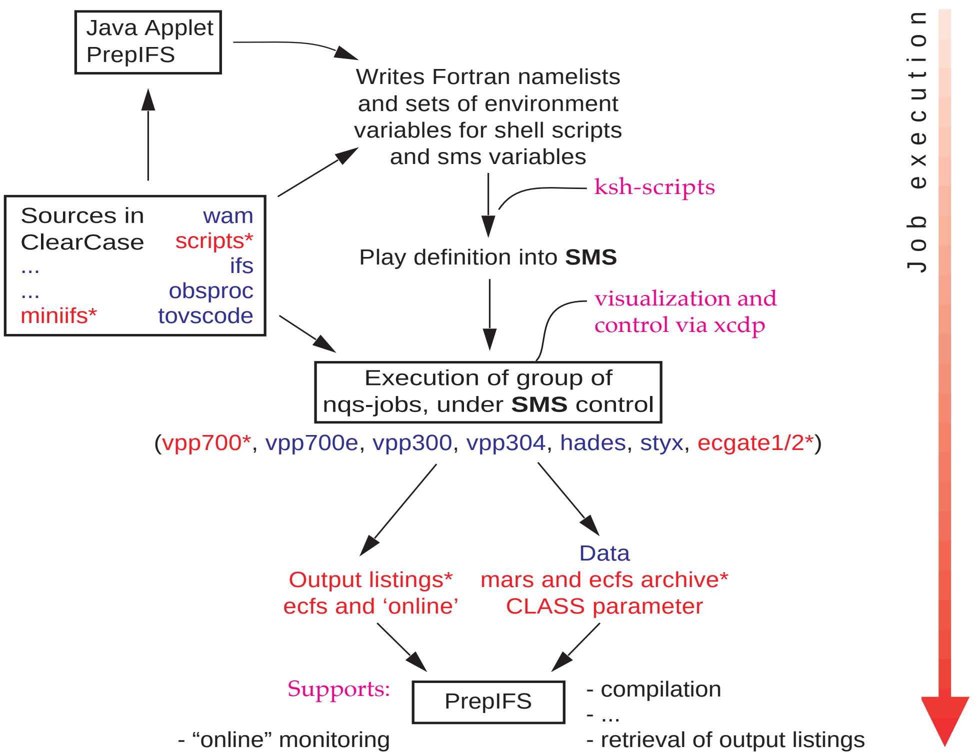

***Figure 2:** Schematic overview of PrepIFS activities*

** Denotes the sources / machines currently accessible for external Member State users*

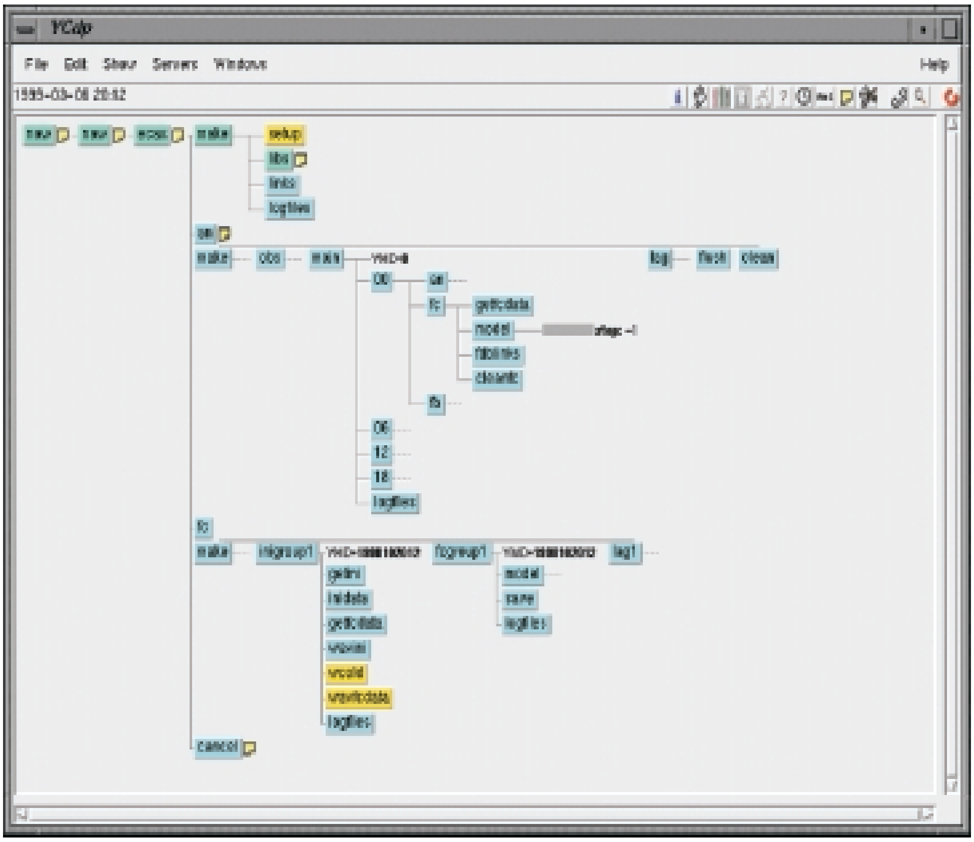

Figure 3: *Xcdp display of a current PrepIFS experiment (set of* ***tasks****) running a special set of forecasts from a previously generated data assimilation.*

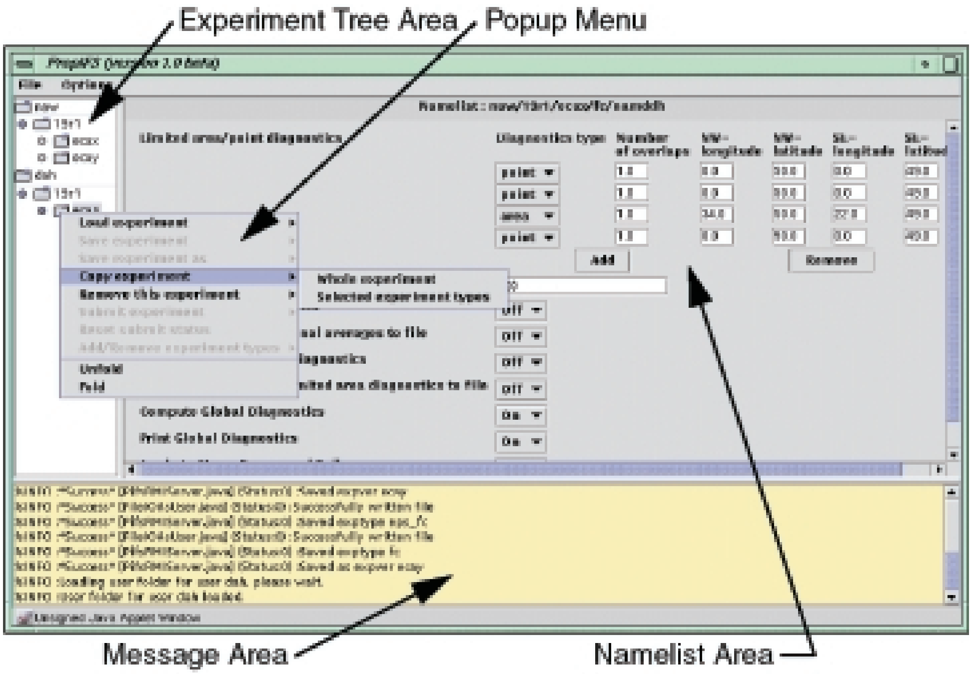

Figure 4: *The PrepIFS - user interface is split into three main areas: the display area for the namelists, the display area for the IFS version number (cycle), the experiments and owners of the experiments and the display area for information and/or warning messages.*

scheduler (SMS). Users talk to SMS using either the command and display program (CDP), or its X-windows equivalent (XCdp). CDP takes command line input and has some full screen capabilities. Currently, XCdp is an X-Windows/ Motif based program. However, it is planned to provide a WWW interface to these vital control tools later. SMS is a server controlling the flow of an experiment during its time in the computer systems. It schedules the various tasks and it provides via XCdp a tool to modify the flow interactively. PrepIFS defines the ‘flow’ and provides the necessary setup which consists of a set of Fortran namelists, a set of environment variables for ksh scripts to control the behaviour of the tasks, a set of SMS definitions, a ClearCase interface and access to scripts and Fortran/C source code. The “variables” defined by PrepIFS are included in each task depending on the machine the task is executed on. SMS macro processing automatically converts the “task containers” into ordinary jobs before

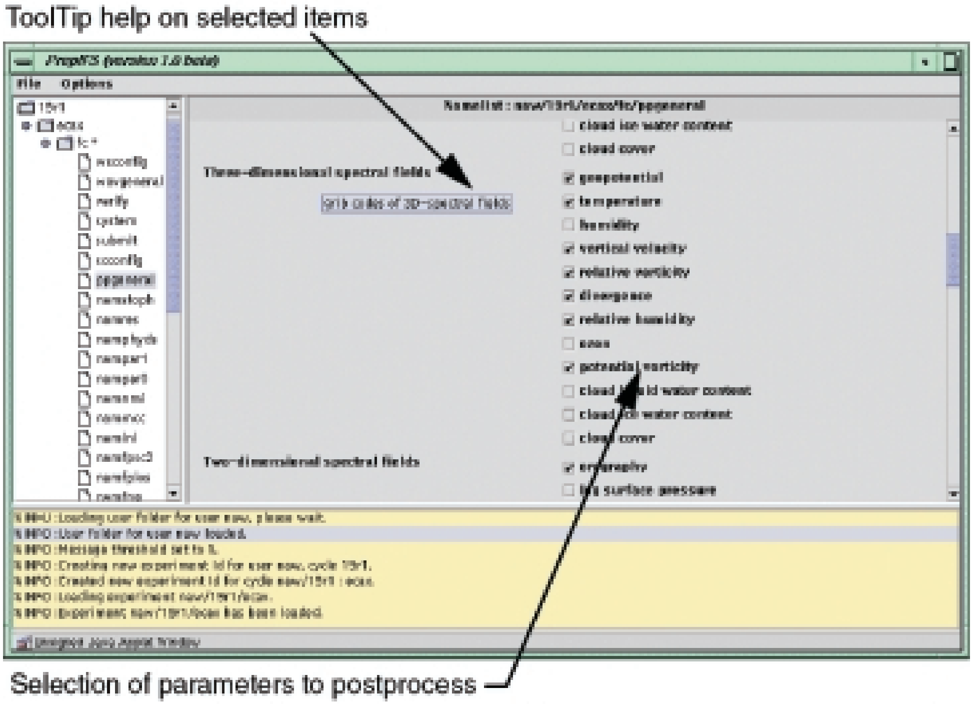

Figure 5: *An example of the display of a typical* ***namelist*** *in PrepIFS. The Experiment Tree Area shows a collection of namelists for the chosen experiment. The Namelist Area displays the variables and values to be set in the form of option menus, buttons, text fields and labels. Descriptive hints and explanations are displayed if the focus of the mouse points to a particular label. Hyper links will be provided to more extensive information (e.g. IFS Fortran code realisation, scientific documents describing specific options, etc.).*

submission. The final execution of each task is controlled via the network queuing system (nqs) on the executing host. Figure 2 gives a schematic overview of the activities of PrepIFS. Figure 3 provides a snapshot of a typical experiment (set of tasks) submitted by PrepIFS and controlled by SMS. The picture is taken from the current XCdp display. PrepIFS enables the user to choose the SMS server to which the experiment should be submitted to. There will be an SMS server provided separately for each Member State to ensure the integrity of the experiments. Scientists at ECMWF may choose which server they want to use by simply providing the name in the user interface. Some of these servers will be monitored by the operators.

The PrepIFS – User Interface

The user interface shown in Figure 4 is split into three main areas. The ExperimentTreeArea displays the hierarchy of an experiment starting with the *owner*, the *IFS version number* (cycle) and the *experiment identifier* (which is also used in the data storage system mars to retrieve the data later on). An 'experiment tree' is further split up into different *types* (e.g. forecast, data assimilation, ocean model...) and into different containers called *namelists* which contain the variables that can be set and modified for each particular experiment setup. A typical example is of the postprocessing *namelist* and is shown in Figure 5. It is important to note, that a *namelist* may refer to a Fortran namelist, a set of sms-variables, a set of ksh–variables or a mixture of all three types.

Summary

The currently used X/motif based tools PREPIFS and PREPAN are gradually being replaced by the JAVA-based equivalent tool which will make remote access to IFS experimentation on ECMWF computers much more practical. It combines the functionality of PREPIFS and PREPAN in order to simplify maintenance with regard to current and future developments of the IFS. The new tool is currently undergoing internal tests and a first version will be available for remote user tests shortly.

Nils Wedi

ECMWF Calendar 1999

Jun 29~30	**Council**	*50th*
Aug 23~27	**Second International Conference on Re-analyses**	
Sep 6~10	**Seminar** – Diagnostics of models and data assimilation systems	
Sep 27~29	**Scientific Advisory Committee**	*28th*
Oct 6~8	**Technical Advisory Committee**	*27th*
Oct 12~13	**Finance Committee**	*62nd*
Nov 1~4	**Workshop** – Use of ATOVS data in numerical weather prediction	
Nov 15~19	**Workshop** – Meteorological Operational Systems	
Dec 1~2	**Council**	*51st*

Table of Member State and Cooperating State TAC Representatives, Computing Representatives and Meteorological Contact Points

Member State	TAC Representative	Comp. Representative	Met. Contact Point
Belgium	Dr. W. Struylaert	Mrs. L. Frappez	Dr. J. Nemeghaire
Denmark	Dr. P. Aakjaer	Mr. N. Olsen	Mr. G. Larsen
Germany	Mr. G.-R. Hoffmann	Dr. E. Krenzien	Mr. D. Meyer
Spain	Mr. T. Garcia Meras	Mr. E. Monreal Franco	Mr. F. Jimenez
France	Mr. E. Legrand	Mrs. M. Pithon	Mr. J. Clochard
Greece	Dr. G. Sakellaridis Mr. I. Bassiakos	Mr. I. Bassiakos	Mr. I. Papageorgiou Mr. P. Xirakis
Ireland	Mr. J. Logue	Mr. P. Halton	Mr. M. R. Walsh
Italy	Dr. S. Pasquini	Dr. G. Tarantino	Dr. G. Maresca
Yugoslavia*			
Netherlands	Mr. S. Kruizinga	Mr. H. de Vries	Mr. G. Haytink
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Hungary	Mr. I. Ihasz		Mr. I. Ihasz
Iceland	Mr. M. Jonsson	Mr. M. Jonsson	Mr. G. Hafsteinsson
Slovenia	Mr. D. Hrček		

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