III WORKSHOP REPORT

1 Introduction

The Ninth Workshop on Meteorological Operational Systems was held at ECMWF 10–14 November 2003.

The objective of the workshop was to review the state of the art of meteorological operational systems and address future trends in the use of medium-range forecast products, data management and meteorological visualisations on workstations. The workshop was organised under the following main subjects:

Use and interpretation of medium-range to long-range forecast guidance

The ECMWF forecasting system now provides the users with forecast guidance from the medium-range to seasonal time scales. Bridging the gap is the monthly forecast run, which is still a test system under evaluation. In March 2003, the operational analysis and forecast production at ECMWF was implemented on the new IBM High Performance Computing Facilities. Shortly afterwards, the second run of the medium-range forecasting system was introduced. The Centre now provides 10-day forecasts from the deterministic and the ensemble forecasting system twice daily to its users based on 00 and 12 UTC analysis times. The more frequent updating of the forecast products provides the users with more recent guidance material, better continuity and the possibility of early detection of changes in the weather pattern of the occurrence of severe weather events. The use of the probabilistic forecast guidance provides the basis for risk assessments.

Operational Centres presented their approaches to medium-range weather forecasting and reported on their experiences with the recent enhancement to the forecasting system. The issue of forecasting extreme weather events in the medium range was addressed and discussed in a working group.

The Centre now makes comprehensive use of operational and research satellite data provided routinely by the satellite operators and processing centres. Timely delivery of the data is essential for operational use in global forecasting systems. The impact and importance of satellite data in global assimilation and forecasting systems will be reviewed in a special session.

Operational data management systems

Web technology has to an increasing extent facilitated the provision of information and data to the users of the Centre's services. Data servers with browser tools for the users have been installed for dedicated delivery of datasets from research projects, such as DEMETER and ERA. Interactive tools and user interfaces were presented and issues of how to harness the benefits of web technology to provide user orientated access to information systems and data were addressed in this session and discussed further in a working group.

Meteorological visualisation applications

In addition to the interactive meteorological visualization applications, increasing web usage demands batch production of plots with increased support for user interaction. Systems for interactive and batch use were presented and demonstrated. Vendors participated and introduced their latest visualisation tools and hardware developments. Updates to existing meteorological visualisation applications and new developments in this area were presented and demonstrated at the exhibition during the workshop.

The reports from the working groups are summarized in this section of the proceedings while the papers from the presentations are given in Section IV.

2 Report of the working group on use and interpretation of medium-range and long-range forecast guidance

- The group discussed the duality of approaches for using ensembles
- On one hand more and more statistical methods are proposed to calibrate ensemble probabilities.
- On the other hand there seems to be room for the forecasters 'subjective interpretation' of ensemble, particularly for severe weather.
- The needs for an interpretation of the dynamical information provided by ensembles should be better accounted for when designing the forecaster workstations environment (possibility to investigate the dynamics of single members, to intervene in the computation of probabilities by weighting differently different scenarios on the basis of recent observations, etc).
- Several Member States have developed Modified Model Output (MMO) applications to allow automatic production based on output modified by forecasters; such databases should be further extended to account for probabilistic information based on EPS information interpreted by the forecaster.

- It was mentioned that calibration methods should be optimised following the specifications of the users - being unlikely that a single calibration will be optimal for many different ranges of applications.

- The demonstration of the socio-economical value of the forecast was shown in many presentations to be more and more required to sustain public funding of meteorological services; the gap between potential value and the value realised by society however needs to be bridged by providing the users with more practical demonstrations of how they can benefit from the current state of accuracy of our forecast (including in probabilistic format); also careful post-processing of the ensembles may help addressing users needs (e.g. area probabilities, selection of forecast ranges).

- Several presentations demonstrated that current ensembles in medium and long range misrepresent the level of model errors; more work however needs to be done to provide an understanding of why multi-model ensembles are so much more successful than single model ensembles in seasonal forecasts (e.g., would these results still hold after each model ensemble is optimally calibrated?).

- Downscaling techniques are very much needed, most notably for severe weather forecasts; there was however some discussion in the group as to whether dynamical methods with small ensembles (qualitative EPS) or statistical (empirical) downscaling methods should be preferred; both should be evaluated against each other, as Ensembles and Poor Man's ensembles have been; analogue techniques have been successfully tested in order to couple ensembles and empirical downscaling methods.

- Several areas (verification, calibration, downscaling) have seen medium-range and seasonal forecast benefiting from using methods originally developed by one or the other; this should be further encouraged in the future by running 'seamless ensembles'.

- Although statistical methods add value, there is still a lot of room for improvement of the dynamical ensembles; work on improving the formulation of initial perturbations, of the uncertainty brought by analysis and model errors and on improving the model resolution is needed. It is expected that such work might deliver in particular improved performance in forecasting severe weather in the early medium-range.

3   Report of the working group on operational data management systems

The working group addressed the following issues:

1   Provision of large datasets
2   Data catalogues
3   Access policies.

3.1   *Provision of large datasets*

- Grid technologies should be investigated.
- Implies availability of infrastructures, such as high bandwidth networks
- For usability, limit data volumes to be downloaded via the web, so download last around 10mn
- For very large data transfers
- Cost of network usage may be an issue
- Send tapes by post ...

3.2   *Access policies*

- All users must be registered
- No anonymous users
- No generic users
- Within WMO FWIS
- Metadata will carry access policies

3.3   *Data catalogues*

- Data organization is application dependent
- Multiple data organization (daily, time-series, ...) may be required, if affordable
- Organise your data according to most likely access patterns
- Catalogue navigation matches data organization
- Search facility for data discovery

- Using style sheets to map metadata from different catalogues
- There is a limit in what a GUI (e.g. web interface) can achieve for data selection
- Expert users may prefer "request languages" to perform complex or recurring retrievals

3.4   Data catalogues: ISO 19115

- WMO-CBS, expert team in Integrated Data Management
- CBS defined a core metadata scheme to be tested
- Workshop in June 2004
- Pilots projects
- UNIDART
- VGISC
- Recommendation
- Each Data Centre should study how the core standard fits their metadata catalogues.

4   Report of the working group on meteorological visualisation applications

4.1   Visualisation techniques for high volume satellite radiances

- The data under discussion is primarily from orbiting satellites. It was noted that it is not always the case that an entire orbit's data is stored together - it may be in separate parts. The data is stored as point values (lat/long/values vectors).
- It was suggested that a 'gridding' approach should be used to transform the data into an image-like structure, so that standard operations (e.g. matrix) can be applied. A well-researched meteorological approach should be used to guide the gridding procedure.
- Such data can then be stored, either permanently or temporarily, in a 'tiled' multi-resolution (both spatially and temporally) form. This can be costly to build, maybe too costly for operational use, but fine for research purposes.
- This data can store references to the raw data, so the user can always get back to that if desired.

4.2   Generating navigable content-rich web output

- The most desirable features for web output are that it should be possible for the user to animate, pan and zoom the data. Hyperlinks are also desired. Level of detail should also be adjustable (referred to as 'decluttering'). The user could do this either automatically, or manually.
- The main problem is that we need a standard way of producing such data.
- Several options were discussed. Of them, WebCGM, VRML and X3D were considered not to be useful, mainly due to lack of maintenance/development.
- MPEG4 is powerful as a data format using a scene-graph description of the data and may therefore be good for decluttering, but the application that 'runs' such a file may not do so in the desired way. For example, an MPEG4 file may be seen simply as a movie by some applications.
- The use of SVG was discussed at length, as noted below.

4.3   Use of SVG

- SVG is able to fulfil all of the requirements for web content.
- Support for SVG is uncertain at present. Although there is a lot of development work being done on SVG and it became a standard last year, the position of influential companies such as Microsoft and Macromedia is unclear. It may or may not become a standard component of web browsers. There is also the issue of some users not being able or willing to download plug-ins for their existing web browser.
- However, Acrobat version 5.1 now has embedded SVG support and SVG is becoming available on mobile phones. Mozilla comes with an option to compile it with SVG support.
- SVG components can be embedded in SVG, giving rise to a hierarchical scene graph.
- One advantage of SVG is that Google can, theoretically, search the embedded text. This is not currently done, but may be in the future.
- The issue of a legal case of patent on plug-in technology was raised.

- It was noted that, although some institutions are being asked for more web content, some are unable to provide too much 'added-value' data on the web.

- Although a 'raw' ASCII SVG file can be large, there is a standard zipped format that is closer in size to binary files.

4.4 Use of XML

- When storing data in XML format (on which SVG is based), the number of decimal places used can be adjusted for an accuracy/file size trade-off.

- Looking more generally at XML, it was stated that the WMO is looking into XML for describing data, but say that there is no point in using XML in order to simply replace old data formats - there must be a real benefit from it. There is a prototype EUMETNET project, EMMA, which uses XML for transferring messages.

- It was suggested that an incremental approach might be best, replacing current formats with XML only when needed.

5 Special session on data requirements for NWP

The requirements for early delivery and frequent updates of forecast guidance have evolved over recent years. NWP centres have significantly reduced their data cut-off times at the expense of available observations in their data assimilation processes. Timeliness requirements for observational data are becoming more stringent for NWP centres.

In this special session, the workshop in plenary addressed the current problems and formulated a number of conclusions and recommendations. The Centre was requested to bring these recommendations to the attention of the relevant WMO bodies through the WMO Secretariat.

5.1 Current problems

- All centres are under pressure from users to deliver forecast guidance earlier.

- NWP centres operating global and regional data assimilation and forecasting systems currently require data within 60 minutes to 2–3 hours after observation time.

- Some centres run long cut-off update cycles to make use of late data 6-9 hours.

- Conventional in-situ data are distributed within 60 to 120 minutes of observation time.

- Satellite data, in particular the global ATOVS data, are received within 3 hours, but blind orbit data may be late by several hours.

- Future operational NWP systems are likely to require data within 30 to 60 minutes.

5.2 Addressing the problem

- "LEO data timeliness – more timely data are needed. Improved communication and processing systems are required to meet the timeliness requirements in some applications areas (e.g. Regional NWP)". (CBS ET on ODRRGOS, Oxford 2002).

- In response to requests from centres in Europe operating limited area models, also covering the Atlantic and Polar Regions, EUMETSAT implemented the EARS system, achieving a near-complete NH coverage for ATOVS within approx. 30 minutes of data time; EUMETSAT is looking into the possibility of adding further data.

- For NPOESS a global distribution of data within 30 minutes is planned.

- The CBS ET on ODRRGOS at its recent meeting, Geneva 3-7 November 2003, decided to review the timeliness requirements for satellite data for use in regional and global NWP.

5.3 Workshop conclusions and recommendations

- The workshop welcomes the initiative of the CBS ET on ODRRGOS to review and update the data requirements for global and regional NWP.

- The workshop recommends that

  - The optimal data delivery time (delay) be set at 30 minutes

  - Satellite data providers be made aware of these timeliness requirements for their data

  - Collection and distribution of in-situ data be further improved to achieve an optimum data delivery time close to the 30 minutes

- The NWP data requirements and the Statement of Guidance be updated by the ET on ODRRGOS to reflect the changing requirements
- The workshop further recommended that
  - Satellite data from future systems be made available in an agreed format, preferably using WMO standards such as BUFR
- Operators of observing systems be encouraged to provide high resolution observations, e.g. vertical soundings from radiosondes in BUFR as well as in the existing TEMP code, where such capability exists
  - To encourage EUCOS to provide more AMDAR data from data sparse regions, in particular over Africa.
- The workshop requested the Centre to bring these recommendations to the attention of the relevant WMO/CBS bodies to ensure that the appropriate actions be taken.