III. WORKSHOP REPORT

1. INTRODUCTION

The Seventh Workshop on Meteorological Operational Systems was held at ECMWF, 15-19 November 1999. The programme and the list of participants are given in the front part of these proceedings.

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 applications on UNIX workstations. The workshop was organised under the following main subjects:

Use and interpretation of medium-range forecast guidance

The session addressed the problems and solutions related to the use of numerical guidance in medium-range weather forecasting. The operational ECMWF Ensemble Prediction System had been developed further in recent years and the product range had been extended. With the introduction of the coupled ocean-wave atmosphere forecasting system additional wave EPS products have become available. The operational procedures for the evaluation of probabilistic forecasts had been developed further to allow a user orientated assessment of the quality and the value of the forecast.

Operational centres presented their approaches to medium-range weather forecasting and reported on their experiences with a combined use of output from different models including ensemble prediction systems. Presentations were included on preliminary attempts to issue or verify forecasts on the seasonal range. The issue of forecasting extreme weather events in the medium range was addressed and discussed in a working group.

Operational data management systems

The development of operational database and archive systems, as well as data delivery systems, was reviewed. Particular consideration was given to the use of the Internet for accessing data and for the provision of on-line data descriptions and documentation. Tools for controlling operational meteorological systems and data flow received special attention, as did the benefits of distributed databases and archives. These issues were addressed and discussed in a working group.

Meteorological UNIX workstation applications

Updates to existing 2/3D visualisation applications and new developments in this area were presented and demonstrated at the exhibition during the workshop. At previous workshops, the UNIX platform had been the focus. This time also topics related to experience in porting meteorological UNIX workstation applications to other platforms such as Java, NT and other UNIX flavours including Linux were presented.

Strategies for porting meteorological visualisation software to other platforms were discussed in a working group. Experience with available porting tools were also addressed.

The reports from the working groups are summarised 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 FORECAST GUIDANCE

Forecasting of severe weather events

1. Definition/selection of the events

1.1 A consensus was quickly reached to limit the scope of the discussion to the medium range aspects as defined as one of ECMWF targets ("A strategy for ECMWF 1999-2008"): "provision of good forecasts of severe weather towards day 4 or day 5 ahead".

1.2 The Working Group first wanted to introduce the distinction between severe, extreme and significant events:

1.2.1 An event might be *severe* by its impact on the user's activity, while whether or not it is *extreme* depends on its relative frequency of occurrence (rare event).

1.2.2 The impact of extreme events is highly variable depending on the users: some events may have severe impacts due to the conjunction of fairly common meteorological events (e.g. long lasting moderate rains causing large scale flooding).

1.2.3 *Significant* events are remarkable without being rare: they are defined with reference to a given sample for which robust verification statistics can be provided.

1.3 Meteorological services usually associate severe events with warnings to the general public or local authorities (risks of hazards for the population or of major disruptions).

1.3.1 The Working Group agreed, however, that the discussion was about early warnings for which new products should be validated; rather than extending the list of existing warning procedures in use by Met Services into the medium range (which would be a very long list of events) it is recommended that ECMWF validates a short list of a few events based on temperature, precipitation and wind – possibly using joint probabilities.

1.4 As a first step the predictability of significant events (as defined in 1.2.3) should be tested.

1.4.1 Although they may not all be associated to severe conditions, they are expected to be important by the way the public perceives the forecast; to predict four days in advance that more temperatures will exceed 30°C over Paris was given as an example of such an event.

1.4.2 For each parameter/area/duration combination, a minimum number of independent events should be found in the sample used for the verification to be conclusive.

1.4.3 Concentrating the studies on highly populated areas was mentioned as a way to limit the combinations to parameter/duration.

1.4.4 An example of how the information on significant event forecast might be brought to the public knowledge, the NCEP Web "Threat assessment" page was mentioned; this page provides from day +3 onwards the areas over the USA where severe events might occur (heavy rain, extreme temperature, high risks of fire ...).

1.5 It was also mentioned that synoptic studies of weather patterns likely to be associated to severe events might also lead to a useful way to predict these events in the medium range.

1.5.1 Cut-off lows in the Mediterranean area, north-easterly over Central Europe were among the synoptic configurations mentioned.

1.5.2 Classifications (clusters, tubes) dedicated to such events should be tested; the neural network configuration in use at SMS is likely to be a useful first step to identify the patterns associated with significant events in recent years.

2. Model guidance

2.1 The use of probabilistic guidance should be systematically associated to the forecast of extreme events.

2.2 Both higher resolution, better consistency and better timeliness of the products were mentioned as important features for an EPS system to provide useful guidance for extreme events.

2.2.1 Running the EPS twice a day is expected to provide a useful step in the direction of better timeliness and consistency.

2.2.2 The use of time-lagged ensembles should be evaluated in the context of extreme events.

2.2.3 It is also expected that running the EPS twice a day may benefit of some of the improvements highlighted by the multi-analysis experiments.

2.3 It was recognised that the information from a higher resolution, single deterministic model was difficult to combine to the EPS information.,

2.3.1 High-resolution forecast could, however, be a useful tool to identify in real time whether resolution might be an important limitation for the EPS forecast (e.g. when the orography contribution is large); such an identification is, however, only possible when the high resolution large scale scenario is captured by at least one EPS member.

2.3.2 Scenarios for blending the information coming from different models in the probabilistic forecast in an objective way are still to be designed and validated.

3. Validation/verification

3.1 The skill of the forecast for significant events should be demonstrated with respect to climatology.

3.2 D. Richardson's economic value diagrams are expected to be the ultimate measure of the forecast benefit to the user.

3.2.1 It was, however, stressed that an economical/social study should be conducted first to identify the distribution of cost/loss applications/forecast perception among the users.

3.2.2 Before such a distribution is known, more classical measures of skill (Brier Skill Scores, Resolution scores, ROC) should be used.

3.3 Significant events should only be verified with respect to independent observation, unless it is established that the analysis provides a good representation of extreme events.

3.3.1 When available, corrections based on statistical interpretation should be applied to the EPS before validation; this however, seems excluded for preliminary studies conducted at ECMWF, as such statistical corrections are usually only available in Member States.

3.3.2 The statistical treatment applied to direct model output should be the object of careful validation in the specific context of the forecast of extreme events.

3. REPORT OF THE WORKING GROUP ON OPERATIONAL DATA MANAGEMENT SYSTEMS

Web Usage

General

Advantages of using the Web and Internet technology were seen as that services were inexpensive, relatively robust, reached a wide audience and were easy to use. The fact that the technology is cross-platform is also seen as being a very important factor.

On the other hand, there were difficulties in the areas of security, operational reliability, variable throughput and an uneven level of availability. Poor visibility of the processes actually taking place was also mentioned.

Documentation

Documentation usage not only includes documentation on systems and software but also monitoring information, problem reporting, management reports, training as well as advertising products and jobs.

WMO information about GRIB/BUFR tables are in (Word) text form which is difficult to handle electronically. A format which included metadata describing the file format (such as XML) would be more directly readable.

Pagination is a problem. Long pages are better if printouts are required, but short ones are better for interactive users to follow links.

Catalogues/searching

Attempts to establish catalogue interoperability protocols between different data producers have looked for standard ways to define metadata describing file contents and formats. Such protocols would allow the development of catalogues and search tools.

A significant amount of work has been done in this area by the Centre for Earth Observation (http://www.ceo.org). Information on some of their projects can be found at http://infeo.ceo.org/ , http://eeis.ceo.sai.jrc.it/ and http//satweb.gaf.de .

Catalogue interoperability protocols are only part of the problem and there should be general interoperability between server and client machines.

Data access

Traditional meteorological data customers have been skilled users. Increasingly, Internet usage is creating a demand from the general public for localised, high-resolution weather information in simple graphical form. These potential clients and their expectations are not well known, although this information gap could be bridged by the marketing of commercial firms.

More sophisticated users (modellers and aviation) require large quantities of binary data of reliable quality delivered on schedule. Such data may need specialised browsers and delivery by non-web methods, e.g. ftp or secure dial-in from a PC.

Tools

It was felt that, although the current situation in the UNIX environment for Web-editing tools was far from satisfactory, it would not be long before adequate tools became available.

Web access from a user machine needs simple HTML and smart applets to handle transactions. GRIB/BUFR formats are not well known by web browsers. Increasing use of vector line drawings may be appropriate for graphical weather data.

Security, accounting, billing

Internet security relies on certified firewalls and measures to thwart deliberate attempts to undermine service. Opening access to weather information creates the possibility of unintentional customer overload in times of 'interesting' weather (storms).

Certain data may be restricted to certain users in order to abide by legal constraints.

Once meteorological data has been accessed over the Web, it may be manipulated and re-posted on other Web sites. There are risks that no acknowledgement of the data source will be made and that quality may be compromised. Conversely, out of date information bearing the originators logo/name could be made available. Unskilled users have no way to judge the trustworthiness of sites offering weather information and may be influenced by cost.

If an aim is to generate revenue over the Web, it is necessary to establish how much users are prepared to pay and to set up ways they can make their 'micro-payments': credit cards or tokens to act as virtual money. Alternatively, sites offering weather data may attract sponsorship or advertising from companies whose business depends on the effects of weather.

Cookies can be left on customer machines to allow some feedback to a server about data access. However, they can be disabled by users and are intended to have a short lifetime.

Products to offer

Some categories of data may be freely available: traditional forecasts, severe weather warnings or data distributed on the GTS. Putting everything on-line, possibly with some restrictions on data volume for individual retrievals, can lead to a reduction in the need for service personnel, and can provide faster, cheaper public access.

Data Flow

Push/pull

Heavy customer demand may have to be managed to avoid denial of service; for example, by the use of mirror sites pre-loaded with weather products. It may be necessary to establish a priority system for customers.

Data can be pushed or pulled to customers using the Internet for real-time data flows. Data producers may choose to broadcast data just once to mirror sites or to selected users on an Internet backbone. Subsequently, users would select or filter data. Other suggestions were that real-time data should be pushed and non-real-time data pulled; that basic data should be pushed and ad hoc requirements met by pulling the data.

Alternatively, a subscription service could deliver tailored data to customers. The service could be catalogue based; the catalogue may be static or dynamically updated from a current database. Or

subscribers could be given tools to dynamically specify and deliver tailored products as is done by the ECMWF dissemination to Member States.

Use of servers

Product catalogues have to be up-to-date and provide 'point and click' human interfaces as well as computer accessible formats.

New standards should evolve for weather data available over the net. They have to develop rapidly to reflect user demand. There are already many mark-up languages for meteorological data and efforts have been made to use general purpose mark-up languages (e.g. XML for METAR).

The idea was expressed that big centres should set up an expert group to meet twice a year, and liaise regularly via email, to develop and maintain standards.

See http://www.wmo.ch/web/www/reports.html#WDM for the final report of the meeting of Interprogramme task team on future WMO information systems post-processing.

Post-processing of data to satisfy a user's request may lead to extended transactions. It may take some time to generate data during which connections can time-out, or be lost or abandoned. Mechanisms will be needed to let a user know when data is ready: mail, polling, ftp. There may be security issues returning data through firewall machines.

4. REPORT OF THE WORKING GROUP ON METEOROLOGICAL UNIX WORKSTATION APPLICATIONS

Porting to Linux

Experience with porting tools/software environment

- Linux distribution

  Several distributions used (RedHat, SuSE, Caldera...) with Corel as a newcomer.
  Mainly SuSE at ECMWF.
  Generally, installation of Linux is difficult. Installers need to know their hardware configuration exactly, especially video configuration.
  Corel claims to have solved configuration problems.
  Laptop most difficult for installing Linux.
  HP/SGI/IBM support Linux as well. All big vendors will start supporting Linux. Dell provide PCs running Linux.

- Compilers

  Problems with compilers. GNU g77 supports ANSI Fortran but not many extensions.
  Mostly good experience with Portland F90 but it takes special linking statements to cope with compilers from different vendors.
  On HP, GNU compilers give more error/diagnostics messages.

- Programming environment

  The basic GNU debugger gdb is line oriented but there is a GUI interface available from Cygnus.
  SNIFF+ is promising. TotalView not released yet.
  SGI not likely to make their 'cvd' tools freely available.
  Data base support for Linux is essential, e.g. Informix and Oracle.

- Motif/LessTif

  Only provisional tests with LessTif – gave problems for METVIEW.
  Some minor features missing. LessTif is free.

- OpenGL/Mesa

  Official OpenGL provided by HP and SGI plus some PC vendors – the rest use Mesa.
  Mesa is only now about to provide GLU 1.2 (for polygon tessellation).
  Fahrenheit seems a dead end.
  Some are still using GKS (and GKX for X-Windows).
  Only OpenGL/Mesa and not GKS provide full support for fast hardware.
  OpenGL uses GLX as the glue to Window systems and PC vendors provide graphics card to achieve fast primitive drawings.
  Drawbacks with OpenGL are lack of printing (PostScript) and lack of font support.
  Version 5.1 of Vis5D runs Linux with Mesa 3.0 and a TNT2 card.

Porting to Java

Strategies for porting meteorological visualisation software to other platforms

- Pure Java versus mix with legacy code

  To be portable it must be pure. Some people think porting can be done in stages, others that the complete application should be ported at the same time.
  As Fortran and C do not have any objects defined, the porting should start with defining of objects.
  Some people think that not all applications are suitable for porting to Java.
  There were portability problems with JDK1.1 but this has been improved in JDK1.2 which has a suite of 200,000 tests.

- Networking

  Even though RMI is currently slow, many people are using it.
  URLs easy to use. French Internet system based on Java and CORBA.

- Graphics

  Java3D has support for fonts and is very powerful for mapping images to different projections, e.g. polar stereographic.
  Java OpenGL bindings seem not to be used.

- Component software

  AWIPS use JavaBeans for dissemination and DWD has tested it and found that its component technology increased opportunities for co-operation.
  JavaBeans has nice visual interface and makes visual programming easy.

Experience with porting tools/software environment

- Compilers

  Sun HotSpot only marginally improvement on client side – mainly for server side.
  IBM VisualAge expected to be very good.
  The Java performance continues to improve.

- Programming environment

  vi, emacs, jBuilder and dbx widely used. No significant problems encountered.

- Breadth and maturity

  Earlier versions of Java had many bugs but Java (i.e. JDK1.2) seems to be much improved. However, there are still many bugs in Swing.
  Printing poor in JDK 1.1 and 1.2.
  Some people waiting for Linux.

- Browser support

  Some browsers support Java 2 and have easy installation. Some more vendors to come.
  Java 2 expected in Netscape 5.0.

Porting to NT

If application is menu-driven, the porting is relatively easy. For drag and drop (e.g. METVIEW) it is a lot more difficult. Using a GUI (e.g. XDesigner) makes it easier.
There is an article published on porting to NT (AMS IIPS Proceedings, January 1999, p.333: Migration AWIPS to Windows NT).
Some use Interix, which has been taken over by Microsoft, to move to NT.
CPTEC has created a windowing layer compatible with both X11 and NT and will make it available on request.
There is enormous interest in porting Vis5D to NT.

Porting to Solaris

Denmark has installed Sun Solaris on PCs without major problems and it provides good performance.