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Cover: Simulation of pollution plume from Fukushima power plant after six days of emission

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Dear readers,

Writing this short introduction always makes me reflect on the year passed. Trying to reconstruct all events that happened makes me a little dizzy. Most striking of course was the Japanese earthquake 10th of March 2011, and - from a meteorological perspective - the Fukushima nuclear accident that followed. It was not only RSMC Toulouse and Exeter who were intensively involved in the incident. Many, perhaps most, of the European NMSs were very active in performing dispersion model calculations in order to serve their National Civil Protection agencies or their national airlines with risk assessments for scheduled flights to Japan.

In May 2010 central Europe - especially the Czech Republic, Slovakia and Hungary - suffered from severe river flooding, causing enormous damage. During the summer, eastern parts of Europe in particular suffered from severe heat waves, and we all remember the immense fires caused by the heat in Russia last summer. Again the winter of 2010-2011 was quite remarkable in many parts of Europe. December was extremely cold over a large area, and parts of western Europe received a remarkable amount of fresh snow during the early winter. December snow in western Europe seems to have become a trend since 2009! Immediately we again ran into shortage of road salt, luckily solved by a milder and less active weather regime during January and February 2011. And then we should not forget the remarkable flooding events over Australia in December and January.

Many of these events were very well forecast by European meteorologists, though some were probably more difficult to foresee. We do notice that by means of further numerical weather model improvements and with help of better forecast tools we are able to make more accurate forecasts nowadays. But forecasters noticing severe weather upstream in Europe are given advance warning of developments that may affect their area of responsibility within the coming period. I even remember Nick Grahame, using the Meteoalarm website, contacting his colleagues in France and Italy to discuss the possible impact of a severe rain event expected on the border of Italy and France in mid-June. Forecasters who are able to contact each other in this manner because they feel part of a European meteorological community sharing their knowledge on the potential evolution of the weather situation are a great example within our discipline. The good work done sharing warnings within the Meteoalarm European meteorological community, and the activities of our own Working Group on Co-operation between European Forecasters (WgCEF) both contribute to sharing of knowledge and in lowering the communication barriers between forecasters of European Weather Services.

This edition of the European Forecaster’s newsletter reflects all the topics discussed in Dublin during our last meeting. I call on you all to recommend this edition to your colleagues. I also call on all readers to send in new contributions for the next 17th edition. All articles were reviewed by Will Lang (from UKMO). Bernard Roulet and Météo-France made it again possible to publish the high quality edited and printed edition. Thanks to André-Charles Letestu (Météo Suisse) our website www.euroforecaster.org is kept up-to-date with information on the Working Group, and our web archive shows the previous editions of the Newsletter.

I wish you inspiring reading hours and hope to see you during our next WgCEF meeting in Bergen, Norway, on Friday 7th October 2011.

Frank Kroonenberg
Chairperson of WgCEF
Notes of the WGCEF meeting in Dublin, 1 October 2010 Custom House

Introduction

- The Chairman opened the session of the 16th Meeting of the Working Group on Co-operation between European Forecasters (WGCEF).
- The Director of the Irish Met Service Liam Campbell welcomed the participants of the Working Group.
- 19 participants, representing 13 NHMSs, attended the meeting.
- The agenda was agreed.
- Messages of absence were received from: Manfred Kurz, Theodoro Rocca (Italy), Knud Jacob Simonsen (Denmark), Vida Raliene (Lithuania), Lola Olmeda (Spain).
- The participants introduced themselves.

Actions from the Last Meeting

The following themes were covered in the day’s programme:
- LAM EPS for short-range forecasting
- High resolution (<10km) NWP models in operational use.

The Chairman’s Report

Dear Working Group members,

The economic crisis, and its possible threat towards our services, is being felt now. As we can see within our group travel expenses are being reduced. Moreover general reductions in budget are either established or are to be expected.

Public discussions nowadays seem to become more subjective. Discussions are often conducted within the media and the political domain, and sometimes start after a severe weather event. Misinterpretation of facts within these discussions, appealing to already existing negative sentiments towards public services, is to be seen.

High quality meteorological services from NHMSs are therefore needed more than ever. Also good PR towards the media, especially during warning episodes, is of high importance.

NHMSs do however have a very good opportunity to develop and show their great benefits to society, such as we have seen during last winter’s ‘Salt Crisis’ and the Volcanic Ash Cloud event. The ash cloud event highlighted the importance of seeking good international NMS co-operation in order to gain high visibility and better results.

Of course our Working Group is a great example of this co-operation. The exchange of knowledge – by discussions during our annual meetings, and the European Forecasters Magazine spreading this information to others – is of high importance. Thanks to all of your contributions we are able to improve each other’s knowledge and more generally the skills of our institutes.

I wish all of us an inspiring 16th meeting of The Working Group on Co-operation between European Forecasters.

I want to thank Met Éireann, in particular Evelyn Cusack, Aidan Kelly and Gerald Fleming for their kind invitation and hospitality.

Discussion of Newsletter N° 15 and the Website

The group thanked Meteo France and especially Bernard Roulet for producing the Newsletter. Meteo
France is willing to produce the next newsletter, and Will Lang will edit it once more.

The group also thanked Andre-Charles for his continued webmaster role for the WGCEF website on behalf of the group. Andre-Charles presented some hit rates. Proposals on changes on the website will be prepared for the WGCEF meeting 2011.

**Nomination and Election of the Vice-Chairperson WGCEF**

Herbert Gmoser (ZAMG, Austria), the current Vice-Chair, informed the group of his intention to step down from the group due to his retirement in 2011. Will Lang (UK Met Office) was elected to replace Herbert as Vice-Chair. It was also decided that the duration of the Chair and Vice-Chair’s office would be 4 years.

**Short Meteoalarm update**

Frank Kroonenberg explained the current Meteoalarm Phase III Eumetnet programme, a consolidation of the Meteoalarm service up to 2012. Also the new developments in the Meteoalarm Extended Features (EF) programme, initiated by the EC, were explained.

**Short Update of New Developments and Applications in the NHMSs (all participants)**

- Greece is facing great problems due to the financial crisis.
- Meteo France: Some local and regional offices would be closed soon, with forecasting increasingly centralised in Toulouse.
- Belgium: Will have a new director (and a new vision?) in 2011.
- Luxembourg is facing staff problems, and is looking forward to becoming an independent weather service, getting out of the airport service.
- UK Met Office: The change of government in 2010 was bringing new perspectives, and the complex funding and ownership arrangements of the Met Office were due to be reviewed in October 2010.
- DWD: New forecasters are only being given short contracts. And there have been difficulties implementing the ‘bachelor’ level of forecaster roles, as they tend to have less knowledge and experience than other forecasters.
- Ireland: The amalgamation of the aviation office and general forecast office has presented some difficulties due to the different nature of the operations involved.
- Slovenia: There has been a reduction of staff. The number of forecasters is decreasing, and there has been no replacement of retired forecasters.
- Finland: New warnings have been implemented for thunderstorm wind gusts, high winds and heavy rain. Two new dual-polarisation radars manufactured by Vaisala Corporation have been brought into use. A new visualization workstation and forecast system has been implemented step-by-step, for which the development work has been done at FMI.
- Croatia: They are unable to employ new staff, so there is more work for fewer people. And money earned by the service goes to the government.
- ZAMG: There has been a new director, Michael Staudinger, since July 2010. It is possible that ZAMG will be privatised in January 2011, with the parliament due to make a decision in November 2010.
- Norway: Some slides “Update of the PROFF project – new tools, new methods” were presented. Automation of products is going further ahead, the goal is that forecasters should only make significant contributions, focussing on severe events and model errors.
- Meteo Swiss: There is pressure to reduce costs, and data may be made freely available.
- KNMI: A free data delivery policy has been agreed upon. Implementation of this system is well under-way.

**LAM EPS for Short Range Forecasting**

Presentations:

- Klaus Bähnke, DWD, Germany: “Developments in Short Range Forecasting at DWD”
• Herbert Gmoser, ZAMG, Austria: “Limited-area Ensemble Forecasting for Short-Range Weather Forecasting”
• Jean Nemeghaire, RMIB, Belgium: ”Limited-area Ensemble Forecasting for Short Range at the RMIB”
• Will Lang, UK Met Office: “MOGREPS-W: Ensemble Forecasting for Severe Weather”

Plan of Action for 2011 (Bergen WGCEF meeting)

• Round table update on new developments in the NHMSs.
• Communication of NHMSs with media and civil protection.
• New developments on short-period high-resolution model ensembling, and operational use of probabilistic short-range forecasts.

High Resolution NWP Models in Operational Use

Presentations:
• Herbert Gmoser, ZAMG, Austria: ”High Resolution NWP Models in Operational Use at ZAMG“
• Ande-Charles Letestu, Meteo Swiss: “Model Verification and its Use for the Forecaster”
• Panos Giannopoulos, HNMS Greece: “High Resolution NWP Models in Operational Use at HNMS”
• Antti Pelkonen, FMI, Finland: “The AROME Mesoscale Model in Aviation and Military Weather Service at FMI”
• Bernard Roulet, Meteo France: “AROME, the High Resolution Model at Meteo France”
• Janez Markosek, Slovenia: “High Resolution NWP Models in Operational Use in Slovenia”

Date and Place of the next meeting

2011 Norway will invite the WG to Bergen, planned for 7 October 2011.
2012 Lithuania has offered to host the WG.

AOB and Closing of the meeting

• Everyone agreed that it had been a good meeting in Dublin.
• Deadline for the Newsletter January 2011
• Herbert Gmoser said his last words in the WG, and he wishes the WG good success in the future.
Limited Area Ensemble Forecasting System ALADIN-LAEF at ZAMG

Introduction

During recent years, Limited Area Model Ensemble Prediction Systems (LAMEPS) have become more important as a scientific tool for improving prediction of high impact weather and for identifying sources of model error on the mesoscale. At ZAMG (ZentralAnstalt für Meteorologie und Geodynamik), the Central European regional ensemble system ALADIN-LAEF (Aire Limitée Adaptation Dynamique Développement InterNational – Limited Area Ensemble Forecasting) has been developed within the framework of the international cooperation of LACE (Limited Area modelling in Central Europe). The main goal of ALADIN-LAEF is to ‘add value’ to probabilistic mesoscale short-range forecasts compared to global ensemble systems. ALADIN-LAEF has run quasi-operationally since 2007, and the current configuration was implemented in February 2009.

Generation of initial perturbations

One of the most challenging tasks for a meaningful LAMEPS is the generation of appropriate initial perturbations. The simplest way to produce initial perturbations for a LAMEPS is by dynamical downscaling of a global ensemble system. The drawback of this method is that it provides meaningful initial perturbations only on scales resolved by the global ensemble system, which usually runs at a coarser resolution than the LAMEPS. The method of dynamical downscaling was used in the first generation of ALADIN-LAEF with ECMWF-EPS as the coupling model. In the current configuration, a more sophisticated method to generate appropriate initial perturbations is implemented, which assures that meaningful perturbations on the ALADIN-LAEF scale are included.

The generation of initial perturbations for ALADIN-LAEF is done separately for atmospheric and surface fields. For the initial perturbation of atmospheric fields, a so-called Breeding-Blending method is used, which combines large scale perturbations from ECMWF-EPS with small scale perturbations from 12h forecasts from the previous ALADIN-LAEF forecasts by digital filtering. The surface initial perturbations are generated by a 12h forecast of ALADIN-LAEF, where in the initial fields ECMWF-EPS surface fields are exchanged with the current ARPEGE analysis. After a 12h forecast the surface fields for each member differ, due to different lateral boundary conditions, provided by ECMWF-EPS, and different model setups. The surface initial perturbations that are created during this short-range forecast are merged with initial atmospheric perturbations from Breeding-Blending and build the initial conditions for the main ALADIN-LAEF forecasts. To account for model uncertainties’ every forecast-integration uses a different ALADIN-configuration. The configurations differ in model cycles of ALADIN and different combinations of parameterization schemes of cloud physics, deep convection, radiation turbulent transport shallow convection and mixing length. More details can be found in Wang et. al 2010.

Operational setup of ALADIN-LAEF

The current configuration of ALADIN-LAEF was implemented in February 2009. The system consists of 16 perturbed members and one control run, where the
latter is driven by the ECMWF-EPS control run. The 16 perturbed members differ in their initial conditions, in the lateral boundary conditions (interpolated from first 16 ECMWF-EPS members) and in the ALADIN-configurations. The horizontal resolution of ALADIN-LAEF is about 18km with 37 levels in the vertical. The system runs twice a day at 00 and 12 UTC with a forecast range of 60h. The model domain covers Central Europe and large parts of the North Atlantic (see Fig. 2). The results of ALADIN-LAEF are archived in the MARS-archiving system at ECMWF with an output frequency of one hour. A number of products like Epsgrams, probability charts or stamp maps are provided to forecasters. These products are available approximately at 9:30/21:30 UTC for the 00/12 UTC runs, respectively.

Validation of ALADIN-LAEF

The current ALADIN-LAEF configuration has been verified for a test period of two summer months in 2007 and compared to the 50 member ECMWF-EPS, which had a resolution of about 50km at that time. It was shown that ALADIN-LAEF is superior to ECMWF-EPS for precipitation and 10m wind forecasts in terms of probabilistic scores. Figure 4 shows the Continuous Ranked Probability Skill Score (CRPSS) for 12 hourly total precipitation, verified for the period from 15/06/2007 to 20/08/2007. The CRPSS is defined such that a skill of 1 represents a perfect model and a value of 0 means that the ensemble system does not have a ‘more-added’ value compared to a reference model. In the results presented, the operational deterministic model of ZAMG is used as reference, so positive values indicate a ‘more-added’ value of the ensemble systems with respect to the operational deterministic model. It is shown that ALADIN-LAEF system (BBSM in Fig. 4) is superior to ECMWF-EPS for precipitation forecasts up to 42 hours and both ensemble systems ‘add value’ to the deterministic model.

Conclusion

ALADIN-LAEF is a powerful limited area ensemble system especially designed for probabilistic mesoscale short-range forecasts. The sophisticated method to generate initial perturbations, as well as the use of different model configurations to account for uncertainties in the model itself, leads to skilful probabilistic forecasts. ALADIN-LAEF has a ‘more-added’ value on the mesoscale, especially in short forecast ranges up to 36h compared to global EPS-systems.

Florian Weidle
ZAMG Austria

References


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Figure 2
LAEF Domain and topography

Figure 3a

Figure 3b

Figure 4
Continuous Ranked Probability Skill Score of ALADIN-LAEF (BBSM) and ECMWF-EPS of 12 hourly Total Precipitation.
Contributions to the GLAMEPS Project at the Royal Meteorological Institute of Belgium (RMIB)

Introduction

GLAMEPS (Grand Limited Area Model Ensemble Prediction System) is a pre-operational ensemble prediction system for short-range probabilistic forecasts. It is being developed in close collaboration between members of the ALADIN and HIRLAM consortia as a European scale, multi-model EPS at a resolution of about 13 km and with a lead time of 42 hours. At the RMIB the ALADIN group participates actively in the development of the ALADIN EPS (AladEPS) component of GLAMEPS.

In section two we briefly describe how GLAMEPS is currently set up, and in section three we focus on the development of the AladEPS component at the RMIB. Examples of some pre-operational GLAMEPS products are presented in section four. We conclude with a few remarks and, including prospects for future development. A detailed description and evaluation of GLAMEPS can be found in Iversen et al. (2011) (see Reference).

A Brief Description of GLAMEPS

The major objective of GLAMEPS is to build a well-calibrated ensemble for short-range numerical weather prediction across Europe by accounting for both the best set of initial conditions and for model uncertainties. To achieve this four different numerical models are combined.

The first is an ensemble of global forecasts (a control run and 12 perturbed runs). In the experimental runs studied extensively in Iversen et al. (2011), this is EuroTEPS, a version of ECMWF-EPS supplemented with singular vectors targeted specifically at Europe (developed by met.no).

These 12+1 global runs are then used as initial and 3-hourly lateral boundary conditions for three Limited Area Models (LAMs): ALADIN, HIRLAM_S and HIRLAM_K. The latter two are versions of the HIRLAM model with different cloud physics parameterization schemes. Figure 1 shows the domains on which these LAMs are run. They are not identical, because ALADIN and HIRLAM use different projections.

In practice the model data (including the global runs that are at a lower resolution) are all interpolated on a common grid. The horizontal grid resolution is about 13 km. A set of twelve ensemble perturbations are run twice a day (at 00h00 and 12h00 UTC) for each model. Considering perturbed and control forecasts for the four models the GLAMEPS system thus comprises 52 members.
A flow chart of the GLAMEPS setup is given in Figure 2. It also includes some additional components that are not discussed explicitly in this article, such as the interpolation tool GL (developed by the HIRLAM community) and the Hppv package (developed at the Spanish meteorological service) used for processing data and forecasts and for producing graphics of probabilistic forecasts.

In the GLAMEPS experiments it was shown that the EuroTEPS targeted EPS improved the spread of the ensemble over Europe. However, these experiments were run before recent improvements in the ECMWF-EPS, such as the introduction of Ensemble Data Assimilation (EDA). An upgraded EuroTEPS is being tested. Presently, the two daily runs of GLAMEPS are coupled to members of the operational ECMWF-EPS. We are still evaluating further the use of EuroTEPS using EPS.

Some Particular Issues with ALADIN

Currently, the ALADIN component is run as a downscaling of the global runs; it does not include data assimilation. However some surface fields (in particular soil moisture) issued from EuroTEPS or ECMWF-EPS are unsuitable for ALADIN because the ECMWF H-Tessel surface parametrization scheme is not fully compatible with the ISBA scheme used by ALADIN (ISBA: Interaction Soil-Biosphere-Atmosphere). So the surface fields for ALADIN are presently taken from the global analysis of the Arpège model run by Météo-France.

We are currently experimenting with replacing this Arpège surface analysis by a surface assimilation run within the GLAMEPS suite. This will also offer the possibility of perturbing the surface fields thus increasing the spread of the AladEPS.

Other ongoing work at RMIB includes new routines for production of graphical products, GRIB data and verification tools. In the future we also hope to investigate running a limited number of extra ALADIN members coupled not to ECMWF-EPS but to the Météo France global ensemble system PEARP.
Examples and Comments on Pre-Operational GLAMEPS Results

GLAMEPS products are issued twice a day to show the dispersion of forecasts every 3 hours up to 42 hours.

Mean and standard deviation fields are displayed for a few parameters: MSLP, 2m T (also TMAX and TMIN at 2m) and upper-air fields T850 and Z500. An example of two of these fields is presented in Figure 3.

Probability charts for several parameters and thresholds are produced: charts for 1-hour or 3-hours accumulated precipitation (rain/snow), 10 metre gusts and (mean) wind speed, and upper-air parameters like 925hPa wind speed. An example probability chart is shown in Figure 4.
In Iversen et al. (2011) it is shown that the multi-model setup and the higher resolution of GLAMEPS significantly improve the resolution and reliability of the ensemble compared to ECMWF-EPS. The use of Bayesian Model Averaging (BMA) for calibration is also shown to be beneficial, but it is not used in the current pre-operational system and further research is needed to make the calibration dependent on geographical location.

**Concluding Remarks**

GLAMEPS is due to become operational in 2011. Some changes that are currently being developed are:

- A slightly enlarged domain
- Dissemination of results in graphical or binary form (GRIB2 or GRIB-api)
- Extension of lead-time up to 54 hours

In a pre-operational phase, access to the experimental GLAMEPS products has been restricted to just a few users, and the feedback of forecasters at the RMIB is needed.

An important issue is the way that the ensemble forecasts will be communicated to forecasters. Maps of probability forecasts (as shown above in Figure 4) are only one way of visualizing forecasts. Other treatments and presentations may be equally important to the forecaster community so as to use the GLAMEPS output in the best way. One additional possibility to facilitate the interpretation of probability forecasts would be to associate probability forecasts to a selection of more probable weather phenomena retrieved from conceptual models.

Jean Neméghaire and Alex Deckmyn
RMIB – Belgium

Reference

High resolution NWP model in operational use in Slovenia

Janez Markošek

Introduction

The high resolution NWP model in operational use in the Slovenian Met Service is Aladin/Si with a 9.5 km horizontal grid spacing. This provides the main source of model data for the forecaster when forecasting extreme ('orange' and 'red') events, especially strong winds and heavy and/or long-lasting precipitation. The strong Bora wind event from March 2010, and the floods of Christmas 2009 and September 2010 were well forecast, and the Met Service was praised by both media and government. Aladin fields are also used as NWP input for the INCA analysis and nowcasting system. An Aladin/Si model with 4.4 km horizontal grid spacing is in is testing phase, and is planned to become operational in late spring 2011. Further improvements in extreme weather forecasting are expected. Two severe weather cases involving strong winds are presented.

Aladin/Si

The high resolution NWP model Aladin/Si with a 9.5 km horizontal grid spacing is run 4 times per day (00, 06, 12 and 18 UTC). The fields are calculated for the next 72 hours. The operational domain is shown in Figure 1.

The main characteristics of the current operational model configuration are:

- 43 vertical model levels
- linear spectral elliptic truncation (E134x127, 258*244 points, with extension zone 270*256)
- Lambert projection
- 400s time step
- initial and lateral boundary conditions from ARPEGE
- LBC coupling every 3 hours
- digital filter initialization
- no data assimilation

In addition, daily runs of the Aladin model with initial and lateral boundary conditions from ECMWF/IFS are prepared and used as backup or for additional information.

The Aladin/Si model with 4.4 km horizontal grid spacing and data assimilation is planned to be operational from late spring 2011. Currently products are computed twice a day (00 and 12 UTC). The model configuration is the same as operational except for:

- linear spectral elliptic truncation (E224x215, 439*421 points, with extension zone 450*432)
- 180s time step
- domain is smaller
- data assimilation cycle is in preparation

Figure 1
Operational Aladin/Si 9.5 km domain
The INCA analysis and nowcasting system is in operational use at the Slovenian Met Service as a tool for nowcasting and very short range forecasts. The main characteristics of the INCA are:

- resolution 1 x 1 km, 401x301 points
- NWP input: Aladin/Si fields
- observations: temperature, humidity, wind and precipitation from AMS, SYNOP and radar measurements
- nowcasting initiated from the analysis and converging to NWP model after 12 hours
- temperature, humidity, wind and several convective indices are updated hourly
- precipitation type, rain and snow rate products are updated every half an hour.

### Case Study of an Extreme Bora Wind

In the late Winter of 2010, Slovenia experienced extreme weather, with a strong Bora wind blowing in the SW part of the country. The highest wind gusts were measured by road weather stations on the motorway passing the Vipava valley. On Wednesday 10th March, the maximum wind speed exceeded 187 km/h.

The main reason for such devastating wind was the air pressure difference between a high pressure area over Middle Europe and a low pressure area, which was moving from the Northern Mediterranean eastwards, passing the Northern Adriatic region on 10th of March.

The operational Aladin/Si NWP model predicted maximum wind gusts of more than 180 km/h in the SW part of Slovenia on the morning of the 10th March, as shown in Figure 2.

The model run which calculated the wind field showed in Figure 2 was from 00UTC on the 10th March. However, previous model runs also predicted nearly the same wind field. The operational forecaster could issue a severe weather warning to Civil Protection authorities and media in good time. There was a press conference a day before the maximum wind speeds occurred. The Meteoalarm code was set to ‘red’ for SW part of the country.

![Aladin/Si model wind gusts (km/h) over Slovenia valid for 10th of March 08 UTC](image)

### Aladin/SI 9.5 versus Aladin/SI 4.4 – Case Study of an Extreme Event

Some severe weather events can cause damage across a relatively small area. With the current resolution of the operational Aladin/Si model these localised phenomena are often not resolved and forecasters have to rely on their experience. It is expected that with higher model resolution (Aladin/Si 4.4 km) forecasters will get a better tool for detecting some severe weather situations. One such case is the so called Tramontana (meaning ‘from the mountains’) wind (NNW-N), which usually has just a few strong wind gusts and sometimes causes damage in the coastal region of Slovenia.

One such case was on the 30th August 2010. A cold front passed through the Nothern Adriatic region early in the afternoon. Usually before the passage of the cold front moderate winds from S to SE are
blowing. In the majority of cases at and after the passage of cold front a Bora wind (NE) starts to blow. This Bora wind can be moderate or strong. But sometimes at the passage of cold front for short time the Tramontana wind with its few strong gusts can cause damage in the coastal region.

In this case Aladin/Si 9.5 failed to predict the Tramontana wind (Figure 3), but Aladin/Si 4.4 forecast it well (Figure 4).

The verification shows, that in this case the Tramontana wind really occurred. In Figure 5 and Figure 6 the wind speed and wind direction in the port of Koper are shown.
Conclusion

Aladin/Si is the main high resolution NWP model in operational use in Slovenia. Following the operational implementation of the Aladin/Si 4.4 km horizontal grid spacing NWP model, better severe weather forecasts for small areas of impact are expected. But even at present, the predicted wind fields are quite good, especially for the main winds which may cause damage in Slovenia. Precipitation amount are also well predicted. This was the case in last two flood events, which affected many parts of the country, the details of which are not presented here.

Figure 5
Maximum wind speed (m/s) in the port of Koper on 30th Aug 2010

Figure 6
Wind direction in the port of Koper on 30th Aug 2010
The Hellenic National Meteorological Service (HNMS) is responsible for providing meteorological support to the state, the military as well as to the Greek public in order to protect human life and property, and to support the national economy. To this end, HNMS operates two high-resolution Numerical Weather Prediction (NWP) systems - COSMO-GR and SKIRON/Eta - which provide detailed deterministic forecasts for an extended area around Greece on a daily basis.

Both NWP models are well-known and widely used by various meteorological services, universities and research institutes around the world. In addition, grid-based forecast and analysis data are received daily from the ECMWF Integrated Forecasting System (IFS). The outputs from all the NWP models are combined with radar, observation and satellite network data to provide the HNMS staff with a plethora of tools to assist their work.

The Regional Weather Forecasting System SKIRON/Eta was developed by the Atmospheric Modelling and Weather Forecasting Group of the University of Athens (Kallos, 1997) for operational use at HNMS. It is based on the NCEP/Eta model (Janjic, 1994), which was originally developed at the University of Belgrade. SKIRON is a full physics atmospheric model with several unique capabilities that make it appropriate for regional/mesoscale simulations in regions with highly variable physiographic characteristics. It has the unique capability to use the "step-mountain" Eta vertical coordinate and it uses non-hydrostatic dynamics. The non-hydrostatic model appears to be computationally robust at all resolutions and efficient in NWP applications (Janjic et al., 2001). Sophisticated parameterizations are utilized in order to represent the various physical processes such as radiation, convection, grid-scale precipitation and clouds, boundary layer and soil processes. The operational domain of SKIRON/Eta at HNMS is 26N-56N, 20W-40E with a spatial resolution of 0.06o (~6-7km). (FIG. 1)

The limited-area model COSMO-GR (formerly known as LM) is based on the Lokal-Modell (LM) (Steppeler et al., 2003) of DWD (Deutscher Wetterdienst). It is based on the primitive hydro-thermodynamical equations describing compressible non-hydrostatic flow in a moist atmosphere without any scale approximations.

Over the last decade, the non-hydrostatic numerical weather prediction model COSMO-GR has evolved into one of the main tools used by HNMS to create localized forecasts. During this period, the COSMO model has undergone significant developments within the operational framework of the COSMO Consortium which includes the national meteorological services of Germany, Greece, Italy, Switzerland, Poland, Russia and Romania as well as numerous European universities and research institutes.

The operational domain of COSMO-GR covers an area with a longitude range of 45o and a latitude range of 24.5o with a horizontal resolution of 0.0625o (~7km) Observations are also assimilated.
employing a nudging analysis scheme (Schraff, 2003).

In parallel, through a technique based on a one-way nesting method, COSMO-GR is running over the wider area of Greece with a horizontal grid of 0.02o (~2 Km). (COSMO_GR-2) (FIG 2.) The results have been systematically evaluated as the model has approached operational use (Andreadis T. et al, 2010).

Both models use initial and 3-hourly lateral boundary conditions from ECMWF (at 0.25x0.25o resolution). They are integrated on an IBM HPC Cluster 1600. Each computing node of the system is an IBM pSeries 655 with 8-way 1.7GHz Power4 central processing units and 16GB of memory interconnected with IBM’s High Performance Switch (HPS 7045). The models run twice a day (00h and 12h analysis) with a forecast horizon of 72 hours (Table 1).

In order to determine the quality of the NWP products of COSMO-GR, SKIRON/Eta and to gain insight into their accuracy and usefulness, a verification process is essential. Through verification, one can monitor, compare and improve the quality of the forecasting systems. At HNMS, a versatile, automated verification system was developed and has been in operation since the end of 2006 in order to provide objective statistics for the performance of the different NWP models. The forecast values of weather parameters are compared with synoptic meteorological data from the HNMS’s operational network of stations, and a range of statistical scores is calculated on a daily, monthly and yearly basis. (Gofa et al, 2008)

HNMS is responsible for the dissemination (via SafetyNet®) of Weather and Sea Bulletins for Shipping and Warnings for the Mediterranean Sea and the Black Sea. The Hellenic Navy Hydrographic Service is responsible for NAVTEX–MSI broadcasts which include the above mentioned meteorological information.

HNMS provides Weather and Sea Bulletins for Shipping and Warnings for the Eastern Mediterranean Sea and the Black Sea, for 36 forecast regions (FIG.3).

A wave model (WAM) (an ECMWF program calculating wave height and direction) is run, using a 24-hour

<table>
<thead>
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<th>TABLE 1: High resolution NWP models at HNMS</th>
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analysis from ECMWF (every 6 hours) and a 48-hour forecast from COSMO-GR_7 (every 3 hours). It produces 0.04° output over the entire Mediterranean Sea. We use 00h and 12h runs (FIG4).

P. Giannopoulos

References:

1. Andreadis T. et al, 2010: Towards very high resolution numerical weather prediction at HNMS with COSMO.GR model, 10th Comecap 2009
3. Scrimizeas P. 2010: Numerical Weather Prediction Activities at HNMS. 17th SRWNP meeting
High resolution NWP model in operational use in Croatia
Stjepan Ivatek Šahdan, Zoran Vakula
Meteorological and Hydrological Service, Croatia

Introduction

In the Meteorological and Hydrological Service of Croatia, a version of the ALADIN model is operationally run twice a day, at 00 and 12 UTC. Coupling files are retrieved from the global model ARPEGE (Meteo-France) with 3 hours frequency. The operational suite has been unchanged since February 2008, though some testing of new versions has been done.

Model results are used for warnings and short range forecasts and are comparable with results from ECMWF and DWD models. Comparison with observations is made for each model runs.

Some model results are visible on www.meteo.hr.

Model Resolutions

- **8 km** horizontal resolution - main integration domain:
  - 37 levels in the vertical, 229x205 (240x216) grid points,
  - Corners: SW (36.18,3.90), NE (50.68,26.90),
  - AL32T3 – ALARO-3MT version with old radiation scheme (Geleyn-Hollingworth)
  - 72 hrs forecast range with 1 or 3 hrs temporal resolution depending on product type.
  - Digital Filter Initialisation.

- **2 km** horizontal resolution - high resolution dynamical adaptation domain:
  - 10 m mean wind and wind gust forecast,
  - 15 levels in the vertical, 439x439 (450x450) grid points.

Dynamical adaptation is run sequentially for each output file, with 3 hour intervals. In the dynamical adaptation, meteorological fields are first interpolated from the input 8-km resolution to the dynamical adaptation 2-km resolution. The same file is used as an initial file and as a coupling file that contains boundary conditions for the model.

Tests of the New Versions

ALADIN 35T1 was ported onto our systems and tested. Unfortunately the verification scores for a 6 month period (June to November 2009) for ALARO+3MT with the old (Geleyn-Hollingworth) scheme were not satisfactory for a change the operational suite.

ALADIN 36T1 (including bug fixes up to 08) has been ported and now a new test will be done with ALARO+3MT most likely with a new radiation scheme.

Figure 1
The domain of the HR NWP model in Croatia and the smaller domain for dynamical adaptation for wind
Tests with 3DVar+CANARI with version 35T1 are promising, though there were still some small problems with T2m and RH2m forecasts in July 2010. It is not clear if this a problem with assimilation or, more likely, with soil parameterisation.

**Main Computer, Storage System and Lines**

**Computer**
- SGI Altix LSB-3700 BX2 Server with 48 Intel Itanium2 CPUs 1.6GHz/6Mb
- 96 Gb standard system memory,
- 2x146 Gb/10Krpm SCSI disk drive,
- 1.6 Tb disk array,
- OS SUSE Linux Enterprise Server 9 for IPF with SGI Package,
- Intel Fortran compiler version 9.0.031 & C++ compiler version 9.1.053,
- Queuing system (PBS Pro).

**Storage system**
- 32Tb disk array - data available immediately for scp or ftp,
- 30TB online on tapes available in reasonable time (usually less than minute),
- and there is no limits for offline storage capacity.

**LBC files and lines**
- global model ARPEGE, coupling frequency 3 hrs,
- Internet and RMDCN through ecgate as backup from July 2006.

**Visualisation**

Visualisation of numerous meteorological fields is done via LINUX PC. Comparison of forecasts with SYNOP and automatic station data are done hourly for today’s and yesterday’s forecasts.

The products are made available on the Intranet & Internet. Internet addresses for some of the ALADIN products are:
- total precipitation and 10 m wind:
  http://prognoza.hr/karte_e.php?id=aladin&param=&it=
- meteograms:
  http://prognoza.hr/nauticari_e.php?id=nauticari
- icons of weather and winds with minimum and maximum temperature:
  http://prognoza.hr/tri_karta_e.php?id=tri&param=Zagrebacka&code=Zagreb_Maksimir
Operational use of AROME at Météo-France

Introduction

The operational use of a high-resolution model in Météo-France started in October 2008 with the AROME (Applications de la Recherche à l’Opérationnel à Meso-Echelle) model. An upgraded version (V2) began in April 2010 and further developments for the next version (V3) are already planned.

An important plan to train forecasters was developed before the introduction of AROME. The forecasters were advised to first use the global model to get information on the synoptic context and the forcing, and then the high-resolution model can give useful information on the final parameters and mesoscale features. This concept will be illustrated by an example of a convective situation over France.

In addition to objective measures, a subjective assessment of the model is made by regional and national forecasters. This subjective measures, based on identification of meteorological ‘issues’, results in a progressive increase in understanding of the model by forecasters and a better knowledge of its strengths and weaknesses.

Finally a meeting took place in Toulouse during February 2009 between forecasters and model researchers to draw up a balance sheet of these two first years of model operational use.

Recent AROME version and future developments

Global Overview of the Météo-France Forecasting System

The global model ARPEGE is run every six hours (102 hours forecast) with a coupled regional model ALADIN (54 hours forecast) and a high resolution model AROME (30 hours forecast). The main characteristics of these models are detailed in Figure 1.

Recent developments of AROME

Version 2 of AROME has been operational since 6 April 2010. One major difference from version 1 is the fact that AROME is now directly coupled to the global model ARPEGE, and no longer to the regional model ALADIN. The main reason for this change is the fact that the resolution of ARPEGE over France is now 10 km (not far from the ALADIN resolution of 7.5 km) and the simplification of the operational computational process with a 15 minutes gain of time in AROME availability.

Figure 1
Operational models running at Météo-France
This change has a neutral or positive impact on model performance as measured by verification scores.

Another difference between V1 to V2 is the increase of vertical resolution from 41 levels to 60 levels. The added levels are situated mainly at low levels: the first level is now at 10m in V2 compared to 17m in V1. 27 levels are implemented below 3000m in V2, compared to 15 in V1 (see Figure 2).

Reflectivity Assimilation in V2

Radar reflectivity cannot be assimilated directly by the model. The process used consists of turning reflectivity into a specific humidity increment: an increase in case of precipitation observed but not forecast, or a decrease in case of precipitation forecast but not observed.

In the example of 8th October 2008, AROME - without reflectivity assimilation - missed the squall line in the South-East of France. With reflectivity assimilation, a positive increment of specific humidity is added in the area of precipitation at 06 UTC (see the orange ellipse in Figure 3) which enables the model to generate a strong squall line of bow-echo type three hours later.

Future developments of AROME (V3)

A strong requirement from forecasters is to enlarge the domain in order to better anticipate and describe perturbations coming from the south and west of France. Figure 4 shows the future enlarged domain, increased in area by 70%.

The next version of AROME will also add hail in the microphysics transformation (see figure 5). That should help the difficult forecast of hail reaching the ground in thunderstorm situations, and should also improve the simulated radar reflectivity of the current model which can’t reach the highest values observed in the radar network in the case of melting hail in clouds.

Evolution of statistical cloud scheme in AROME

The description of the subgrid variability in cloud cover is given by a probability function which depends on the intensity of turbulence. In some cases with stable and cold atmosphere, there is currently an underestimation of low cloud cover when the relative humidity is high. To correct this default, another term will be added in the equation of
nebulosity which depends on a critical moisture profile. This change was suggested by a study of Wim de Roy from Netherlands (Hirlam Newsletter November 2010 page 21-29). Figure 6 below shows the positive impact of this change in the red ellipse for the example of 13 May 2008.

Example of AROME Outputs in a Convective Situation

The synoptic context of 13th May 2009 is summarized by the ANASYG graphic chart in Figure 7 which includes both surface and upper-air features.

A strong south-westerly flow at altitude from Spain to France is indicated by the jet with diffluence at the exit. An active PV anomaly in upper levels interacts with warm air in low levels and produces an area of deep convection in the South-West of France. After this synoptic analysis of the situation, the question for the forecaster is to qualify the severity of the convection. If severe and organized convection is expected, then warnings are required. Aid to answering to this question can be found in AROME forecast reflectivity (see Figure 8).
where strong thunderstorm cells move quickly from the Gulf of Biscayyean across the South-West of France. Notice that each successive run of AROME before and after the 18 UTC run forecast the same type of convection, so this kind of poor man ensemble prediction provides a good confidence for the occurrence of heavy thunderstorms.

The comparison of the forecast reflectivity with the radar observed reflectivity (see Fig 9) shows a quite realistic forecast in spite of some delay in the convection starting up. There is also an under-estimation of reflectivity intensity, which can be explained by the lack of hail in the model’s microphysics, so the simulated reflectivity can’t reach the highest intensity observed in case of melting hail in thunderstorms.

The 18 UTC run of AROME simulated the same shaped bow echo as observed at 02h30 UTC north-east of Bordeaux, where observations reported hail and very strong gusts (see Figure 10). The forecaster, with the knowledge of the conceptual model of bow echo which is a very active type of squall line, had therefore a strong argument for issuing warnings in the area.

This situation is a good example of the value added by AROME to global models in the description and behaviour of the convection: it

**Figure 7**
ANASYG 06 UTC 2009/05/13

**Figure 8**
Forecast reflectivity by AROME run 2009/05/12 18 UTC

**Figure 9**
Observed reflectivity on 2009/05/12
suggested fast moving thunderstorms cells and possible organization of a bow echo – a very active type of severe convection – and was very helpful to the process of issuing warnings.

AROME Verification

Objective Measures
As with any operational model, AROME is monitored using objective performance measures. Specific tests like “Brier Scores” are performed to avoid the double penalty effect which could affect high resolution forecast when the area of highest values observed are correctly forecast but often shifted from their actual position.

For example, these measures show a positive contribution of AROME compared to ALADIN for the summer convection and for convective cloud coverage.

Subjective Assessments
A very important subjective assessment is made in each of the seven meteorological regions and in the central office forecast in Toulouse. This is based on the concept of ‘meteorological issue’ of the day. This means that each day the forecaster focuses on what is interesting in the situation from a forecast point of view. A wide range of issues are available: fog, low clouds, breezes or local winds, synoptic or regional winds, snow, frontal structure, orographic structure, organization of convection, etc. The chosen issue is entered in a database via a web interface and the assessment of the accuracy of the forecast in relation to the selected issue is done by another forecaster afterwards.

For each issue entered in the database, the forecaster must specify his degree of confidence in the forecast of AROME. The confidence scale ranges from very good to very low through “I do not know”. Comparing the distribution of trust between the periods October 2008-March 2009 and May 2009-April 2010 shows a significant decrease in the proportion of “I do not know” responses. This indicates that the forecasters are gaining a better knowledge of the characteristics, strengths and weaknesses of the models.

Examples of subjective control results
The database allows to determine the proportion of good forecast and false alert for various parameters (see figure 11). It gives useful informations on the impact of model changes from the forecaster point of vue. It is for example interesting to notice that the major changes in AROME in April 2010 have resulted in a decrease in false alerts according to forecasters.
The database is sufficiently detailed to investigate certain meteorological issues rather finely.

For convection, spacial shift based on the type of convection, time lag for the beginning and end of convection can be analyzed. For low-level phenomena, the error in areas affected by fog or low clouds, start and dissipation of fog can be analyzed.

Figure 12 beside shows the results for spatial shift of convection: three out of four, convection is properly seated near 150 km.

Conclusion

Analysis of the two last years of operational running of AROME confirms a positive use of the model by forecasters. Convincing results come from the forecasts for convection. Both objective and subjective measures show good behaviour of the model when forecasting convective storms. AROME gives good information on the type of convection and risks including heavy precipitation, while the number of false alerts remain rather low. However, there is sometimes some inconsistency between successive runs with illusory details in convection organization. Subjective measures are an important element contributing to a better use of the model by forecasters. They also provide useful feedback to researchers on the model behaviour: for instance, the improvement in V2 AROME for fog and low cloud forecasts has been notice by forecasters although it is more difficult to identify using objective measures.

Bernard Roulet
Meteo France

References


Experiences with Harmonie at KNMI Wim de Rooy, Cisco de Bruijn, Sander Tijm, Roel Neggers, Pier Siebesma, Jan Barkmeijer hirlam newsletter n°56 november 2010
Model Verification and Its Relevance for Forecasters

André-Charles Letestu, MeteoSwiss

Introduction

Whilst numerical models are becoming more accurate and numerous, weather forecasters are becoming increasingly confused faced with so much information. Which model to trust in which meteorological situation?

It is difficult for the forecaster to know the strengths and weaknesses of all the models. The interaction between forecaster and modeller could still be improved. A good model skill doesn’t have the same meaning for a forecaster or a modeller; the actual model verification is performed over long periods or averaged over large areas. This only provides general global information, but doesn’t meet the specific needs of the forecaster. The forecaster would like to know specifically when to trust the accuracy of the model.

As a part of the project COST733, an evaluation of the different weather types was made by looking at the ability to represent different precipitation patterns in the Alpine domain. For verification purposes we are more interested in differentiating weather classes where the models have difficulties from those where it performs well.

History

Back in 1987, the sources of information were much fewer. In Switzerland, the forecasters had access to only one model (ECMWF). In those days, the horizontal resolution was about 200 km. The representation for the Alps within the model was very rough. A large bell-shaped orography contained the Alps, Jura and Massif Central without differentiation. The forecaster needed a good knowledge of the climateology of the region as well as the understanding of the weaknesses of the model. Nowadays, the output of the model is so detailed that it is difficult for the end user to form his opinion objectively.

Available verification

Fig 1 shows examples of model verification available in Switzerland, issued on a regular basis. Fig 1a represents the mean error over Europe of the surface pressure between the model COSMO 7 and the SYNOP observation for the Spring season. Fig 1b shows the bias and the standard deviation of the model COSMO 7 compared to the Payerne ascent and averaged over one season (Spring).

Figure 1
Systematic verification of the COSMO7 model. 1a: Pressure surface verification (mean error) comparison with SYNOP data for Spring 2010. 1b: Upper air verification (temperature), comparison with Payerne ascent (00z and 12z) for Spring 2010.
Although the verification is very useful for the monitoring of model skill, for the forecaster, very little relevant information can be extracted. In the case of the surface pressure verification, the verification period is far too long and the information is difficult to extract. For the upper-air verification, only the systematic errors can be pointed out.

**Stratification by weather type**

Following the above remarks, the forecaster needs a type of verification which allows him to criticise objectively the model output. Stratification by weather type is one way to achieve this.

**Models**

The verification presented below is based on the COSMO-7 local model. Switzerland is a participating member of the COSMO (Consortium for Small scale Modelling) and has developed two fine-mesh models, COSMO-7 and COSMO-2. Along with the IFS model, they are the most widely used by forecasters in Switzerland.

Briefly, the main features of both models are:

**COSMO-7:**
- Grid length: 6.6 km
- Vertical levels: 60
- Outputs: 3 daily: 00z, 06z and 12z.
- Forecast duration: 72 h
- Boundary conditions: ECMWF
- Own assimilation: Nudging

**COSMO 2:**
- Grid length: 2.2 km
- Vertical levels:
- Outputs: 8 daily: 00z, 03z, 06z, 09z, 12z, 15z, 18z, and 21z.
- Forecast duration: 24 h except for the 03z run up to 36h.
- Boundary conditions: COSMO 7
- Own assimilation: Nudging, radar assimilation

**Stratification by weather type**

Different methods of classification are currently used at MeteoSwiss, many of which are used to recover old weather situations in order to perform a similarity analysis. For the purpose of analysing the model’s performance, a simpler and automatic classification must be used. Since 2002, weather situations have been analysed according to the main flow. Two classes are defined; advective and convective based on the 500 hPa wind. The advective cases are classified according to the direction of the flux in steps of 45 degrees; the convective cases are catalogued according to 3 classes: high, low, and flat corresponding to the surface pressure pattern. Until 2008, the classification was performed manually; since 2009, an automatic method has been used. The results of the two methods are very consistent even if the automatic method shows more northerly flow and fewer high pressure situations.

**Fuzzy verification method**

Very often, verification methods spoil the skill of fine mesh models; the precipitation could be shifted either in time or in space. Globally, the rain could be well forecast but may arise too early or too late.

The idea of the fuzzy verification method (E. Ebert, 2008) is to compare forecast and observations over a square (window) containing a defined number of grid points and a chosen threshold. This window is displaced over the model area and a skill score is calculated. By varying the size of the window and the threshold, a neighbourhood plot containing the skill can be drawn with the threshold in abscises and spatial scale in ordinate (fig. 2). It shows if the model is better for high or low thresholds, respectively small or larger scale. The same plot can be used by subtracting the skill of two models (i.e COSMO-7 and COSMO-2). The

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**Figure 2**

How to read a neighborhood plot
result will point out where a model is better than another. In case of different grid lengths, the spatial scale has to be adjusted between the two (Weusthoff et al. 2010).

**Scores**

Two skill scores are generally used in fuzzy verification; Upscaling (Zepeda-Arce et al. 2000) and the Fraction Skill Score (Roberts & Lean 2005). The results presented here are performed using the fraction skill score.

This score is defined thus: within the window defined above, the fraction of the observation and the model output data exceeding the threshold value over all the grid points within the window are computed. The Fraction Skill Score (FSS) is defined as the ratio between the two. The FSS is ideally suited for considering the overall performance of a model. The zero value corresponds to a mismatch and 1 to a perfect match.

**Results for 2009**

The stratified verification of the model was performed for precipitation by comparing model data and radar accumulated data. The data set has been chosen as follows:

For the COSMO data, the 3 hour accumulated precipitation for the lead-times +04h and +07h: 00z and 12z runs for COSMO7 and the 00z, 03z, 06z, 09z, 12z, 15z, 18z, 21z runs for COSMO2 have been used.

Three hour accumulation data from the Swiss Composite radar (NASS) have been used as precipitation observations. In the case of missing data, the whole day was omitted (26 days).

Fig 3 shows the result of the stratified verification for the year 2009. The difference between COSMO7 and COSMO2 has been displayed in order to show in which situation, for which threshold or for which scale one model is better than another. One grid point of COSMO7 corresponds to three grid points of COSMO2. Focusing on high pressure situations (H), COSMO2 is clearly better than COSMO7 especially for low threshold and small scales. The details for a north-westerly situation (fig 4) show that for the two models, the skill is better for low threshold and large scale, but the difference between the two shows that COSMO2 is better for the 10 mm/3h threshold.

Switzerland being a mountainous country, it is also interesting to know spatially where a model is good and in which situation. Fig 5 shows for one year, the average distribution of precipitation predicted by the model (COSMO7) for a given situation. By comparing with the radar data reported on the same grid, the differences point out the area where the skills of the model are the least accurate.
Guidelines

Regularly, modellers issue fact sheets in which they describe the weaknesses and the strengths of the models for the last season. They also issue guidelines in order to help forecasters to use the model appropriately. Although the reading is very enlightening, many soft links are included in the text, and it is also very detailed. The forecaster has to search for the information. During a shift, this information should be easy to access.

Following a meeting of COST in Geneva, June 2010, a list of recommendations concerning the guidelines was issued:

- The guidelines should be self-contained (without links).
- They could look like a manual, for example for the use of a parameter or for the treatment of a specific situation.
- A ‘light’ version could be at the disposal of the forecaster on duty (usually under time constraints), while a longer version could be studied offline.
- This longer version could be used as an education tool for newcomers.
- The shorter version could be implemented as a seasonal factsheet.
- The seasonal factsheets should include (if possible) the expected changes of the current model version with respect to the version which was running the previous season.
- Generally speaking the guidelines should be short, attractive and meaningful.

The forecaster should also be part of the process by:

- Providing forecaster feedback organized either by mailbox, a forum or regular discussions.
- At the end of each season a debriefing could be organized and a synopsis written. This could form a good base for the following corresponding season.

Some suggestions that would be an aid to forecasters

Day to day verification

At the end of each day, plots similar to fig 5 could be produced for rainfall and sunshine comparing the different runs of the models with respective rainfall accumulated data from the radar, and the sunshine data derived from satellites.

Synthetic map

The map (fig 6) represents another way to summarize the skill of a model especially in mountainous regions. The patchwork of colors show the climatological regions, the letters the direction of the flow and the + or – signs the indication whether the model has over or under estimated the rainfall for the given situation. A similar chart could be produced for sunshine or other parameters.

Advice

To avoid having to extract relevant information from amongst comprehensive guidelines, a short text could be inserted next to each forecast parameter.
This information would describe the skill of the model for the specific parameter, the present weather situation and the actual season. For example: “northerly flow, the model tends to overestimate precipitation along the northerly side of the Alps”.

**Conclusions**

With the multiplicity of models and their fast-growing evolution, it is sometimes difficult for the forecaster to have an objective opinion regarding quality and choice. A good or a bad experience concerning the model can influence one’s choice (Gaia, 2007).

Verification issued by the modelers are very often not precise enough to be used as guidelines. The verification is carried out to analyze the general skill of the model over a large area or a very long time. The crucial question for the forecaster is this: where and under which conditions the chosen model is most effective, and which corrections need to be applied? The verification is not easy to access especially when under stressful shift conditions. Updates of models are also frequent; minor updates occur a few times a year often confusing the user. For instance a model could, over a short interval, overestimate and/or underestimate the convection.

The forecaster is also interested in how different models evolve synoptic patterns. For instance, are there some models which are better than others in forecasting the end of an omega block? Do some models produce more cut-offs than others?

In this article some verification ideas have been suggested:

- A day to day verification, in order to see the skill of the model at a glance whilst the recollection of the situation is still fresh.
- The guidance should be easily accessed, such as short text on the side of the browser.
- A synthetic map should summarize the skill of a parameter by region and by season.

**References**

The Gordon Bennett Cup is the world’s oldest and most prestigious gas balloon race. The first competition started in Paris on September 30th 1906. The event was sponsored by James Gordon Bennett Jr., millionaire, sportsman and owner of the New York Herald newspaper.

The rule is simply to fly as far away from the launch site as possible. The contest was organized almost every year before World War II except during World War I. The resurrection of the race took place in Paris in 1983 starting from the “Tuileries Garden”. The winner travelled a distance of 690 km. In 2010 the race started from Bristol, United Kingdom.

As this 54th Gordon Bennett race started from England, it was important to have a wind direction not going towards the open ocean. Fortunately the starting period 25.09-02.10.2010 was well-chosen and a northwesterly wind was forecast with a tendency to turn westerly during the flight window. For the race, the ‘Maximum distance’ therefore meant the greatest distance from Bristol towards eastern Europe in a contest area limited by the organizers. After take-off a northerly wind brought the competitors southwards in the direction of Bordeaux in France.

The French team – with headquarters in Nancy and comprising four persons – proposed to take a more southerly track to avoid the “Tramontane” wind east of Toulouse. For safety reasons in case of an emergency landing, the pilots wished to avoid strong surface winds with a speed of locally more than 20G30kts generated by the blocking of the Pyrenees.
Balloon FR 1 landed in safe conditions in northern Spain after 1122km. The landing took place on the 27th at around 0800hrs with no more than 5 kts and few clouds. The crossing of the Mediterranean Sea was not scheduled with that balloon.

Balloon FR2 crossed the Pyrenees as well, in the direction of Sardinia. Then the intention was to cross Italy and if possible reach the Bulgarian Black Sea coast. It was very important to avoid the large unstable area extending from Tunisia towards Albania and Greece. On the other hand a certain amount of instability was forecast for northern Italy. The idea was to navigate in between these two unstable areas with the possibility of landing at the Bulgarian coast. The option of flying to the Greek Peloponnese (the greatest possible distance) was rapidly abandoned due to unstable weather conditions in the whole southern part of the Mediterranean Sea.

The wind speed forecast for the 28th was around 20-30kts at an altitude of 3000m in the direction of Sardinia and Italy. Italian air traffic regulations do not permit VFR flights to cross land areas during the night. So the tactic of the coordination team was to arrive at the Sardinian coast at noon crossing Sardinia in the afternoon, and to reach Italy on the morning of the 28th, after that crossing the Italian territory during the day. During the 27th of September thunderstorm activity in the whole south Mediterranean was increasing and extending to Sicily and Calabria. To avoid the forecast thunderstorm activity between Bari and Tirana (Albania) it was planned to use the southwesterly winds at 3000m over Italy. While crossing Sardinia the western part of the mountain range has an altitude of about 4000-5000ft. A cruising altitude between 7000 and 9000 ft seemed to be sufficient to avoid the turbulence created on the lee side of the mountain range. But suddenly, after having crossed the mountains, the balloon came into the downdraft of a lee rotor. The altitude of the balloon decreased rapidly down to only 500ft and the balloon began moving in a westerly direction. To get the cruising altitude back, the pilots had to jettison 30-40kg of sand, hoping not to waste too much time to get back to about 8000ft to reach the 25kts wind. It was vital to get out of the Italian territory before sunset. After some long minutes the GPS tracker information from inside the balloon arrived at the Bristol headquarters. The news was good, and there had been only five minutes left before disqualification.
During the following night, the sky was cloudy and temporarily overcast with some occasional light rain. The balloon had to go low to use lower wind speeds in order to avoid reaching the Italian coast before the legal time in the morning. The pilots therefore did not have the option to fly at 3000m over the rain area. To compensate for the weight of the water some more ballast had to be dropped. The consequence was that future options were reduced once more; it was now impossible to reach the scheduled landing places in Bulgaria. The remaining ballast permitted flight only as far as Serbia. For security reasons (Serbia has not cleared all the landmine fields) the pilots decided to land in Italy near Salerno on the 28th after a distance of 1805 km from the starting place. At 0700 hrs in the morning, after 55 hrs 53’ minutes, the total flight distance was 2498 km. This was far enough to achieve 4th position in the final result.

Conclusion

The choice of the southerly route had the advantage that the greatest distance was possible over northern Albania to the south easterly Bulgarian border.

The gas balloon is extremely sensitive to convective weather. Thunderstorm activity was very intensive in the south Mediterranean Sea as well as in northern Italy. Stronger convection was forecast over Serbia after the 29th of September. On the other hand the ballast necessary for flying the distance to the Black Sea had been used to compensate the rotor over Sardinia.

The trajectory forecast using the HYSPLIT model from the 25th to the 29th was very accurate. The Gordon Bennett race is one of the most challenging competitions due to the long distance a number of meteorological phenomena which may be encountered en route. The combination of air traffic rules, the flying of the balloon and the weather conditions require a maximum of competence from the pilots and the whole team on the ground.

Final results

Logistic Team in Nancy

Christophe Houver, coordination and communication;
Jacques Llopis, air law regulation;
Simon Pelard, trajectories;
Claude Sales, meteorology.

Claude Sales
Head of the Luxembourg Metoffice